# EVALUATION OF VIBROTACTILE ALERT SYSTEMS FOR SUPPORTING HAZARD AWARENESS AND SAFETY OF DISTRACTED PEDESTRIANS

A Thesis

by

ANGELA CHRISTINE MARSALIA

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

| | |
|---|---|
| Chair of Committee, | Mark E. Benden |
| Committee Members, | Thomas K. Ferris |
| | Qi Zheng |
| Head of Department, | Thomas J. McDonald |

December 2013

Major Subject: Occupational Health

# ABSTRACT

There are an increasing number of motor-vehicle accidents due to distracted drivers not paying attention to their surroundings. The use of smart phones and tablets are also on the rise, which can contribute significantly to this problem. Drivers, bicyclists, and pedestrians tend to interact with these devices and become distracted, limiting their ability to see or hear approaching hazards. The purpose of this study was to determine whether vibrotactile cues are effective in improving hazard recognition and safety of distracted pedestrians. As vibrotactile alert systems, a helmet and suspenders were compared and tested on 27 college students and faculty from Texas A&M University in College Station, TX. Eight C-2 Tactors[†] by Engineering Acoustics, Inc. were placed into the displays with four distinct locations (front, back, right, and left). The STISIM Drive® driving simulator M100 system was used to measure and evaluate response times and hit rates. Each participant walked on a treadmill while hazards were presented via the driving simulator. Twelve trials were performed by each participant at approximately three minutes each, for a total of 2 hours in one day.

Results showed that having no display present was significantly different than having a vibrotactile display present (p = .007), while suspenders display was not significantly different from the helmet display present. Repeated – measures (within – subjects) ANOVA models and post – hoc pairwise comparison tests showed that hit rates and response times had significant effects. Qualitative results showed that there were more participants who preferred having suspenders while walking as a pedestrian. Mixed – effects ordinal regression models showed that both displays also influenced the participants’ ratings (relative to no display) of performance, effectiveness, accuracy, comfortableness, and mental effort in a significant way. The average hit rates increased and response times got faster when participants had a display present, as expected. These results show a positive outlook for the future involving the effective use of vibrotactile alert systems. Fatalities involving distracted drivers and pedestrians from collisions are prevented and eliminated with the presence of these displays.

## ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Mark Benden, and my committee member, Dr. Thomas Ferris and Dr. Qi Zheng, for their guidance, support, and teaching throughout the course of this research study. I have learned a great amount from these three in the past two years and am very grateful to have had them on my committee.

Thanks also to the graduate research students working in the lab for helping me with programming and all of the technical issues. I probably couldn't have done this study without their expertise. I would also like to reach out to all of the students and faculty at Texas A&M University who were willing to participate in this study. If it weren't for them, testing could not have been done in time. I would also like to extend my gratitude to the National Institute for Occupational Health & Safety (NIOSH), which helped with the expenses, and to my family for being there for me through the touch times and for lending me a treadmill at the last minute.

TABLE OF CONTENTS

CHAPTER Page

LIST OF FIGURES

# CHAPTER I

# INTRODUCTION AND LITERATURE REVIEW

## Background

There are an increasing number of motor-vehicle accidents due to distracted drivers not paying attention to their surroundings. The use of smart phones and tablets are also on the rise, which can contribute significantly to this problem. Drivers, bicyclists, and pedestrians tend to interact with these devices and become distracted, limiting their ability to see or hear approaching hazards, such as listening to music and talking or texting on their smart phones. A case-control study evaluated associations between traffic fatalities and the use or presence of cellular phones given the involvement in a collision (Violanti, 1998). The control group consisted of drivers who were not killed in a crash (non-fatal) and the cases defined the drivers who were killed as a result of a traffic collision (fatal). Results by Violanti (1998) suggested that phone usage showed a two-fold, six-fold, and a three-fold higher risk than speed, inattention, and alcohol/drug use, respectively.

Teenage drivers are among the highest risk group for automobile crashes. In a study, researchers mailed and collected 539 complete questionnaires that evaluated teens' self-reported frequency of talking and texting on their cell phones while driving (O'Brien, Goodwin & Foss, 2010). Results showed that 79% reported talking on a cell phone while driving; 71% reported ever sending or reading a text message while driving; females were more likely to report having a friend to text a message for them; 16%, 40%, and 62% reported that it was very dangerous to talk, read a text, and sending a text while driving, respectively; and 78% were under the impression that they were not allowed to talk or text on a cell phone while driving (O'Brien et al., 2010).

There are several influences that can impact teenage driving behaviors. Driving behaviors may involve speeding, unsafe passing, tailgating, impaired driving due to drinking or fatigue, lack of wearing seat belts, in addition to failure to yield the right of way at intersections (Shope, 2006). These influences, as portrayed by Shope (2006) are the following: driving ability; developmental factors; personality factors; demographic factors; perceived environment; and the driving environment. The following three theories depicted in the study by Shope (2006) are important when addressing these influences and driving behaviors of young teenagers: 1.) Social Learning Theory is based on the fact that people behave in ways that they have learned by receiving positive reinforcement; 2.) Social Cognitive Theory applies a vital, changeable model in which behavior, personal, and environmental factors all interact with one another; and 3.) Problem Behavior Theory illustrates that while behavior is influenced by multiple factors, behaviors viewed as problems sometimes serve as educational principles. Pradhan, Simons-Morton, Lee & Klauer (2011) studied the effects on teenage novice driver behaviors involving hazard perception while performing secondary tasks, comparing before and after 12 months of driving experience. There were a combination of three secondary tasks and three hazard perception scenarios, including 1.) Hidden hazard (stop sign) and an odometer task; 2.) Hidden hazard (pedestrian) and an odometer task; 3.) Hidden hazard (pedestrian) and a texting task; and 4.) Hidden task (animal) and a cell phone task (Pradhan et al., 2011). The main finding in the Pradhan et al. (2011) study was that there was an improvement regarding hazard perception behavior among teenage novice drivers after 12 months of driving experience, however there was no progress in behavior when performing the cell phone task.

In addition to teenage driver incidents, an increasing percentage of traffic crashes involve pedestrians. A distracted pedestrian is at a greater risk than a distracted driver for accidents and crime victimization due to a reduction in situational awareness and an increase in unsafe behavior (Nasar, Hecht & Wener, 2008). Two studies were examined in this paper: 1.) Using a mobile phone and recalling objects for pedestrians; and 2.) Safety implications of using a mobile phone while walking. The following was reported by Nasar et al. (2008): results concluded that pedestrians noticed significantly more objects when they were not having a conversation on the mobile phone compared to those who were having a conversation; out of the 19% using a mobile phone, 25% listening to music on an iPod, and 56% not using either one, the safest behavior was shown in the neither group, with the higher percentage of unsafe behavior shown in those using a mobile phone. This study also agrees with findings of other studies that involved drivers with a high workload as having a lower fixation or reduced visual scanning of their surroundings.

There are many interventions that can be implemented to help reduce risks posed by cell phone usage and teenage driving. Interventions can include enforcing laws that restrict cell phone usage; education or awareness campaigns; a way of providing protective constraints to prevent careless actions, such as blocking calls or text messages; and publicizing or advertising correct norms and practices concerning the appropriate behavior towards cell phone use and driving (O'Brien et al., 2010; Shope, 2006). Other interventions suggested by Shope (2006) can involve parents setting a proper driving example; restricting nighttime driving; licensing age can be revised; sleeping needs and past behavior can also be considered when making the right recommendations; along with evaluating interventions already implemented to predict and monitor unintentional results.

The design of vehicles and roadways is a way to produce more safe and livable streets. The relationship between safety and design illustrates that drivers are interpreting and learning the potential hazards of the road environment and then adjusting their behavior in response (Dumbaugh & Gattis, 2005). This concept illustrates the balance of an individual's safety, which is the practical measure of crash performance, and security, which describes one's subjective perception of safety. A positive approach in designing a safe and livable street, as proposed by Dumbaugh & Gattis (2005) is to accommodate designs that are intended for high-speed driving behavior, in addition to alleviating hazards in the road by utilizing signs and pavement markings.

**Multiple Resource Theory & Applications**

A potential solution to the problem of distraction due to mobile devices is Multiple Resource Theory (MRT). MRT is defined as a theory that can predict human performance associated with performing multiple tasks at one time or multitasking (Wickens, 2002; Wickens, Hollands, Bradbury & Parasuraman, 2012). Since visual resources are relatively unavailable for displaying hazard information, other displays, like auditory and tactile channels are helpful. There are four distinct levels or dimensions applying this theory. First, the processing stages, involves the perception and cognition (the working memory), in addition to responding. Second, are the perceptual modalities, including visual, auditory, and tactile channels. In the case of distracted driving, if a dual-task involves both a verbal (texting or reading a message on a cell phone) and an auditory (listening to music) channel to be used, the tactile channel will then have the best advantage for presenting information regarding certain hazards on the road. Third, Wickens (2002) and Wickens et al. (2012) present processing codes depicting the analog or spatial processing between linguistic or verbal processing; manual (spatial) and voice (verbal) control responses are also involved. Fourth, the visual channels are distinguished, such as focal (foveal) vision, which is necessary for fine detail and noticing patterns; whereas, ambient (peripheral) vision is used for orienting senses, in addition to an individual's speed and direction through an environment (Wickens, 2002; Wickens et al., 2012). These four dimensions are represented in a three-dimensional cube figure and can illustrate how multiple tasks can occupy overlapping levels on a dimension, which can greatly represent any interference between the levels due to competition of resources and factors in the "resource demand" to the left and the "multiple resource conflict" to the right of the model (Wickens et al., 2012).

To present MRT, a study conducted by Elliot, van Erp, Redden & Duistermaat (2010), evaluated three field – based settings with a tactile navigation system for use in multiple operational tasks. Navigation performance was measured and compared when participants (soldiers) used a map and compass, a standard Army handheld GPS system, and a tactile GPS system (Elliot et al., 2010). There were three experiments involving the transition from a lab setting to a rough terrain setting; during the nighttime along with a secondary visual task; and the combination of the visual and tactile devices together forming a multimodal display (Elliot et al., 2010). Results of the Elliot et al.

(2010) study showed that the visual display promoted global awareness, whereas the tactile display promoted local guidance; however, it was mainly concluded that the tactile navigation display can be used in demanding environments and exceeds the performance of visual displays when high cognitive and visual workload is present.

**Introduction to Auditory, Visual & Tactile Displays**

Sonification is a form of auditory display and uses non-speech audio to interpret and visualize information. Nees & Walker concluded that non-speech audio can carry out various types of information to reduce some of the limitations set by established visual displays (2009). A 2001 study by Walker & Lane used magnitude estimation to investigate selected "data-to-display mappings, polarities, and psychophysical scaling" capacities depicting data principles to fundamental hearing specifications for blind or visually impaired listeners. There were three sets of sound stimuli used in this study, including frequency, tempo, and brightness. Participants then made theoretical magnitude estimates of the temperature, size, pressure, velocity, and number of dollars that the sounds appeared to symbolize. Despite the fact that further research in Walker & Lane's (2001) study needed to be conducted, results showed that there was a significant association between the sighted participants and the visually impaired individuals on the data polarity, the magnitude of the slopes, and the slopes that were acquired from the data-to-display mappings. Walker published another study a year later to illustrate three experiments on the magnitude estimation, including, 1.) Data dimensions (temperature, pressure, velocity, and size in experiment 1; all of those along with number of dollars in experiment 2), 2.) Display dimensions (horizontal lines, vertical lines, and solid circles in experiment 1), 3.) Pitch and perceived tempo in experiment 2, and 4.) Frequency and tempo were separated and organized by data dimension and participant in experiment 3. Results of Walker's study (2002) showed that the represented data had a significant effect on the value estimations for visual stimuli, however there was no significant linear relationship for the represented data of the sound parameter.

In relation to sound displays, a study by Hameed, Ferris, Jayaraman & Sarter (2009) researched how participants can effectively use peripheral visual and tactile cues to promote certain tasks and manage interruptions all while carrying out a challenging visual task. There was an arithmetic task and an interrupting task involved along with three notifications, consisting of a baseline visual "uninformative" cue; a peripheral vision "informative" cue; and a tactile "informative" cue (Hameed et al., 2009). Findings illustrated that both the "informative" cues resulted in higher detection rates compared to the baseline cue and it was suggested that tactile cues might be potentially valuable for tasks that require more visual demand, such as in occupations involving aviation, process control, and medicine (Hameed et al., 2009).

A meta-analysis by Elliot, Coovert, Prewett, Walvord, Saboe & Johnson (2009) found that performance improves when adding tactile cues to an existing visual cue and that tactile alerts were more effective than visual alerts; however performance did not improve when tactile directional cues were used in lieu of visual directional cues. Therefore, it is important to further define and investigate the best practices of tactile cues in more demanding environments. Multi-modal connections among auditory, vision, and touch in more complex environments were studied to distinguish how spatial performance is affected (Cholewiak & McGrath, 2006; Ferris & Sarter, 2008; Baldwin, Spence, Bliss, Brill, Wogalter, Mayhorn & Ferris, 2012). Participants were presented with visual, auditory, and tactile stimuli, in addition to three tasks involving, a high priority task, where participants had to quickly respond to stimuli as targets by pressing a button; monitor and respond to radio communications; and a low priority task, consisting of using a joystick to manually control a fixed aerial vehicle by pulling the joystick trigger (Ferris & Sarter, 2008). Results indicated that these multi-modal connections do affect performance in more complex settings and that they contrast among auditory, visual, and tactile stimuli; faster response times were illustrated for the ipsilateral auditory cued visual targets compared to un-cued targets; slower response times were shown for the ipsilateral visually cued tactile targets than un-cued tactile targets, and faster times were also presented for the contralateral tactile cueing of auditory targets (Ferris & Sarter, 2008). Cholewiak & McGrath (2006) found that performance was better for the unimodal condition, which consisted of accuracy targeting for visual or tactile senses, areas at the edges of the display compared to the center; and there was an increase in errors for the bimodal condition, which consisted of visual and tactile senses occurring and presented together, in the center of the display.

**Vibrotactile Displays in Practice**

There are different types of parameters or characteristics that make up a vibrotactile display in order for a response to occur. Frequency can range from 20 to 1000 Hz; however, 250 Hz is the maximum for sensitivity. 1.) Amplitude can be combined with frequency in a single parameter and no more than four different amplitudes should be used, 2.) Duration or rhythm and the pulse rate are important to determine how short or long a cue can be, 3.) Waveform can be a sine or a complex (square or triangle) wave, 4.) Defining where the tactors should be located on the body are useful for sensitivity, and 5.) Comfortable stimuli to avoid annoying the user that lasts over longer periods of time (van Erp, 2002; Brewster & Brown, 2004; Hayward & Maclean, 2007; Jones & Sarter, 2008). Limitations can also evolve with vibrotactile displays, including spatial effects, describing spatial masking and apparent location of the stimulus; in addition to temporal effects, which defines temporal masking, adaptation effects, and spatio-temporal interactions (van Erp, 2002). For example, Gallace, Tan & Spence (2006) evaluated “change blindness”, in which participants fail to recognize changes caused by the presence of some pattern of disruptions having a masking effect on temporary senses that usually revolve around the location of change, and found that the tactile sense can be affected. Another article by Ferris, Stringfield & Sarter (2010) examined whether “change blindness” can be shown regarding the detection of vibration intensity changes while secondary tasks and a vibrotactile display are present and conducted in a simulated hospital room. There were five different intensity vibrations, which translated the trends of a patient’s blood pressure, included baseline, blank interval, masked interval, a mudsplash, and gradual presentation conditions (Ferris et al., 2010). Independent variables consisted of presentation condition, whether there was a change or not in the trial, the magnitude of a change, and the number of tasks performed in a trial (Ferris et al., 2010). Results of this study by Ferris et al. (2010), showed that performance was best in the baseline condition and worse in the gradual condition; there was an ability to detect vibration intensity change that were of a larger magnitude; and the addition of a secondary task did not interfere with detecting changes in vibration intensity overall.

Research by Spelmezan, Jacobs, Hilgers & Borchers (2009) evaluated three studies incorporating the design of a full-body tactile motion instructions display and to determine whether users recognize these instructions during physical activities, such as snowboarding in this case. The first study involved collecting qualitative data on the general perception of tactile cues transported across the body; the second study determined how well participants recognized the designed set of tactile motion instructions when performing tasks that require both cognitive and physical workload in a lab setting using a Nintendo Wii Fit balance board; and the third study is the same as the second; however, the conditions are in an extreme field-based environment in an indoor winter sport resort on a 1700 ft. long slope (Spelmezan et al., 2009). Results suggested that the location of the tactors on the body can greatly affect the perception of tactile cues; that the designed set of tactile instructions are recognized and distinguished with high accuracy under field-based conditions, complying to effective cues that signify how to move the body; and spatial location is the dominant measure when encoding instructions, whereas temporal designs should be used when encoding instructions continually and to enhance the tactile cues (Spelmezan et al., 2009). Morrison, Knudsen & Anderson (2012) examined tactile sensitivities using a wearable vibration belt in both a lab and field-based settings testing a significant diverse group of participants aging from 7 to 79 years old. There were two types of events that the participants had to perform, including 1.) Continual tasks, where participants were asked to actively respond to each vibration and also take photos of objects or things that interest them as they walked; and 2.) Event-based tasks, such as counting, estimating, looking for information, knowing or learning the history of the city they were in (Aalborg), taking photos, and selecting one photo (Morrison et al., 2012). Findings in this study further concluded that actions are slowed down when needing to use visual information;

qualitative data from the participants proved that vibrations were more likely missed in field-based setting than in the lab; and participants felt that the vibrations were less forceful in the field environment (Morrison et al., 2012). Overall, Morrison et al.'s (2012) study helps to clarify and ensure the critical needs for designing and producing for the elderly as well as for an expansive age range with determinable measures accepted at the beginning. A similar study by Srikulwong & O'Neill (2011) tested and used survey results in a pilot study involving pedestrian navigation that compared two tactile methods for depicting landmarks using one or two actuators. The four measures of the tactile display utilized were distinguishability, learnability, memorability, and user preferences; and this tactile system supported commuting, questing, and exploring purposes in navigation (Srikulwong & O'Neill, 2011). Results from the online and face-to-face participants illustrated that significantly more landmarks were used when questing and exploring than when commuting; the overall conclusion found by Srikulwong & O'Neill (2011) was that the 1-actuator method scored lower than the 2-actuator method for learnability, memorability, and user preferences amidst landmarks; however, both the methods were rated equally in the distinguishability measure.

There are very few studies that involve testing vibrotactile displays on the head. As described by Myles & Kalb (2009), it is important to first examine tactile sensitivities of the different locations of the head in order to determine the effectiveness of the frequencies of the tactile signal. Myles & Kalb (2009) concluded that all locations of the scalp are not equally sensitive; the crown is less sensitive than the skin near the forehead, temples, and lower part of the back of the head; and the back of the head was shown to be more sensitive than the front of the head. Mann, Huang, Janzen, Lo, Rampersad, Chen & Doha (2011) tested six vibrotactile actuators placed inside a helmet using a Microsoft Kinect 3D sensor range camera to help avoid collisions for blind or visually impaired individuals and those who work in rough environments. Mann et al. (2011) found that the usual operating range (30cm to 6m) of the Kinect camera was appropriate for indoor navigation in common congested hallways. A more recent study by Dobrzynski, Mejri, Wischmann & Floreano (2012) tested a head-attached vibrotactile display to determine how tactile displays might be useful to guarantee that allocating of cognitive effects does not harm existing workloads. Dobrzynski et al. (2012) found the following three major design factors when testing a vibrotactile system on the head, 1.) The comfort strength of the tactile stimulation should be acknowledged and estimated; 2.) Testing multiple tactors at the same time should be avoided due to the accuracy in recognizing the right number of effective tactors severely reduces compared to testing just a single tactor at a time; and 3.) The accuracy of localizing the tactile stimulus should stay consistent over the entire range of stimulation in order to illustrate major differences of the various locations of the head.

Another characteristic of testing vibrotactile displays is to examine the effectiveness of continuous movement of the tactors. Rahal, Cha & Saddik (2009) present a study on this particular characteristic to distinguish and evaluate differences between gender (male versus female); the duration of sensory stimulation (temporal); the position and location of continuous movement with respect to the axis of the limb (transverse versus longitudinal), and the limb site (dorsal of the forearm and upper arm); and the impacts of altering temporal intensities of the vibrotactile tactors between linear and logarithmic designs. Rahal et al. (2009) found that participants favored linear intensity along the longitudinal axis compared to the logarithmic; females had the highest mean for linear intensity and males had a higher mean for logarithmic intensity due to the differences in muscle capacity of the female and male limbs resulting in contrasting tactile sensitivities to the bone; and there was also a decrease in the effectiveness of continuous movement as the duration of the stimulus increased. Ferris & Sarter (2011) also investigated the magnitude of a continuously moving vibrotactile display in terms of helping anesthesiologists recognize trends in physiological information and to correctly respond to the display before the health of a patient approaches an urgent condition. There were health measurements for each scenario tested, including affected blood pressure (MAP), affected respiratory measures (ETCO2 &/or TV), and an “emergency” event that affected blood pressure and one of the respiratory measures (Ferris & Sarter, 2011). In addition, Ferris & Sarter (2011) evaluated display arrangements consisting of a baseline (visual and auditory) and some form of tactile display (alarm, continuous, or hybrid) along with visual and auditory signals. It was then concluded from this study that all tactile display arrangements led to faster detection and correction times of performance in physiological monitoring of the patients; the hybrid display had better scores and multitasking performance than both the alarm and continuous displays; and participants ranked the alarm display the highest (except for annoyance and comfort) and the continuous display was ranked the lowest (Ferris & Sarter, 2011). Therefore, according to Ferris & Sarter (2011), this suggests that continuous displays are less annoying and have the potential to promote multitasking performance when there is a high demand for visual and auditory senses.

**Vibrotactile Cues & Driving**

Many studies have addressed the potential use of vibrotactile cues by testing them in a driving simulator to detect different hazards or navigation purposes on the roadway while performing secondary tasks or under a high workload. A 2007 study evaluated four directional alert approaches, including an auditory, haptic, both haptic and auditory, and both haptic and non-directional auditory, to signal drivers to the direction of a potential collision event (Fitch, Kiefer, Hankey & Kleiner). The directional auditory alert consisted of four speakers located in each corner of the vehicle and the directional haptic seat alert consisted of 8 x 8 arrangement of pager vibration motors in the seat pan (Fitch et al., 2007). Results suggested that the haptic seat alerts may be effective for alerting drivers of a collision event and may decrease annoyance to the driver (Fitch et al., 2007). In a later study by Fitch, Hankey, Kleiner, & Dingus (2011), results indicated that manual and verbal response accuracy of drivers to alerts decreased as the number of alerts increased at one time, and drivers also made fewer mistakes when the alerts were presented in different or unique locations compared to a common or the same location. The study concluded that distinguishing multiple haptic seat alerts at one time can increase the driver's workload, which can interfere with how they respond (Fitch et al., 2011).

Another study by van Erp & van Veen (2001) presented several classes of information regarding the use of a vibrotactile display in automobiles when driving, such as 1.) Spatial information; in which the visual sense is restricted to the field-of-view or errors may occur when 3D information is presented on a 2D visual display causing high visual workload; 2.) Warning signals; 3.) Communication (silent and private); 4.) Coded information (speed, engine rpm, and fuel supply); and 5.) General purposes, like using tactile information to a guide a driver to different locations, indicate preference points, and can be implemented in the workplace of the driver. It was concluded from this study that there are faster reaction times, lower mental effort, and lower workload when using a tactile navigation display compared to a visual display (van Erp & van Veen, 2001). Two studies conducted by Ho, Tan & Spence (2005) and Ho, Reed & Spence (2006) investigated the potential use of vibrotactile warnings to present spatial information to drivers and whether the driver's responses to potential front-to-rear-end collisions could be prevented by wearing a vibrotactile warning display that indicated the direction of the probable collision. The vibrotactile display used two tactors triggered by a 290 Hz sinusoidal signal that were attached to a Velcro belt and attached around the participant's waist over their clothing (Ho et al., 2006; Ho et al., 2005). The driving performance variables recorded were: speed, lateral distance from the center of the road, distance headway, distance to the following vehicle, accelerator pedal force, brake pedal force, steering wheel angle, and gear position engaged; whereas the dependent variables consisted of response time, shortest headway, braking force index, percentage of collisions, and lateral deviation (Ho et al., 2006). Results showed that participants responded significantly more quickly to the frontal critical events in the cued condition than the un-cued condition; having the vibrotactile display on led to an earlier braking response and a larger safety distance from the lead vehicle compared to not having the display present, and it was also concluded that it is better to have this warning display present to help people performing dual or multiple tasks than to not have a warning signal at all (Ho et al., 2005; Ho et al., 2006). Krausman & White (2008) examined the performance of participants when detecting and localizing tactile warning signals while riding in a moving vehicle. A ride motion simulator along with eight tactors arranged in two adjustable belts were used, along with a 2 by 2 by 3 by 8 within-subjects design that employed four independent variables, including vehicle type (Bradley fighting vehicle versus a high mobility multipurpose wheeled vehicle), terrain (cross country versus gravel), tactile system (MIT versus TACTICS 1 versus TACTICS 2), and tactor location (N, NE, NW, S, SE, SW, W, E); two dependent variables, including the percentage of signals detected and the percentage of signals correctly localized were also measured (Krausman & White, 2008). Results illustrated that a significantly lower percentage of signals were correctly detected with the MIT system compared with TACTICS 1 & 2 during baseline; the cross-country terrain had higher localization rates with TACTICS 1 & 2 than with the MIT system when the vehicles were moving; and localization rates were significantly lower at the South location compared to N, NE, and NW locations, however the NE position was significantly higher than the West (Krausman & White, 2008). A more recent study by Underwood, Crundall & Chapman (2011) compared hazard perception responses in a driving simulator with responses while driving on a road. Results indicated the following: when scanning the roadway, experienced drivers were more likely to respond to stop signs and pedestrians compared to novice drivers; when scanning while watching hazard perception movies, experienced drivers increase their scanning when observing more demanding roads; and when looking at hazard perception responses in a driving simulator, experienced drivers were found to more likely recognize potential hazardous scenarios compared to novice drivers (Underwood et al., 2011). Therefore, according to Underwood et al. (2011), it is important to consider hazard perception, cognitive skills, and perceptual motor skills when evaluating the effectiveness of a driving simulator.

## Signal Detection Theory & Applications

Signal Detection Theory (SDT) is associated with an absent (no) or a present (yes) signal; it is a theory that can apply to any type of situation where there is two different sensory cues, such as a signal and a noise, that are difficult to distinguish (Wickens et al., 2012). There are four classes of joint events that detect human performance. They include hits, misses, false alarms, and correct rejections; these values are recorded as percentages (Wickens et al., 2012). According to Wickens et al. (2012), the hit rate is the probability of a signal given a yes response, the miss rate is the probability of a signal given a no response, the false alarm rate is the probability of a non – signal given a yes response, and the correct rejection rate is the probability of a non – signal given a no response; a perfect performance would have no misses or false alarms involved. When analyzing the data and probabilities from the signal detection, it is important to use a receiver operating characteristic curve (ROC) to comprehend the combined effects of both sensitivity and any form of response bias (Wickens et al., 2012). There is also a different application of the Signal Detection Theory called fuzzy SDT rate, which can calculate the measures of response bias (C) and sensitivity (d'). Response bias is defined also as beta and is the ratio of neural activity produced by signal and noise. Sensitivity is defined by the distinction between noise and the distributions of a signal along the X axis and contains values from 0.5 to 2. Signal Detection Theory described by Wickens et al. (2012) can also be applied in many areas, such as medical diagnosis, memory recognition pertained to eyewitness testimony, in addition to alarm and alert systems. Therefore, this theory is helpful to evaluate the effectiveness of vibrotactile displays in many situations by calculating the response rates for a more accurate and reliable analysis.

**Purpose, Objectives & Research Questions of the Study**

The purpose of this study is to determine whether vibrotactile cues are effective in improving hazard recognition or awareness and safety using a treadmill and a driving simulator. Certain hazards that are addressed involve pedestrians, including the elderly, children and teenagers, along with the disadvantaged (those that are handicapped, blind, or deaf); bicyclists; motorcyclists; other motor - vehicles; in addition to workers who drive on the job to transport hazardous materials, freight, or passengers, such as bus drivers or large trucks; and also those who work in construction and operate forklifts or other types of machines. Due to limited visual and auditory senses from talking or texting on cell phones or listening to music, this research is intended to investigate whether a tactile display involving touch can increase awareness and provide faster reaction times and increase hit rates to certain hazards.

The objectives and research questions of this study are the following:

1.) Determine whether the presence of vibrotactile displays make a difference in hazard recognition and to distinguish which display, helmet or suspenders, is more effective

   (a.) How does performance with the helmet display compare with the suspenders display?

   (b.) How accurately can participants distinguish and translate the vibrotactile cues when presented with varying degrees of secondary task workload or distractions (a visual and an auditory distraction)?

2.) To examine the effectiveness of the tactors in a helmet and suspenders to determine the best variables in a single alert signal that can create the fastest response time and the best performance in regards to the severity of a "true" hazard and the participant's proximity to a hazard

   (c.) How fast do participants respond to certain hazards in each trial without a vibrotactile cue present or any secondary tasks (distractions) compared with having the cue and the distractions present?

   (d.) How effective is increasing the intensity of the single alert signal when a "true" hazard is present compared to a "false" hazard (for the purposes of creating a false alarm or a correct rejection)?

3.) To determine the overall performance (effectiveness), comfort, usefulness, reliability, accuracy, and mental effort on each display

   (e.) How do participants perceive or rank their performance on a Likert scale from 1 to 5 (1 being the least and 5 being the most)?

   (f.) How do the participant's responses compare to their actual performance?

# CHAPTER II

# RESEARCH METHODS

## Participants

A total of 27 college students and faculty, 16 females and 11 males, were recruited from Texas A&M Health Science Center-School of Rural Public Health and Texas A&M University in College Station, TX. Out of these participants, there were twenty (or 74%) in the 21 – 29 age group, with 5 participants in the 30 – 40 age group, and 1 participant each in the 18 – 20 and 41 – 50 age groups. Approval for this study was gained through Texas A&M University's Institutional Review Board (IRB). Consent forms were given to the participant prior to testing, along with a demographic questionnaire. A qualitative questionnaire concerning the testing procedures and conditions was also given to the participant after the testing was completed. Participation was voluntary, and participants were compensated $10 for approximately 120 minutes of their time.

The study consisted of a case-control, within-subjects model. The cases depict distractions (tasks) while walking on a treadmill using the driving simulator, which include: 1.) Listening to music with headphones; 2.) Reading/texting on a touchscreen device; and 3.) Both tasks together. Participants listened to a playlist of current popular songs on an iPhone® at a louder than normal hearing level. As for the reading/texting task, participants used the same iPhone® to play iTextSpeed® by Minicog app, a typing test. They had to read and text different words after one another as fast as they could while walking on the treadmill and responding to hazards. The control consisted of no distractions (tasks) during the testing. The number of participants depended on the number of consent forms signed and returned after promoting the study via email. The participant consent form can be found in Appendix C.

**Instruments**

The study compared a helmet and a pair of suspenders as vibrotactile displays (shown in figure 1). There were eight vibrating "tactor" devices (C-2 Tactors[†] developed by Engineering Acoustics Inc., manufactured in Casselberry, FL) placed into these displays with four distinct locations (front, back, right, and left). From the study by Myles & Kalb (2009), all areas of the scalp have unequal sensitivities. Therefore, to create a strong, confined vibration to the body, two tactors were placed at each of the four locations, depicting equidistant points on a circle. It is also important to consider the difficulty of having reliable skin contact, especially at the spine. According to van Erp (2002), the density of a tactor is essential in detecting an understandable vibrotactile alert. The helmet used is a hard hat used for construction, industrial, and manufacturing occupations. The pair of suspenders can serve as a vest or a backpack.

**Figure 1. Helmet and Suspenders displays with tactors.**

The STISIM Drive® driving simulator M100 system, manufactured by Systems Technology, Inc. in Hawthorne, CA (as shown in figures 2 and 3) was used in this study in a controlled laboratory setting (courtesy of Dr. Thomas Ferris's Human Factors and Cognitive Systems Lab at Texas A&M University). This driving simulator includes a single driving display that can support any sized monitor or projection display and allows up to a 60 degree field-of-view for the driver ("M100 driving simulation,"). There are several features also involved, such as high speed graphics and sound processing, interactive and programmable roadway events, and transmission options available. Many benefits of this car simulator include: realistic roadway environments; ready to drive, test, and evaluate; controlling events, signal lights, pedestrians, and vehicle traffic; and ease of operation and maintenance. The performance measures that are recorded in the simulator are the following: number of accidents or collisions (for scenarios with a vehicle, pedestrian, obstacle, and off-road); using the brake and accelerator to measure and observe driving behavior, reaction time, time to collision, and tailgating; using the steering and handling for lane positioning and deviation, or centerline and edge crossings; determining driver compliance and attention with the use of signal lights, signs, turning, and divided attention; and the user can select certain types of data to program via Scenario Definition Language. For the purposes of this study, the driving simulator was set on autopilot (the simulator controlled steering and speed throughout each trial and ignored crashes). A projector was also used, instead of the monitor, to allow a more viewable area. Participants were instructed to respond as fast as they could whether or not they thought a hazard was going to collide into them. As for responding to hazards, the participants pushed the arrow buttons (right and left) on the keyboard that was attached to the treadmill once they first saw a hazard on the driving simulator. Then once the hazard had already passed, participants pressed the opposite arrow key button to get back in the middle of the sidewalk.

Participants continuously walked on a treadmill during each trial with stops in between trials. The treadmill used in this study was the ProForm LX 360 motorized treadmill (figure 3). Its features include: hand and foot rails, safety key/clip, cushioned walking platform for maximum exercise comfort, speed control button, incline option, an LED track, time/distance display, calories/fat calories/speed display, and the ability to fold up.

**Figure 2. STISIM Drive® driving simulator.**

**Figure 3. ProForm LX 360 treadmill.**

## Procedure

Pilot testing was first conducted on two graduate research assistants in the laboratory to test the best parameters for the "tactors" on the helmet and the suspenders and to get an initial idea of the test conditions while walking on the treadmill. These pilot tests helped to determine the location, frequency, intensity, and the duration of vibration in a single signal in order to provide the fastest response time when recognizing the severity of a "true" hazard and the participant's proximity to the hazards. Programming the alert signals in the tactors using C++ was also utilized to sync them together with the driving simulator via a serial cable and Bluetooth capability. The alert signals were programmed based on the number, type of hazard (true of false), and direction of the hazard presented. There was also initial pilot testing conducted that involved programming the various hazards for each trial in the driving simulator to determine the right parameters and configurations in correlation to the middle of the sidewalk. These parameters included: the amount of distance (in feet) between each hazard, time, velocity, direction, position, speed, in addition to the type of graphics presented.

Demographic questionnaires (as shown in Appendix A) were first distributed to participants before performing any testing on the treadmill using the driving simulator. This questionnaire served to assess age, gender, how often (on average) a participant walks per day (in minutes); average amount of time (in minutes) reading per day; average amount of time (in minutes) texting on a touchscreen device per day; average amount of time (in hours) playing video games per week; the type of touchscreen device used; in addition to how often participants listen to music and what kind of music participants listen to when walking (or driving).

Prior to starting the actual testing, practice runs and training were conducted to give the participant an idea of what testing would be like. The training sessions consisted of walking on the treadmill with: 1.) Just the driving simulator on to indicate the middle of the sidewalk; 2.) The different types of hazards that were presented; 3.) Responding to hazards while reading/texting on an iPhone; and 4.) The helmet display present to get participants used to the vibrations while reading/texting and responding to hazards. For the actual testing, the following 12 trials were randomly assigned for each participant: 1.) No display & No distractions (tasks) 2.) No display & Listening to music; 3.) No display & Texting; 4.) No Display & Both tasks together; 5.) Helmet display & No tasks; 6.) Helmet display & Listening to music; 8.) Helmet display & Texting; 8.) Helmet display & Both tasks together; 9.) Suspenders display & No tasks; 10.) Suspenders display & Listening to music; 11.) Suspenders display & Texting; and 12.) Suspenders display & Both tasks together. These test conditions were randomized throughout the trials for each participant to eliminate and control for order – effect bias. There were also 4 different simulation scenarios, each semi – randomized, with the same type of hazards presented. The approximate testing time for each trial was 3 minutes and lasted for 1.5 to 2 hours overall in one day.

A qualitative questionnaire, in Appendix B, was given to the participants after testing was conducted. The purpose of this questionnaire served to evaluate self-reported responses of the participants on a Likert scale of 1 (least effective) to 5 (most effective). These responses determined participants thoughts and opinions describing overall performance, effectiveness, accuracy, comfort, mental effort, and the difficulty level, when presented with distractions, of the vibrotactile displays (helmet versus suspenders) compared to the baseline (no vibrotactile display). Participants were also asked which display they would use if they were to have one while walking as a pedestrian and whether the speed of the driving simulator interfered with their judgment of responding to the hazards.

The various hazards involved approaching vehicles, bicycles, and other pedestrians from each of the four directions (front, back, left, and right). There were 8 "true" hazards in each trial mixed in with 14 total events. To define a "true" hazard, the hazard had to be at a very short distance from the participant (colliding into the participant). Two different signals were presented. A "true alarm" displayed increasing intensity of the tactors in either vibrotactile display as the "true" hazard got closer to the participant. A "false alarm" involved less intensity of the tactors as events were presented farther away from the participant.

**Data Analysis**

This study analyzed two things: 1.) Self-reported responses of the qualitative questionnaire, in Appendix B, and 2.) Quantitative results of each participant on the treadmill using the driving simulator. The independent variables were the type of vibrotactile display (no display, helmet, and suspenders) and the type of distraction or secondary task performed (no tasks, listening to music, reading/texting on an iPhone®, and both tasks together). Dependent variables included self-reported responses from the qualitative questionnaire, and the quantitative results from testing participants, including response times and hit rates for each trial. In order to determine if a participant would have a false alarm, they were required to press the arrow keys (right and left) on the keyboard to indicate whether they detected a "true" or "false" hazard and to determine the response time (which is the time a hazard is first presented to the time the participant responds). Sensitivity (d') values, measured as $d' = z(H) - Z(F)$, and response bias (C) values, measured as $c = -\frac{z(H)+z(F)}{2}$ (where "H" refers to hit rate and "F" refers to false alarm rate) were also reported and compared to illustrate the signal detection theory (SDT) paradigm for each trial. Table 1 shows a 2x2 table illustrating the SDT paradigm for this study.

**Table 1. 2x2 table illustrating SDT paradigm.**

| | Response: Different (*yes)* | Response: Same (*no)* |
|---|---|---|
| Stimuli (True Alarm): YES (*different)* | HIT | MISS |
| Stimuli (False Alarm): NO (*same)* | FALSE ALARM | CORRECT REJECTION |

For self-reported responses, analysis was two sided and collected using the qualitative questionnaire, in Appendix B. Self-reported responses, ranging from 1 (least effective) to 5 (most effective) were quantified for each vibrotactile display and type of secondary task (distraction). The relationships between the type of vibrotactile display and self - reported responses (ratings) were quantified using mixed effects ordinal logistic regression models. Repeated-measures (within – subjects) ANOVAs were also used to quantify the response times and hit rates for each trial.

Analysis for the treadmill testing was recorded in the driving simulator and logged on the computer. Invisible collision blocks were programmed on each side of the sidewalk to record a time mark for when a participant first responds to a hazard. These were used to calculate the response times from the start times of each hazard in each trial. The distribution of the data for each trial was observed and if the distribution was normally distributed, with no outliers, then a paired t-test was performed.

Potential confounders for this study included random-effects factors (like the randomized order of hazards, distractions, and vibrotactile display), as opposed to fixed-effects factors, such as the type of vibrotactile display and the type of trial or scenario. The significance level for statistical tests, concerning self-reported responses from the qualitative questionnaire, was $p \leq 0.05$ for a two-sided test. For the purpose of this study, the null hypothesis is that the level of effectiveness for participants using the helmet display during the trials while walking on the treadmill is equal to the participants using the suspenders display. Both displays (helmet and suspenders) are also equal to the control (no distractions presented).

The significance level for statistical tests concerning response time (in seconds) and hit rates (in percentages), with regards to having a vibrotactile display present or not, was also $p \leq 0.05$ for a two-sided test. All of these measures used descriptive statistics to better illustrate the dependent and independent variables. Categorical variables were described using proportions, while continuous variables were described using ranges, means, medians, and standard deviations. Finally, the relationship between the quantitative and qualitative results was also described.

CHAPTER III

# RESULTS

As applied in Ferris, Stringfield & Sarter (2010), repeated measures linear models (using the General Linear Model Formulation in SPSS Statistics 22.0) were utilized to determine main effects and two-tailed Fisher's LSD post – hoc analysis tests were used to identify the differences between means for any significant interaction effects. To measure signal detection theory (SDT), the sensitivity (d') and response bias (C) values were also calculated using the z-values of the hit and false alarm rates. As values reached 0% (0.0) or 100% (1.0), a standard correction was applied. For false alarms, N is defined as the maximum number (the amount of false alarms in each trial) and 1/N as the smallest number (not including 0), so instead of using 0, the approach is to use 1/(2N) (Ferris, Stringfield & Sarter, 2010; Wixted & Lee, n.d.). For hit rates, instead of using 1.0, the approach is to use 1 – 1/(2N), where N is now defined as the amount of hits in each trial. In this case, N = 6 for the maximum number of false alarms and N = 8 for the maximum number of hits in each trial.

## Demographics

For the average amount of time walking per day, 22% of participants walk 1- 30 minutes, 30% walk more than 30 but less than 60 minutes, and 30% walk 60 minutes or more a day. There were 81% of participants who read and 56% of participants who text on a touchscreen for more than 30 minutes a day. The majority of participants (59%) do not spend time playing video games; however there were 26% of participants who play video games for an average of 1 to 2 hours per week and 15% who play for more than 2 hours a week. For listening to music while walking (or driving), more than half of participants (70%) often/very often listen to music per week, while 26% sometimes listen to music and 4% do not listen to music. In addition, there were 70% of participants that listen to rock/hip hop (pop) music while walking (or driving). For a more graphical representation, refer to Appendix D.

### Hit Rates

"Hit rates" were defined as the percentage of true hazards that were identified correctly for each trial. All twelve trials per participant were individually counted for the number of hits, misses, false alarms, and correct rejections. The percentage of both hits and misses equaled 100% and the percentage of both false alarms and correct rejections equaled 100%.

<u>No Display vs. Display</u>

To determine whether the presence of vibrotactile displays make a difference in hazard recognition, it was important to compare no display versus display. Figure 4 shows the average hit rate across participants as 84% (*SD* = .11014) for no display and 88% (*SD* = .11063) for display.

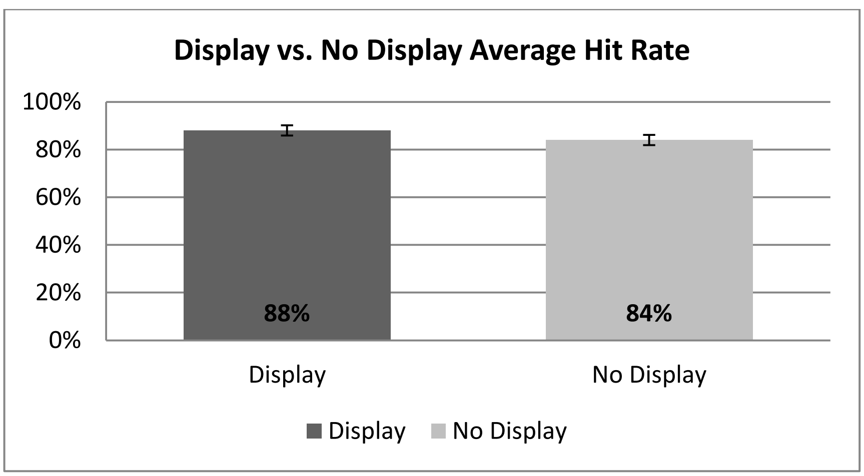



**Figure 4. Display vs. No display average hit rate across subjects. Error bars represent standard error.**

When conducting a paired samples T test, having no display was significantly different than having a vibrotactile display present (p = .007); therefore, the null hypothesis is rejected. The statistical output for this test can be shown in Appendix E.

Figure 5 shows a boxplot comparing hit rates when having no display versus having a vibrotactile display present. Since the boxplot for display is much higher than the boxplot for no display, this proves that there is a difference between the groups.

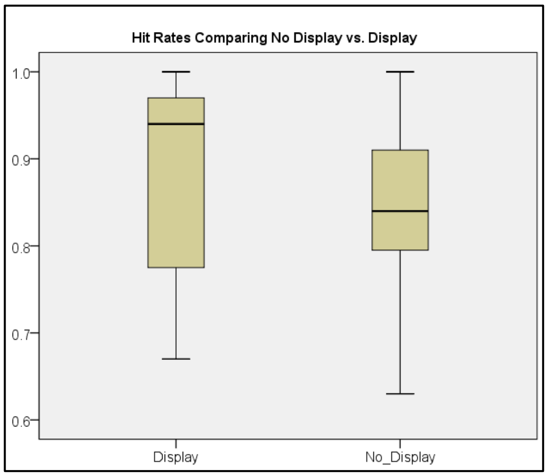



**Figure 5. Boxplots for display (left) vs. no display (right).**

<u>Helmet vs. Suspenders</u>

To distinguish which display is more effective, it was also important to compare helmet versus suspenders. Figure 6 shows that the average hit rate across participants was 88% (*SD* = .11770) for helmet display and 89% (*SD* = .12004) for suspenders display.

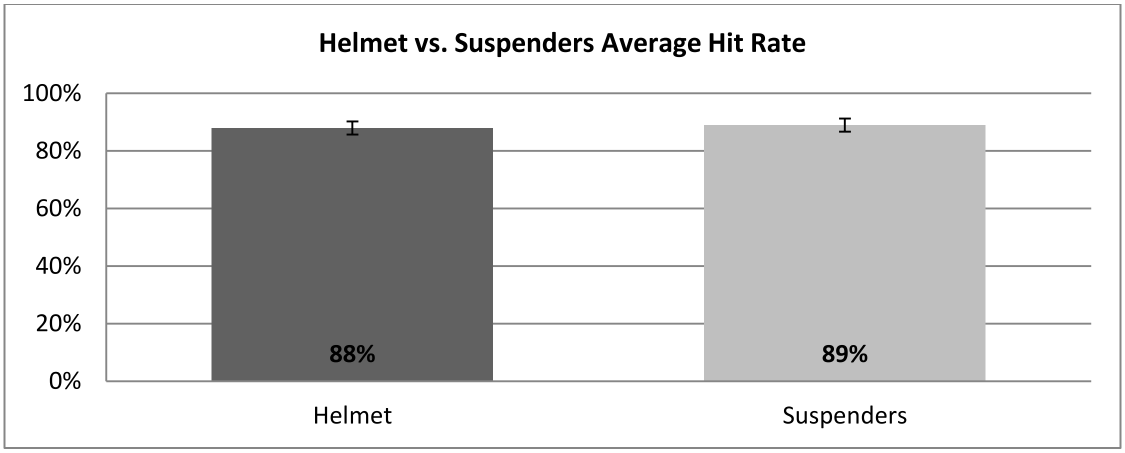



**Figure 6. Helmet vs. Suspenders average hit rate across subjects.**

When conducting a paired samples T test, suspenders display was not significantly different than helmet display present; therefore, the null hypothesis failed to reject. The statistical output for this test can be shown in Appendix F. Figure 7 shows a boxplot comparing hit rates when having the helmet display present versus having the suspenders display present. Since the medians for both boxplots are nearly the same, this suggests and proves that there is no difference between the groups.

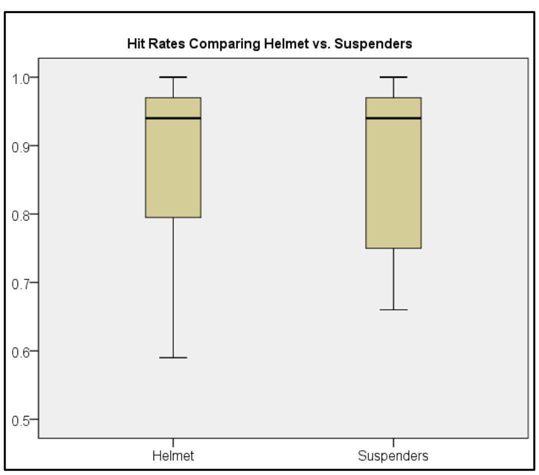



**Figure 7. Boxplots for helmet (left) vs. suspenders (right).**

No Display vs. Suspenders vs. Helmet per Secondary Task

In order to identify and interpret whether the vibrotactile displays were effective while secondary tasks or distractions (listening to music and texting) were presented, it is imperative to compare each display per distraction. Figure 8 shows the average hit rates across participants for all four tasks (distractions) compared to each display.

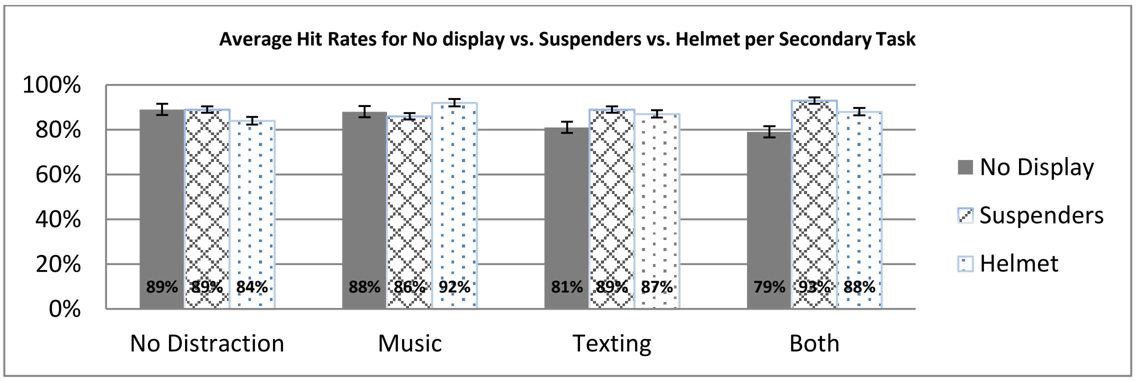



**Figure 8. No Display vs. Suspenders vs. Helmet per secondary task average hit rates across subjects.**

The Mauchly's Test of Sphericity is the test of an assumption of the univariate approach to repeated – measures ANOVA ("Interpreting the repeated-measures,"). If this test is significant ($p < .05$) then the sphericity assumption is violated. When the assumption is violated it is important to use the multivariate results or use the epsilon values, defined as measures of degrees of sphericity, to adjust the numerator and denominator degrees of freedom ("Interpreting the repeated-measures,"). The multivariate tests can be used regardless of whether sphericity is violated or not; however, when epsilon values are high (closer to 1 or above) and close to reaching sphericity then the multivariate tests may be less valuable to use in order to determine significant effects. Therefore, it is better to adjust the epsilon values in order to show statistically significant results. When the epsilons are less than .75, the Greenhouse-

Geisser values should be used and when they are more than .75, then the Huynh-Feldt values should be used ("Interpreting the repeated-measures,").

After performing a repeated – measures ANOVA, Mauchly's Test of Sphericity was significant for "task" and "display*task" interaction, but not significant for "display". Therefore, multivariate tests were used regardless of whether or not the sphericity assumption is violated. Based on the multivariate results of the within – subjects effect (as shown in Appendix G), "display" was a significant effect ($F(2, 25) = 4.561$; $p = .020$), as was the "display*task" interaction ($F(6, 21) = 5.509$; $p = .001$), but "task" was not significant. When adjusting epsilon values in the "Tests of Within-Subjects Effects", the results were accurate, with significant effects in the "display" and "display*task" interaction and no significant effects with "task". From the pairwise comparisons for just the "display", no display was significantly different from suspenders display ($p = .005$) and not significantly different from the helmet display. The helmet display was not significant from suspenders display. From the pairwise comparisons for the "display*task" interaction, when listening to music, the suspenders display was significant from helmet display ($p = .020$). When texting, having no display present was significant from suspenders display ($p = .035$). When both distractions were present, having no display was significant from suspenders display ($p < .001$) and helmet display ($p = .013$). When no display was present, having no distraction and listening to music were both significant from texting ($p = .030$; $p = .023$) and both distractions ($p =.008$; $p = .001$), respectively. When suspenders display was present, listening to music was significant from both distractions ($p = .010$). When helmet display was present, listening to music was significant from texting ($p = .046$). All other interactions were not significantly different for hit rates.

**Response Times**

"Response times" were measured by calculating the difference from the start time that a hazard was presented on the projector screen from the driving simulator to the time that a participant responds by pressing the arrow keys (right or left) on the keyboard. If a participant missed a true hazard, the slowest possible response time for that specific hazard was recorded, based on the time that it exited the projection screen.

<u>All True Hazards</u>

Looking at all true hazards within a trial (8 out of 14 total events), the average response times (in seconds) across subjects were relatively faster in all test conditions for the suspenders and helmet compared to having no display present (shown in figure 9).

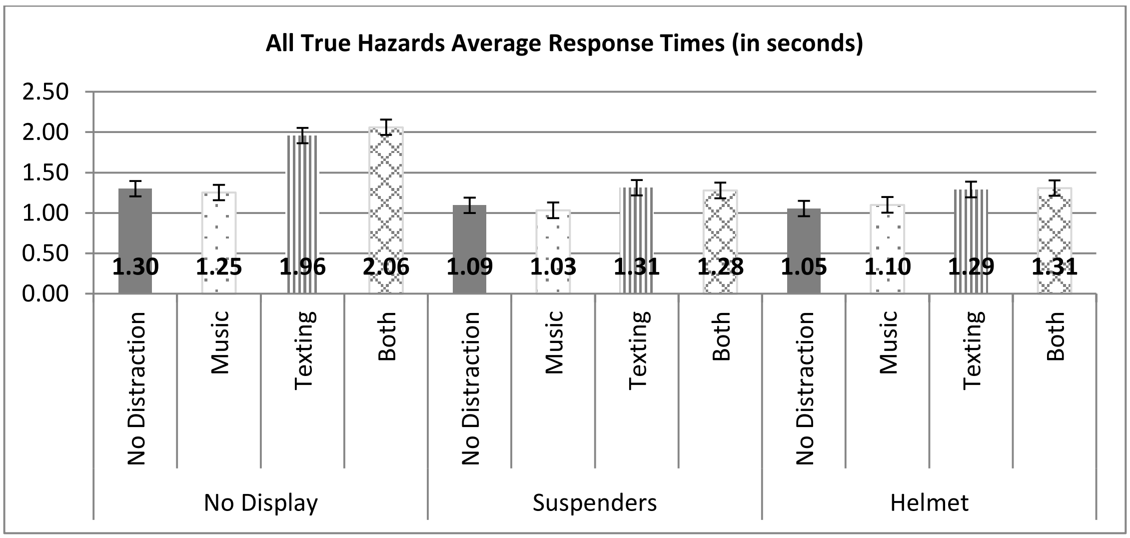



**Figure 9. Average response times for all true hazards across subjects.**

In this case, for all true hazards, the Mauchly's Test of Sphericity was significant for "task," with an epsilon value of .929, and the "display*task" interaction, with an epsilon value of .629, but not significant for "display". Based on the multivariate tests of the within – subjects effects (as shown in Appendix H), "display" was a significant effect ($F(2, 25) = 58.762$, $p < .001$), as was "task" ($F(3, 24) = 16.440$, $p < .001$), and "display*task" interaction ($F(6, 21) = 6.434$, $p = .001$). When adjusting epsilon values in the "Tests of Within-Subjects Effects", the results were also significant. From the pairwise comparisons for "display", no display was significantly different from both helmet and suspenders displays ($p < .001$), but the helmet display was not significant from the suspenders display. Pairwise comparisons for "task" showed that no distraction and listening to music were both significant from texting and both distractions ($p < .001$), but having no distraction was not significant from listening to music and texting was not significant from having both distractions present. From the pairwise comparisons for the "display*task" interaction, in all four tasks (no distraction, listening to music, texting, and both), no display was significant from suspenders display ($p = .027$; $p = .004$; $p < .001$; and $p < .001$) and helmet display ($p = .001$; $p = .025$; $p < .001$; and $p < .001$), respectively. Having no distraction and listening to music were both significant from texting ($p < .001$) and both distractions ($p < .001$) when not having a display present. When the suspenders display was present, having no distraction was significant from texting ($p = .020$) and listening to music was significant from texting ($p < .001$) and both distractions ($p = .012$). When the helmet display was present, having no distraction and listening to music were both significant from texting ($p = .011$; $p = .045$) and both distractions ($p = .016$; $p =.012$), respectively. All other interactions were not significantly different for all true hazards displayed on the simulator.

The following sections describe and analyze each type of true hazard displayed:

*Approaching vehicle from right*

When looking at just one type of true hazard, approaching vehicle from the right, it showed that Mauchly's Test of Sphericity was significant, indicating that the data violates the sphericity assumption of the univariate approach to repeated-measures ANOVA. Thus, the multivariate tests were used regardless of whether or not sphericity was violated (as shown in Appendix I). Multivariate tests of the with-in subjects effects showed that "display" was a significant effect ($F(2, 25) = 6.051$; $p = .007$), as was "task" ($F(3, 24) = 4.767$; $p = .010$), but the "display*task" interaction was not significant. From the pairwise comparisons for just the "display", no display was significantly different than suspenders display ($p = .004$) and helmet display ($p = .002$) but the helmet and suspenders displays showed no significant difference. Pairwise comparisons for "task" showed that texting was significant from no distraction ($p =$

.010) and listening to music ($p = .008$), but having no distraction was not significant from listening to music and both distractions, while no distraction, listening to music, and texting all were not significant from having both distractions present. From the pairwise comparisons for the "display*task" interaction, when texting, having no display was slightly significant from suspenders display ($p = .046$) and helmet display ($p = .048$). When there was no display present, texting was significantly different from no distraction ($p = .029$) and listening to music ($p = .034$). All other interactions were not significantly different when the approaching vehicle from right hazard was displayed on the simulator.

*Vehicle in front*

The second type of true hazard, vehicle coming from the front, also showed that Mauchly's Test of Sphericity was significant, which violates the sphericity assumption. Based on the multivariate results (as shown in Appendix J), "display" was a significant effect ($F(2, 25) = 10.678$; $p < .001$), as was "task" ($F(3, 24) = 12.080$; $p < .001$), and "display*task" interaction ($F(6, 21) = 2.877$, $p = .033$). When adjusting epsilon values in the "Tests of Within-Subjects Effects", the results were also significant. From the pairwise comparisons for just the "display", no display was significantly different than suspenders display ($p < .001$) and helmet display ($p < .001$) but the helmet and suspenders displays showed no significant difference, as expected. Results were also the same when looking at pairwise comparisons for "task". It showed that no distraction and listening to music were both significant from texting and both distractions ($p < .001$), but having no distraction was not significant from listening to music and texting was not significant from having both distractions present. From the pairwise comparisons for the "display*task" interaction, when listening to music, having no display was significant from suspenders display ($p = .004$), and suspenders display was significant from helmet display ($p = .003$). When texting, having no display was significant from both suspenders display ($p = .021$) and helmet display ($p = .030$). When presented with both distractions, having no display was significant from both suspenders and helmet displays ($p < .001$). When there was no display present, having no distraction and listening to music were both significantly different from texting (p = .008; p = .002) and both distractions (p < .001; p < .001), respectively. When the suspenders display was present, having no distraction and listening to music were both significant from texting (p = .036; p < .001) and both distractions (p = .010; p < .001), respectively. When the helmet display was present, having no distraction was significant from texting (p = .023) and both distractions (p = .016). All other interactions were not significantly different when the vehicle in front hazard was displayed on the simulator.

*Bicyclist in front*

The third type of true hazard, bicyclist coming from the front, also showed that Mauchly's Test of Sphericity was significant, violating the sphericity assumption. Based on the multivariate results (as shown in Appendix K), "display" was a significant effect (F (2, 25) = 9.824; p = .001), as was "task" (F (3, 24) = 5.212; p = .006), and "display*task" interaction (F (6, 21) = 3.968, p = .008). When adjusting epsilon values in the "Tests of Within-Subjects Effects", the results were also significant. From the pairwise comparisons for just the "display", no display was significantly different than suspenders display (p = .001) and helmet display (p < .001) but the helmet and suspenders displays showed no significant difference, as expected and shown in previous results. Pairwise comparisons for "task" showed that no distraction was significant from texting (p = .008) and both distractions (p = .001), while both distractions was significant from listening to music (p = .004) and texting (p = .029). Listening to music was not significantly different from no distraction and texting. From the pairwise comparisons for the "display*task" interaction, when both distractions were present, having no display was significant from suspenders and helmet displays (p < .001), but helmet display was not significant from suspenders display. When there was no display present, having both distractions was significantly different from no distraction (p < .001), listening to music (p = .002), and texting (p = .008). All other interactions were not significantly different when the bicyclist hazard was displayed on the simulator.

*Pedestrian from right*

The fourth, and final, type of true hazard, pedestrian coming towards the participant from the right, also showed that Mauchly's Test of Sphericity was significant for "task" and "display*task" interaction, but not significant for "display". Based on the multivariate results (as shown in Appendix L), "display" is a significant effect ($F (2, 25) = 28.724$; $p < .001$), as was "task" ($F (3, 24) = 7.963$; $p = .001$), but "display*task" interaction was slightly not significant. When adjusting epsilon values in the "Tests of Within-Subjects Effects", the results were accurate with "display" and "task" having a significant effect and "display*task" interaction having no significant difference. From the pairwise comparisons for just the "display", no display was significantly different than suspenders and helmet displays ($p < .001$) but the helmet and suspenders displays showed no significant difference, again as expected and shown in previous results. Pairwise comparisons for "task" showed that no distraction was significant from both distractions ($p = .016$), while listening to music was significant from texting ($p = .003$) and both distractions ($p < .001$). From the pairwise comparisons for the "display*task" interaction, for all four tasks (no distractions, listening to music, texting, and both distractions), having no display was significant from suspenders display ($p = .001$; $p = .017$; $p < .001$; and $p = .003$) and helmet display ($p < .001$; $p = .036$; $p < .001$; and $p = .002$), respectively. In addition, as shown in all previous results, helmet display was not significant from suspenders display. When no display was present, having no distraction was significant from texting ($p = .036$); listening to music was significant from texting ($p = .001$) and both distractions ($p < .001$). When the suspenders display was present, listening to music was significant from texting ($p = .023$) and both distractions ($p = .037$). All the tasks for the helmet display and all other interactions were not significantly different when the pedestrian hazard was displayed on the simulator.

**Performance Over Time**

Figure 10, below, represents the average hit rates and response times across participants over time (two – hour testing period). From the graph, it shows that overall, response times got faster from 1.51 seconds in Trial 1 to 1.24 seconds in Trial 12. On the contrary, hit rates stayed pretty even throughout the trials.

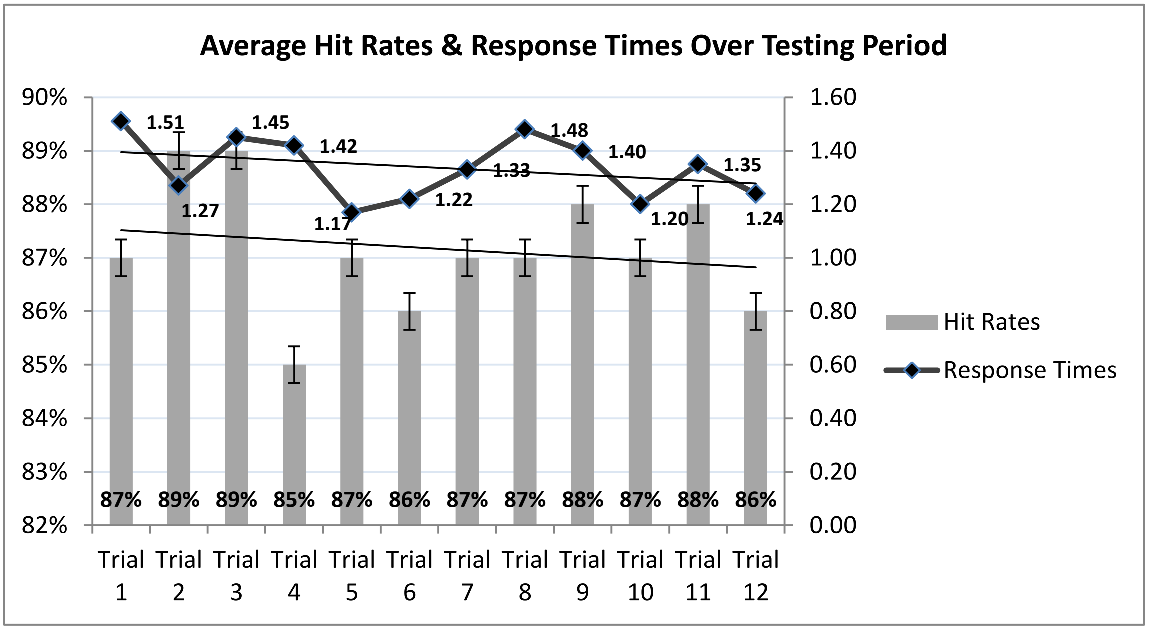



**Figure 10. Average hit rates & response times over testing period.**

### Signal Detection Theory - Sensitivity (d') & Response Bias (C)

Figure 11, on page 36, depicts sensitivity or d' (bars correlating with the left axis) and response bias or C (squares correlating with the right axis) for each display and secondary task (distraction). Sensitivity (d') utilizes the hit and false alarm rates to depict the certainty of decision making when responding to hazards.

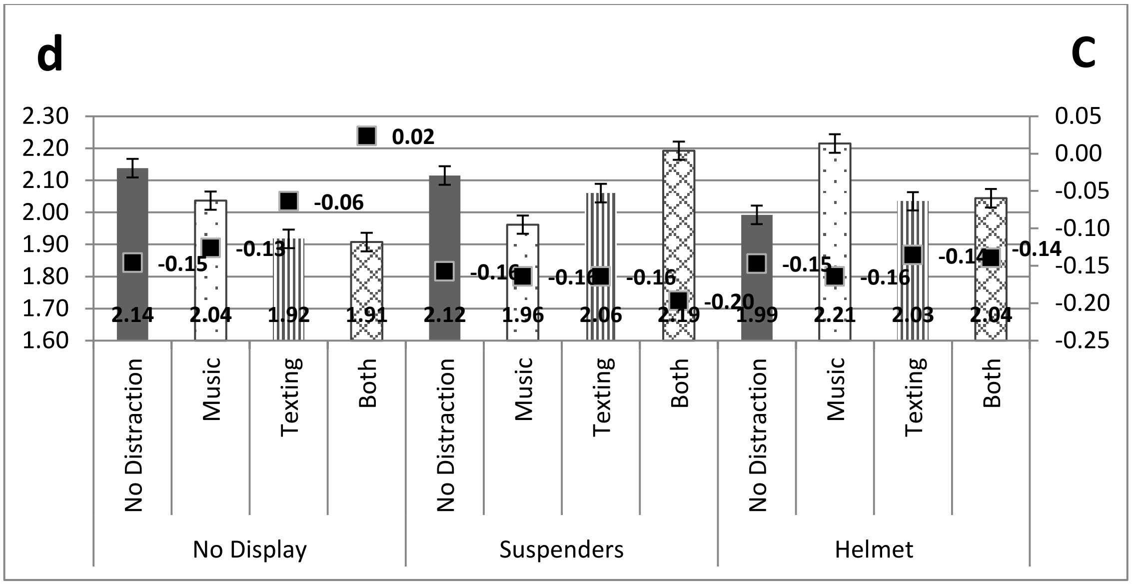



**Figure 11. Sensitivity (d'): bars correlated with left axis; and Response bias (C): squares correlated with right axis; for each display per secondary task. Error bars represent standard error.**

Sensitivity (d') did not have any significant effects; however, pairwise comparisons showed that when listening to music, the suspenders display was slightly significant from the helmet display (p = .043). All other interactions were not significant for sensitivity. Response bias (C) describes the extent to which a participant's response is more probable than another. For instance, a participant may be more likely to respond when a signal is present (negative C values) or more likely to respond when a signal is not present (positive C values). Multivariate results showed that "display" was a significant effect ($F(2, 25) = 4.076$, $p = .029$), whereas "task" and "display*task" interaction was not a significant factor affecting the value of C. Pairwise comparisons for "display" showed that having no display was significant from the suspenders display (p = .007). In addition, from the pairwise comparisons for the "display*task" interaction, when having both distractions present, no display was significant from suspenders display (p = .002) and helmet display (p = .006). When there was no display present, having both distractions was significant from no distractions (p = .011) and listening to music (p = .012). All other interactions were not significant for values of C. In this case, referring back to figure 11, it is implied that there was an overall tendency for participants to more likely respond when a signal was present, since there were more negative C values present (refer to Appendix M).

**Qualitative Data**

Display Preference & Speed Interference

Figure 12 illustrates that 74% preferred having the suspenders display over the helmet display (26%) while walking as a pedestrian. Several participants commented that the suspenders were more comfortable and functional, light to wear, and can easily be covered by clothing. When wearing the helmet, hair may have been a factor contributing to the comfort ratings. Furthermore, there were a few participants that commented that they felt like they reacted faster with the helmet compared to the suspenders.

The speed of the driving simulator was set to 15 feet per second. The average walking speed for adults is around 3 to 4 feet per second. Therefore, it was important to determine whether the participants felt like the speed interfered with their judgment in detecting hazards. Figure 13 shows that 78% chose “no” that the speed did not interfere and 22% chose “yes” that the speed did interfere. Out of the participants who chose “yes,” some commented that it affected their judgment of speed; faster speed requires quicker responses; and it was less likely to respond to hazards with a faster simulator speed.

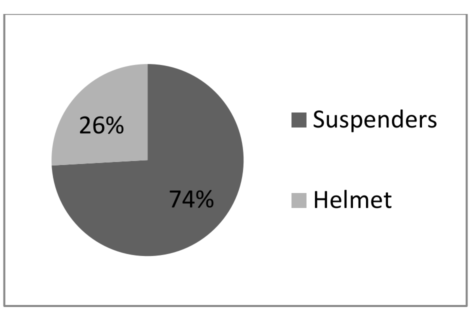



**Figure 12. Display preference.**

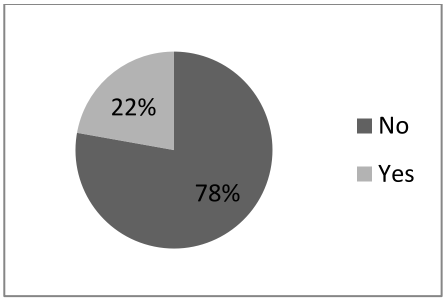



**Figure 13. Speed interference.**

<u>Ratings on Performance, Effectiveness, Accuracy, Comfortableness & Mental Effort</u>

Figure 14 shows the average ratings across participants on overall performance, effectiveness, accuracy, comfortableness, and mental effort of each display (no display, suspenders, and helmet). A rating of 1 indicates the least, while a rating of 5 indicates the most. Helmet and suspenders were rated the most for performance, effectiveness, and accuracy. The helmet display rated having the least comfort and having no display rated having the most mental effort.

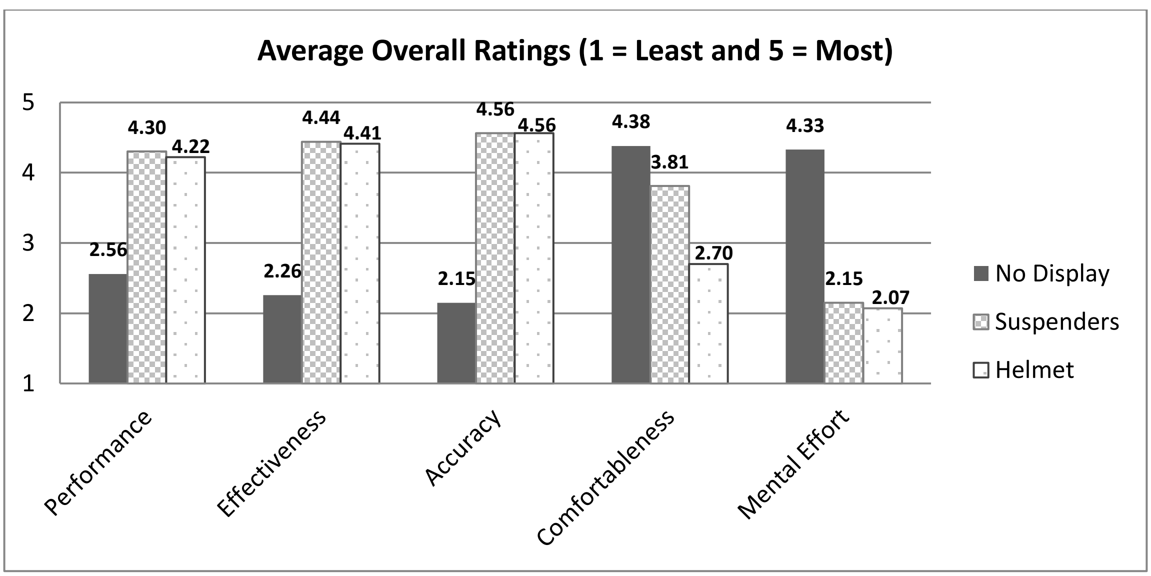



**Figure 14. Average overall ratings.**

Mixed – effects ordinal regression models using the GLIMMIX procedure in SAS were conducted in order to determine significant effects for each rating (refer to Appendix N). The GLIMMIX procedure observes estimations and interprets generalized linear mixed models (GLMs); however for this particular procedure, the GLM test is extended by integrating correlations among the participants' responses (Schabenberger, n.d.). From these models, it was shown that both displays (helmet and suspenders) influenced the participants' ratings (relative to no display) of performance ($F (2, 49) = 11.91$, $p < .0001$), effectiveness ($F (2, 49) = 16.83$, $p < .0001$), accuracy ($F (2, 47) = 15.19$, $p < .0001$), comfortableness ($F (2, 48) = 9.98$, $p =.0002$), and mental effort ($F (2, 49) = 15.78$, $p < .0001$) in a significant way. These results corroborated with Figure 14.

Ratings on Difficulty of Distractions

Figure 15 shows the average ratings across participants on how difficult the secondary tasks or distractions were for each display (no display, suspenders, and helmet). A rating of 1 indicates the least difficult, while a rating of 5 indicates the most difficult. No distractions and listening to music were rated the least difficult for all displays. Texting and both distractions were rated the most difficult when no display was present compared to when a display was present.

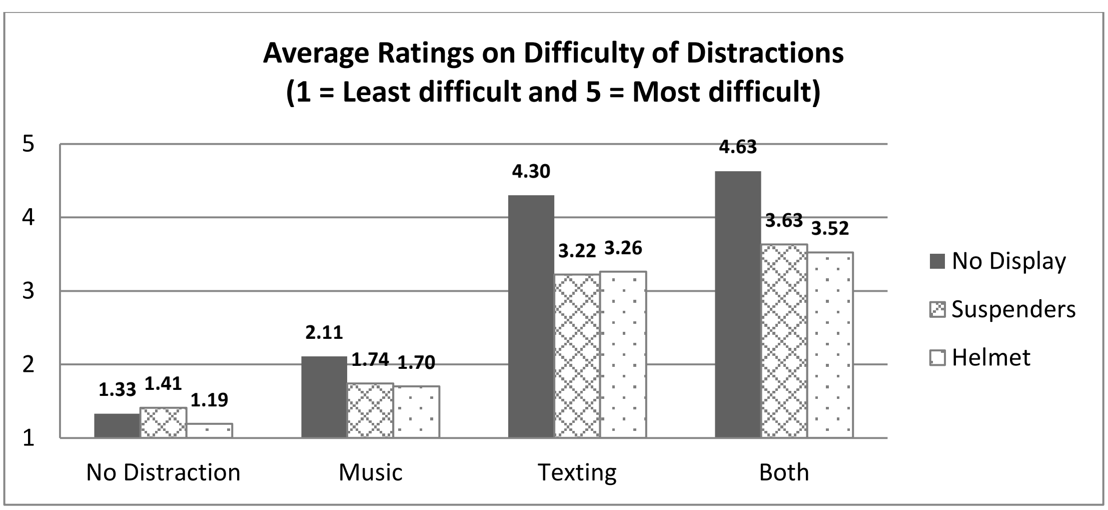



**Figure 15. Average ratings on difficulty of distractions.**

The same mixed – effects ordinal regression models were also performed for ratings on the difficulty of distractions in order to determine significant effects. From these models, it was shown that all distractions (listening to music, texting, and both) influenced the participants' ratings (relative to no distractions) for no display ($F (3, 75) = 13.75$, $p < .0001$), helmet display ($F (3, 75) = 17.22$, $p < .0001$), and suspenders display ($F (3, 75) = 14.83$, $p < .0001$) in a significant way. These results support Figure 15.

CHAPTER IV

DISCUSSION

The purpose of this current study was to determine whether vibrotactile cues are effective in improving hazard recognition and safety of pedestrians. To determine this, the study compared response times and hit rates of adults ranging from 18 to 50 years old when wearing a helmet display versus suspenders display versus wearing no display at all. Past studies have shown that tactile alert displays are more effective than visual and auditory alert displays in demanding environments where a high cognitive and visual workload exist (Elliot et al., 2010; Hameed et al., 2009 ). For this study, researchers sought to prove that the level of effectiveness for participants using the helmet display were equal to the participants using the suspenders display, and to distinguish that both displays (helmet and suspenders) were equal to the control (no display and distractions present). Results supported these hypotheses (failed to reject) in that the data analysis for this study showed no statistical significant difference between the helmet and suspenders and between both displays and the control ($p > .05$); however, data showed a statistical significance between display and secondary tasks or distractions ($p < .05$).

**Public Health Impact & Future Studies**

With new technology on the rise and more people becoming distracted due to using new technology, leading to motor-vehicle and pedestrian crashes, it is certain that intervention strategies to help prevent these crashes are needed, especially for teenagers, young adults, and older adults. A possible intervention would be to implement a vibrotactile alert system in a vehicle. Vibrating sensors can be placed in the driver's seat and seat belt in order to alert the driver of a potential hazard on the road. Since results showed that there was an increase of hit rates and faster response times while having a vibrotactile display present when distracted by both, visual and auditory distractions, there is a promising outlook for future studies related to distracted driving.

The use of the helmet and suspenders displays, in this study, was proven to be viable to wear on adults based on a two-hour period; however, further studies need to be conducted in the field, such as a construction site or oil and gas refinery that require a helmet and a vest to be worn for a 6 to 8 hour work period. This can help determine worker's reactions and perceptions on whether the displays are effective under different conditions in the field, as a proxy for high – noise and visual workload industrial environments. Pre and post studies should be encouraged to evaluate potential response time, improvements, and to measure whether there was a decrease of accidents in the workplace from wearing vibrotacile displays.

Implementing these displays in a backpack for children to wear when riding a bicycle or walking could also help to evaluate whether children would wear them and how fast they would react when a hazard approaches. It is also important to not only focus on children and teenagers, but also the older population. According to Clark (2001), teenagers are at a greater risk of getting into a motor – vehicle crash while under the influence of alcohol, unrestrained and not wearing a seat belt, driving over 60 mph (speeding), and riding as a passenger with an intoxicated driver. There is also an increase in texting and talking on the phone among teenage drivers (O'Brien et al., 2010). In contrast, older individuals (over 65 years of age) are more likely to die or get seriously injured in a crash involving visual and hearing problems, physical disabilities, prescription medications, or problems in dealing with multiple sensory conditions. There are an increasing number of older individuals that drive and therefore, building a vibrotactile display into a vehicle or clothing may be helpful.

It is also essential to determine where the alert signals on the body are more effective and whether participants favor that display. It was suggested from results by Spelmezan et al. (2009), that the location of the tactors on the body can greatly affect the perception of tactile cues. This statement can support this study in that there was a higher average hit rate across participants for suspenders display (93%) compared to the helmet display (88%) when both distractions were present. In addition, over half of participants (74%) preferred the suspenders display over the helmet display if they were to walk as a pedestrian.

## Limitations

A limitation of this study is that more participants are needed in order to further assess whether age and gender affect the difference of response times and hit rates when responding to hazards and walking on the treadmill. Another limitation involved the setup of the keyboard on the treadmill and the hand position of the participant. Participants were encouraged to keep their hand by the keyboard arrow keys in order for them to respond as fast as they could; however, several participants kept their hand to the side or on the handrail, which may have delayed the fastest response times. The keyboard was sometimes unresponsive when the arrow buttons were held down, which may have led to unintentional misses. If more time was permitted, a recommendation for this keyboard issue is implementing an emergency-type button or a remote control to press in order to avoid the hazards. The participant also had to position themselves in the middle of the sidewalk after a hazard passed; however several participants forgot to or stayed on the very edge of the sidewalk, which also may have interfered with response times. In addition, the tactors or alert signals may not have been reliable and accurate, as there was one signal that did not vibrate for the last hazard in a couple of trials. Also, the suspenders display was difficult to work with when adjusting to different participants' heights and the tactors on the back may not have been sensed or effective as the other tactors were when hazards were displayed on the projector screen. The alert signals were meant to vibrate based on the hazard's position and direction on the simulator. For instance, if a pedestrian was walking from the left to the right, the tactors would vibrate on the left side. This might have been a problem when responding due to the pedestrian walking from the left to right on the participant's right side. A recommendation for this issue would be to conduct further studies on alert signal directions presented in a pedestrian setting with a helmet or suspenders to determine whether people react faster when having the signal vibrate on the same side that the hazard is approaching or vice versa. By analyzing a person's response times in relation to a hazard's direction could help with designing alert systems. Lastly, since there were 4 different simulation scenarios that were semi-randomized throughout the 12 trials, response times may have shown a slight learning curve and sensitivity values may not have been accurate due to the fact that participants got familiar with the scenarios and types of hazards displayed.

# CHAPTER V

# CONCLUSIONS

Hit rates and response times were proven by this study to be effective enough to detect a difference between no display and having a display (suspenders or helmet) present with secondary tasks (distractions) in a controlled laboratory environment. The average hit rates increased and response times got faster when participants had a display present, as expected. Overall, results failed to reject (supported) the null hypotheses, defined in the research methods as: 1.) Level of effectiveness for the helmet display equals to the suspenders display, and 2.) Both displays (helmet and suspenders) equals to the control (no display and no distractions present). Other covariates such as age, gender, and whether the participant had more experience with walking, reading, texting, and playing video games did not significantly affect the “no display” and “display” differences. These results are positive for the future use of vibrotactile displays and to determine slight changes of hit rates and response times. As concluded from this study, fatalities involving distracted drivers and pedestrians from collisions are prevented and eliminated with the presence of vibrotactile displays.

REFERENCES


Baldwin, C., Spence, C., Bliss, J., Brill, J., Wogalter, M., Mayhorn, C. & Ferris, T. (2012). Multimodal cueing: the relative benefits of the auditory, visual, and tactile channels in complex environments. *Proceedings of the Human Factors and Ergonomic Society 56$^{th}$ Annual Meeting*, 1431 – 1435.

Brewster, S. A. and Brown, L. M. (2004). Tactons: structured tactile messages for non-visual information display. In *Australasian User Interface Conference 2004, ACS Conferences in Research and Practice in Information Technology*, Dunedin, New Zealand, 28, 15-23.

Clark, D. (2001). Motor vehicle crash fatalities in the elderly: Rural vs. urban. *The Journal of Trauma Injury, Infection, and Critical Care*, 51, 896 – 900.

Cholewiak, R. & McGrath, C. (2006). Vibrotactile targeting in multimodal systems: accuracy and interaction. *Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems*, Alexandria, Virginia, 413 - 420.

Dobrzynski, M., Mejri, S., Wischmann, S. & Floreano, D. (2012). Quantifying information transfer through a head – attached vibrotactile display: principles for design and control. *IEEE Transactions on Biomedical Engineering*, 59(7), 2011 – 2018.

Dumbaugh, E. & Gattis, J. (2005). Safe streets, livable streets. *Journal of the American Planning Association*, 71(3), 283 – 300.

Elliot, L., van Erp, J., Redden, E. & Duistermaat, M. (2010). Field-based validation of a tactile navigation device. *IEEE Transactions on Haptics*, 3(2), 78 – 87.

Elliot, L., Coovert, M., Prewett, M., Walvord, A., Saboe, K. & Johnson, R. (2009). A review and meta-analysis of vibrotactile and visual information displays (ser. ARL/TR). *Aberdeen Proving Ground, MD: Army Research Laboratory*, 1 – 18.

Ferris, T. & Sarter, N. (2011). Continuously informing vibrotactile displays in support of attention management and multitasking in anesthesiology. *Human Factors*, 53(6), 600 – 611.

Ferris, T., Stringfield, K. & Sarter, N. (2010). Tactile “change blindness” in the detection of vibration intensity. *Proceedings of the Human Factors and Ergonomics Society 54$^{th}$ Annual Meeting*, 1316 – 1320.

Ferris, T. & Sarter, N. (2008). Cross – modal links among vision, audition, and touch in complex environments. *Human Factors*, 50(1), 17 – 26.

Fitch, G., Hankey, J., Kleiner, B. & Dingus, T. (2011). Driver comprehension of multiple haptic seat alerts intended for use in an integrated collision avoidance system. *Transportation Research Part F*, 1 – 13.

Fitch, G., Kiefer, R., Hankey, J. & Kleiner, B. (2007). Toward developing an approach for alerting drivers to the direction of a crash threat. *Human Factors*, 49(4), 710 – 720.

Gallace, A., Tan, H. & Spence, C. (2006). The failure to detect tactile change: a tactile analogue of visual change blindness. *Psychonomic Bulletin & Review*, 13(2), 300 - 303.

Hameed, S., Ferris, T., Jayaraman, S. & Sarter, N. (2009). Using informative peripheral visual and tactile cues to support task and interruption management. *Human Factors*, 51(2), 126 – 135.

Hayward, V. & Maclean, K. (2007). Do it yourself haptics: part I. *IEEE Robotics & Automation Magazine*, 88 – 104.

Ho, C., Reed, N. & Spence, C. (2006). Assessing the effectiveness of "intuitive" vibrotactile warning signals in preventing front-to-rear-end collisions in a driving simulator. *Accident Analysis and Prevention*, 38, 988 – 996.

Ho, C., Tan, H. & Spence, C. (2005). Using spatial vibrotactile cues to direct visual attention in driving scenes. *Transportation Research Part F*, 8, 397 – 412.

Interpreting the repeated-measures anova using the spss general linear model program. (n.d.). Retrieved from http://oak.ucc.nau.edu/rh232/courses/EPS625/Handouts/RM-ANOVA/RM ANOVA - SPSS Interpretation.pdf

Jones, L. & Sarter, N. (2008). Tactile displays: guidance for their design and application. *Human Factors*, 50(1), 90 – 111.

Krausman, A. & White, T. (2008). Detection and localization of vibrotactile signals in moving vehicles (ser. ARL/TR). *Aberdeen Proving Ground, MD: Army Research Laboratory*, 1 – 18.

Mann, S., Huang, J., Janzen, R., Lo, R., Rampersad, V., Chen, A., & Doha, T. (2011). Blind navigation with a wearable range camera and vibrotactile helmet. In

*MM'11 Proceedings of the 19th ACM international conference on Multimedia*, Scottsdale, Arizona, 1325-1328.

Morrison, A., Knudsen, L. & Anderson, H. (2012). Urban vibrations: sensitivities in the field with a broad demographic. In *Wearable Computers (ISWC), 2012 16$^{th}$ International Symposium*, 76 – 79.

Myles, K. & Kalb, J. (2009). Vibrotactile sensitivity of the head (ser. ARL/TR). *Aberdeen Proving Ground, MD: U.S. Army Research Laboratory*, 1 – 11.

M100 driving simulation system. (n.d.). Retrieved from http://www.stisimdrive.com/datasheets/STISIM_Drive_M100_Datasheet.pdf

Nasar, J., Hecht, P. & Wener, R. (2008). Mobile telephones, distracted attention, and pedestrian safety. *Accident Analysis and Prevention*, 40, 69 – 75.

Nees, M. & Walker, B. (2009). Auditory interfaces and sonification. *The Universal Access Handbook*, 507 – 521.

O'Brien, N., Goodwin, A. & Foss, R. (2010). Talking and texting among teenage drivers: a glass half empty or half full? *Traffic Injury Prevention*, 11(6), 549 – 554.

Pradhan, A., Simons-Morton, B., Lee, S. & Klauer, S. (2011). Hazard perception and distraction in novice drivers: Effects of 12 months driving experience. Presented at *Proceedings of the Sixth International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design*, 614 – 620.

Rahal, L., Cha, J. & Saddik, A. (2009). Continuous tactile perception for vibrotactile displays. In *Robotic and Sensors Environments, IEEE International Workshop*, 86 – 91.

Schabenberger, O. (n.d.). *Introducing the glimmix procedure for generalized linear mixed models*. SAS Institute Inc., Cary, NC. Retrieved from http://www2.sas.com/proceedings/sugi30/196-30.pdf

Shope, J. (2006). Influences on youthful driving behavior and their potential for guiding interventions to reduce crashes. *Injury Prevention*, 12(1), i9 – i14.

Spelmezan, D., Jacobs, M., Hilgers, A. & Borchers, J. (2009). Tactile motion instructions for physical activities. In *Proceedings of the CHI 2009 Conference on Human Factors in Computing Systems*, *ACM Press*, Boston, Massachusetts, 2243 – 2252.

Srikulwong, M. & O'Neill, E. (2011). Wearable tactile display of landmarks and direction for pedestrian navigation: a user survey and evaluation. *International Journal of Mobile Human Computer Interaction*, 3(3), 31 – 49.

Underwood, G., Crundall, D. & Chapman, P. (2011). Driving simulator validation with hazard perception. *Transportation Research Part F*, 14, 435 – 446.

van Erp, J. (2002). Guidelines for the use of vibro-tactile displays in human computer interaction. In *Proceedings of Eurohaptics 2002,* University of Edinburgh, Scotland, 18 – 22.

van Erp, J. & van Veen, H. (2001). Vibro-tactile information presentation in automobiles. In *Proceedings of Eurohaptics 2001*, University of Edinburgh, Scotland, 99 – 104.

Violanti, J. (1998). Cellular phones and fatal traffic collisions. *Accidental Analysis and Prevention*, 30(4), 519 – 524.

Walker, B. (2002). Magnitude estimation of conceptual data dimensions for use in sonification. *Journal of Experimental Psychology: Applied*, 8(4), 211 – 221.

Walker, B. N., & Lane, D. M. (2001). Psychophysical scaling of sonification mappings: A comparison of visually impaired and sighted listeners. In *J. Hiipakka, N. Zacharov, & T. Takala (Eds.), Proceedings of the Seventh International Conference on Auditory Display*, Espoo, Finland, 90 – 94.

Wickens, C., Hollands, J., Banbury, S., & Parasuraman, R. (2012). Engineering Psychology and Human Performance, *Pearson Education, Inc*., 4.

Wickens, C. (2002). Multiple resources and performance prediction. *Theoretical Issues in Ergonomics Science*, 3(2), 159 – 177.

Wixted, J., & Lee, K. (n.d.). *Signal detection theory*. Retrieved from http://kangleelab.com/signal detection theory.html

APPENDIX A

DEMOGRAPHIC QUESTIONNAIRE

**Participant #:**

**1.) Gender?**
**a.)** Female; **b.)** Male

**2.) Age?**
**a.)** 18 – 20; **b.)** 21 – 29; **c.)** 30 – 40; **d.)** 41-50

**3.) If possible, what is your average amount of time (in minutes) walking per day?**
**a.)** 0; **b.)** 1 – 30; **b.)** More than 30 and less than 60; **c.)** 60 or more

**4.) If possible, what is your average amount of time (in minutes) reading per day?**
**a.)** 0; **b.)** 1 - 30; **c.)** More than 30

**5.) If possible, what is your average amount of time (in minutes) texting on a touchscreen device per day?**
**a.)** 0; **b.)** 1 – 30; **c.** More than 30

**6.) What kind of touchscreen device do you use?**

**7.) If possible, what is your average amount of time (in hours) playing video games per week?**
**a.)** 0; **b.)** 1 – 2; **c.)** More than 2

**8.) On average, how often do you listen to music per week while walking (or driving)?**
**a.)** Don't listen to music; **b.)** Sometimes; **c.)** Often; **d.)** Very often

**9.) If possible, what type of music do you listen to while walking (or driving)?**
**a.)** None; **b.)** Rock/Hip Hop (Pop)**; c.)** Country; **d.)** Alternative; **e.)** Other: __________

APPENDIX B

QUALITATIVE QUESTIONNAIRE

**Participant #:**

**1.) Rate your overall performance for each display?**

| | ***Worst*** | | | | ***Best*** |
|---|---|---|---|---|---|
| Helmet | **1** | **2** | **3** | **4** | **5** |
| Suspenders | **1** | **2** | **3** | **4** | **5** |
| No Display (Baseline) | **1** | **2** | **3** | **4** | **5** |

**Other Comments?**

**2.) Rate the overall effectiveness for each display?**

| | ***Least Effective*** | | | | ***Most Effective*** |
|---|---|---|---|---|---|
| Helmet | **1** | **2** | **3** | **4** | **5** |
| Suspenders | **1** | **2** | **3** | **4** | **5** |
| No Display (Baseline) | **1** | **2** | **3** | **4** | **5** |

**Other Comments?**

**3.) Rate the overall accuracy of each display in detecting hazards?**

| | ***Least Accurate*** | | | | ***Most Accurate*** |
|---|---|---|---|---|---|
| Helmet | **1** | **2** | **3** | **4** | **5** |
| Suspenders | **1** | **2** | **3** | **4** | **5** |
| No Display (Baseline) | **1** | **2** | **3** | **4** | **5** |

**Other Comments?**

**4.) Rate the overall comfortableness for each display?**

| | ***Least Comfort*** | | | | ***Most Comfort*** |
|---|---|---|---|---|---|
| Helmet | **1** | **2** | **3** | **4** | **5** |
| Suspenders | **1** | **2** | **3** | **4** | **5** |
| No Display (Baseline) | **1** | **2** | **3** | **4** | **5** |

**Other Comments?**

**5.) Rate your overall mental effort used for each display?**

| | ***Least Effort*** | | | | ***Most Effort*** |
|---|---|---|---|---|---|
| Helmet | **1** | **2** | **3** | **4** | **5** |
| Suspenders | **1** | **2** | **3** | **4** | **5** |
| No Display (Baseline) | **1** | **2** | **3** | **4** | **5** |

**Other Comments?**

**6.) Rate how difficult the secondary tasks (distractions) were without either display?**

| | ***Least Difficult*** | | | | ***Most Difficult*** |
|---|---|---|---|---|---|
| No tasks | **1** | **2** | **3** | **4** | **5** |
| Listening to music | **1** | **2** | **3** | **4** | **5** |
| Reading/Texting on a touchscreen device | **1** | **2** | **3** | **4** | **5** |
| Both tasks together | **1** | **2** | **3** | **4** | **5** |

**Other Comments?**

**7.) Rate how difficult the secondary tasks (distractions) were with the HELMET display?**

| | ***Least Difficult*** | | | | ***Most Difficult*** |
|---|---|---|---|---|---|
| No tasks | **1** | **2** | **3** | **4** | **5** |
| Listening to music | **1** | **2** | **3** | **4** | **5** |
| Reading/Texting on a touchscreen device | **1** | **2** | **3** | **4** | **5** |
| Both tasks together | **1** | **2** | **3** | **4** | **5** |

**Other Comments?**

**8.) Rate how difficult the secondary tasks (distractions) were with the SUSPENDERS display?**

| | ***Least Difficult*** | | | | ***Most Difficult*** |
|---|---|---|---|---|---|
| No tasks | **1** | **2** | **3** | **4** | **5** |
| Listening to music | **1** | **2** | **3** | **4** | **5** |
| Reading/Texting on a touchscreen device | **1** | **2** | **3** | **4** | **5** |
| Both tasks together | **1** | **2** | **3** | **4** | **5** |

**Other Comments?**

**9.) If you were to have a display while walking as a pedestrian, which display (1. NO DISPLAY, 2. HELMET, or 3. SUSPENDERS) would you choose? Why?**

**10.) Did the speed of the driving simulator interfere with your judgment of responding to hazards? If yes, please explain.**

**Other comments/suggestions for this study?**

APPENDIX C

CONSENT FORM

**TEXAS A&M UNIVERSITY HUMAN SUBJECTS PROTECTION PROGRAM**

**CONSENT FORM**

Project Title: **THE DESIGN OF VIBROTACTILE ALERT SYSTEMS TO SUPPORT HAZARD AWARENESS AND SAFETY OF PEDESTRIANS USING A TREADMILL.**

You are invited to take part in a research study being conducted by **Angela C. Marsalia**, a researcher (or study coordinator) from Texas A&M University and funded by **NIOSH Training Grant Program**. The information in this form is provided to help you decide whether or not to take part. If you decide to take part in the study, you will be asked to sign this consent form. If you decide you do not want to participate, there will be no penalty to you, and you will not lose any benefits you normally would have.

**Why Is This Study Being Done?**
The purpose of this study is to determine whether vibrotactile cues are effective in improving hazard recognition or awareness and safety pedestrians using a treadmill and a driving simulator. Certain hazards that are addressed involve pedestrians, including the elderly, children and teenagers, along with the disadvantaged (those that are handicapped, blind, or deaf); bicyclists; motorcyclists; other motor - vehicles; in addition to workers who drive on the job to transport hazardous materials, freight, or passengers, such as bus drivers or large trucks; and also those who work in construction and operate forklifts or other types of machines. Due to limited visual and auditory senses from talking or texting on cell phones or listening to music, this research is intended to investigate whether a haptic display involving touch can increase awareness and provide a faster reaction time to certain hazards.

**Why Am I Being Asked To Be In This Study?**
You are being asked to be in this study because you are:
1. An undergraduate, graduate student, and faculty either at Texas A&M Health Science Center – SRPH or Texas A&M University, who is 18 – 50 years of age;
2. Able to walk on a treadmill for at least 30 minutes at a slow, but leisurely pace;
3. Familiar with reading and texting on a touchscreen device;
4. Must be 250 pounds or less to walk on the treadmill; and
5. English - speaking only

**How Many People Will Be Asked To Be In This Study?**
Overall, a total of approximately 100 people will be invited to participate in this study at one laboratory center at Texas A&M University; however, up to 40 participants are required.

**What Are the Alternatives to being in this study?**
None, the alternative to being in the study is not to participate.

**What Will I Be Asked To Do In This Study?**
You will be asked to fill out a demographic questionnaire prior to testing and a qualitative questionnaire once the testing is done. Participants will be tested by walking on a treadmill using a driving simulator and presented with various hazards in each trial that are randomly situated. The following 12 trials will also be randomly assigned for each participant (except for 1):

1.) Test or practice run with no vibrotactile display, hazards, or distractions to get familiar with walking on the treadmill and using the driving simulator;
2.) No distraction with helmet;
3.) No distraction with suspenders;
4.) Listening to music with headphones (no vibrotactile display);
5.) Reading/texting on a touchscreen device (no vibrotactile display);
6.) Both listening to music and reading/texting on a touchscreen device (no vibrotactile display);
7.) Listening to music with helmet;
8.) Reading/texting on a touchscreen device with helmet;
9.) Listening to music with suspenders;
10.) Reading/texting on a touchscreen device with suspenders;
11.) Both listening to music and reading/texting on a touchscreen device with helmet;
12.) Both listening to music and reading/texting on a touchscreen device with suspenders

Your participation in this study will last up to **2 hours or less** and includes **one** visit.

**Will Photos, Video or Audio Recordings Be Made Of Me during the Study?**
The researchers will take photographs during the study for PowerPoint and poster presentation purposes only if you give your permission to do so. Indicate your decision below by initialing in the space provided.

________ I give my permission for photographs to be made of me during my participation in this research study.

________ I do not give my permission for photographs to be made of me during my participation in this research study.

**Are There Any Risks To Me?**
The things that you will be doing are no greater than risks that you would come across in everyday life. The types of hazards include:

1. Participants will be using both their visual and auditory senses at the same time while walking on a treadmill and responding to approaching hazards via a driving simulator, therefore there might be potential for tripping or falling and any other adverse events involved when falling on the treadmill;
2. Cramping;
3. Blisters or a burning sensation of the feet;
4. Ankles aching;
5. Any dizziness or weakness when walking and performing secondary tasks (distractions);
6. Burning sensation in the chest;
7. Joint pain; and
8. The information of participants will be gathered and protected, however they can still be identified (*Note: Information will be discarded after the study is completely finished)

**Are There Any Benefits To Me?**
The direct benefit to you by being in this study is that you will be walking on a treadmill, which:

1. Produces less impact on bones and joints;
2. Works different muscles of the lower body;
3. Helps manage chronic health conditions, boosts immune system, and strengthens the heart;
4. Also, participants do not have to worry about tripping over rocks, tree roots, getting a sunburn, or getting drenched by a rainfall;
5. Increase in hazard awareness;
6. Improved driving and pedestrian environment; and
7. Decrease in total number of motor-vehicle and pedestrian - related collisions in a population or in society

**Will There Be Any Costs To Me?**
Aside from your time, there are no costs for taking part in the study.

**Will I Have To Pay Anything If I Get Hurt In This Study?**
If you suffer any injury as a result of taking part in this research study, please understand that nothing has been arranged to provide free treatment of the injury or any other type of payment. However, all needed facilities, emergency treatment and professional services will be available to you, just as they are to the community in general. You

should report any injury to Dr. Mark Benden at (979) 845-8773. You will not give up any of your legal rights by signing this consent form.

**Will I Be Paid To Be In This Study?**
You will receive $10 in cash for participating in this study. Disbursement of your payment will occur in person, in the laboratory, right after testing is completed.

**Will Information From This Study Be Kept Private?**
The records of this study will be kept private. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be stored securely and **only the PI, Co-I's, research assistants, and I** will have access to the records.

Information about you will be stored in a locked file cabinet and properly discarded of once the study is officially done; computer files will be protected with a password. This consent form will be filed securely in an official area.

People who have access to your information include the Principal Investigator and research study personnel. Representatives of regulatory agencies such as the Office of Human Research Protections (OHRP) and entities such as the Texas A&M University Human Subjects Protection Program may access your records to make sure the study is being run correctly and that information is collected properly.

The agency that funds this study (**NIOSH**) and the institution(s) where study procedures are being performed (**Texas A&M University**) may also see your information. However, any information that is sent to them will be coded with a number so that they cannot tell who you are. Representatives from these entities can see information that has your name on it if they come to the study site to view records. If there are any reports about this study, your name will not be in them.

Information about you and related to this study will be kept confidential to the extent permitted or required by law.

**Who may I Contact for More Information?**
You may contact the Principal Investigator, Dr. Mark Benden CPE, Ph.D., to tell him about a concern or complaint about this research at (979) 845-8773 or mbenden@srph.tamhsc.edu. You may also contact the Co - Investigator, Dr. Thomas Ferris Ph.D., at (979) 458-2340 or tferris@tamu.edu.

For questions about your rights as a research participant; or if you have questions, complaints, or concerns about the research, you may call the Texas A&M University Human Subjects Protection Program office at (979) 458-4067 or irb@tamu.edu.

**What if I Change My Mind About Participating?**

This research is voluntary and you have the choice whether or not to be in this research study. You may decide to not begin or to stop participating at any time. If you choose not to be in this study or stop being in the study, there will be no effect on your student status, medical care, employment, evaluation, relationship with Texas A&M University, etc. Any new information discovered about the research will be provided to you. This information could affect your willingness to continue your participation.

**STATEMENT OF CONSENT**

**I agree to be in this study and know that I am not giving up any legal rights by signing this form. The procedures, risks, and benefits have been explained to me, and my questions have been answered. I know that new information about this research study will be provided to me as it becomes available and that the researcher will tell me if I must be removed from the study. I can ask more questions if I want, (if applicable) and I can still receive services if I stop participating in this study. A copy of this entire consent form will be given to me.**

________________________________________________________________________

Participant’s Signature Date

____________________________________ ______________________________

Printed Name Date

**INVESTIGATOR'S AFFIDAVIT**:

Either I have or my agent has carefully explained to the participant the nature of the above project. I hereby certify that to the best of my knowledge the person who signed this consent form was informed of the nature, demands, benefits, and risks involved in his/her participation.

____________________________________ ______________________________

Signature of Presenter Date

____________________________________ ______________________________

Printed Name Date

APPENDIX D

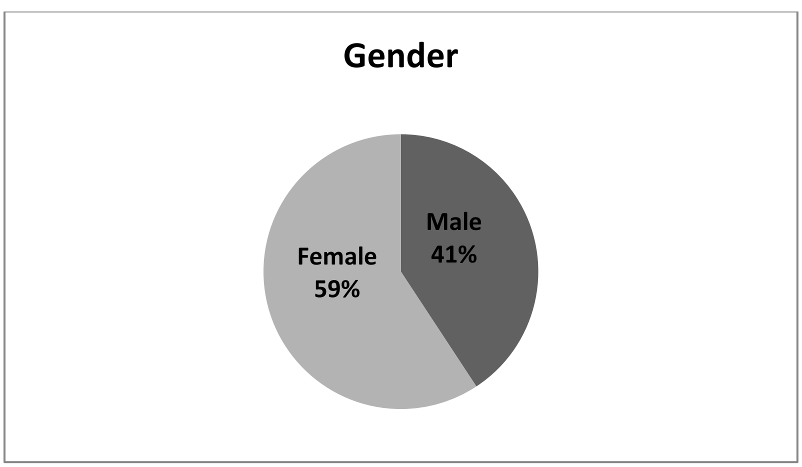
RAW DATA/GRAPHS/STATISTICAL OUTPUTS

## ***Demographics***

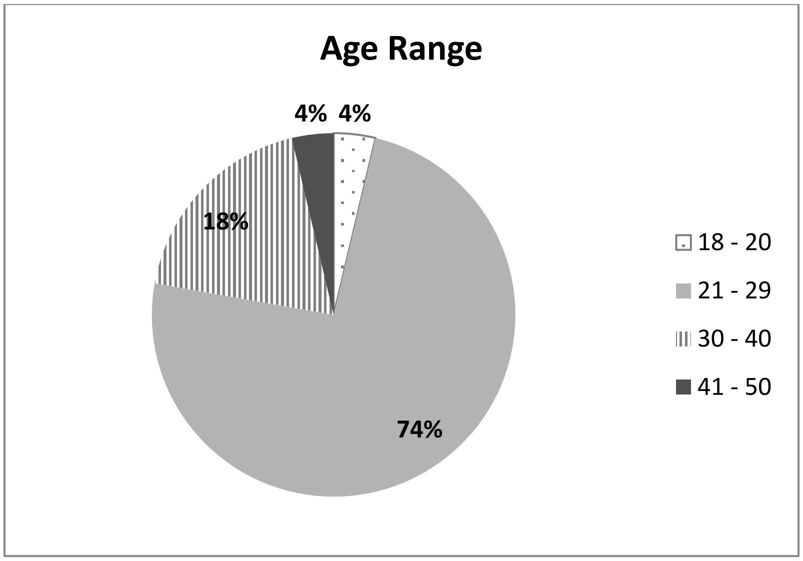
| Participant # | Gender | Age | Average time walking per day? | Average time reading per day? | Average time texting per day? |
|---|---|---|---|---|---|
| 1 | 1 | 2 | 3 | 3 | 2 |
| 2 | 2 | 3 | 3 | 3 | 2 |
| 3 | 2 | 2 | 3 | 3 | 2 |
| 4 | 1 | 2 | 3 | 2 | 3 |
| 5 | 1 | 2 | 2 | 3 | 3 |
| 6 | 2 | 3 | 2 | 3 | 2 |
| 7 | 2 | 2 | 4 | 3 | 3 |
| 8 | 1 | 2 | 3 | 3 | 3 |
| 9 | 1 | 2 | 4 | 2 | 2 |
| 10 | 1 | 2 | 4 | 3 | 3 |
| 11 | 1 | 1 | 3 | 2 | 3 |
| 12 | 1 | 2 | 3 | 3 | 2 |
| 13 | 2 | 2 | 2 | 3 | 2 |
| 14 | 1 | 2 | 3 | 3 | 2 |
| 15 | 2 | 2 | 2 | 2 | 3 |
| 16 | 2 | 3 | 4 | 3 | 3 |
| 17 | 1 | 3 | 3 | 3 | 2 |
| 18 | 2 | 2 | 4 | 3 | 3 |
| 19 | 1 | 3 | 4 | 3 | 2 |
| 20 | 2 | 4 | 4 | 3 | 3 |
| 21 | 1 | 2 | 3 | 3 | 3 |
| 22 | 2 | 2 | 3 | 3 | 3 |
| 23 | 1 | 2 | 2 | 3 | 2 |
| 24 | 1 | 2 | 3 | 3 | 3 |
| 25 | 1 | 2 | 3 | 3 | 3 |
| 26 | 2 | 2 | 4 | 2 | 3 |
| 27 | 1 | 2 | 2 | 3 | 2 |

| Participant # | Kind of touchscreen device used | Average time playing video games | How often listening to music | Type of music listened to the most |
|---|---|---|---|---|
| 1 | iPhone and an iPad | 1 | 4 | 2, 5 |
| 2 | Droid Incredible Smartphone | 2 | 3 | 2 |
| 3 | iPhone | 1 | 2 | 3 |
| 4 | iPad | 1 | 1 | 2 |
| 5 | Samsung Galaxy | 2 | 4 | 2, 3, 4 |
| 6 | An iPad | 2 | 2 | 2 |
| 7 | Smartphone & tablet | 1 | 2 | 2 |
| 8 | Phone, iPad, laptop | 1 | 4 | 2, 4 |
| 9 | Droid | 1 | 4 | 2, 3, 4 |
| 10 | iPhone/iPad | 1 | 4 | 2 |
| 11 | Smartphone Galaxy S2 | 3 | 4 | 5 |
| 12 | iPad/iPhone | 1 | 2 | 3 |
| 13 | Nokia Xpress Music Phone & iPad 2 | 1 | 4 | 2, 3 |
| 14 | iPod touch | 2 | 3 | 5 |
| 15 | iPhone | 3 | 4 | 2 |
| 16 | iPad | 3 | 4 | 2, 3, 4, 5 |
| 17 | iPad | 1 | 2 | 1 |
| 18 | iPhone | 2 | 4 | 4 |
| 19 | iPad | 1 | 4 | 2 |
| 20 | Smartphone | 3 | 4 | 2 |
| 21 | iPhone | 2 | 4 | 3 |
| 22 | iPad/iPhone | 2 | 4 | 2 |
| 23 | Mobile phone | 1 | 2 | 5 |
| 24 | Cell phones | 1 | 4 | 2 |
| 25 | Cell phone | 1 | 2 | 2, 4 |
| 26 | iPhone 4S | 1 | 3 | 2 |
| 27 | iPhone 4S | 1 | 4 | 2 |

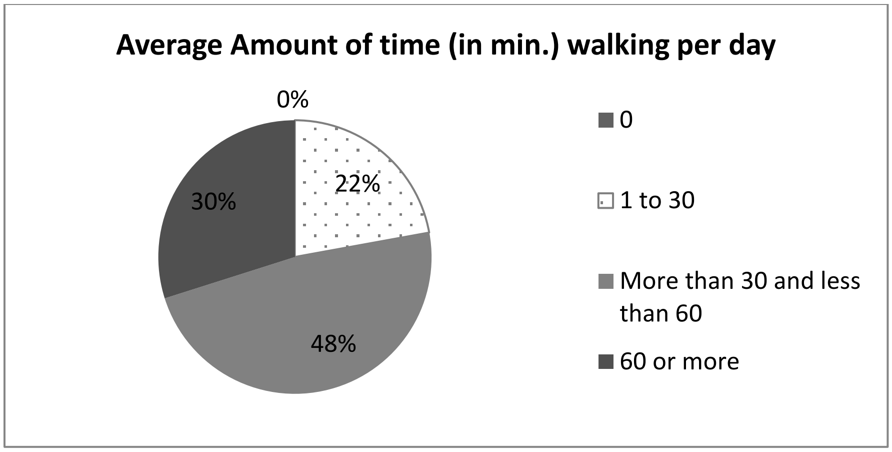
| | Gender | |
|---|---|---|
| | Male | Female |
| Percent | 0.4 | 0.6 |
| Number | 11 | 16 |



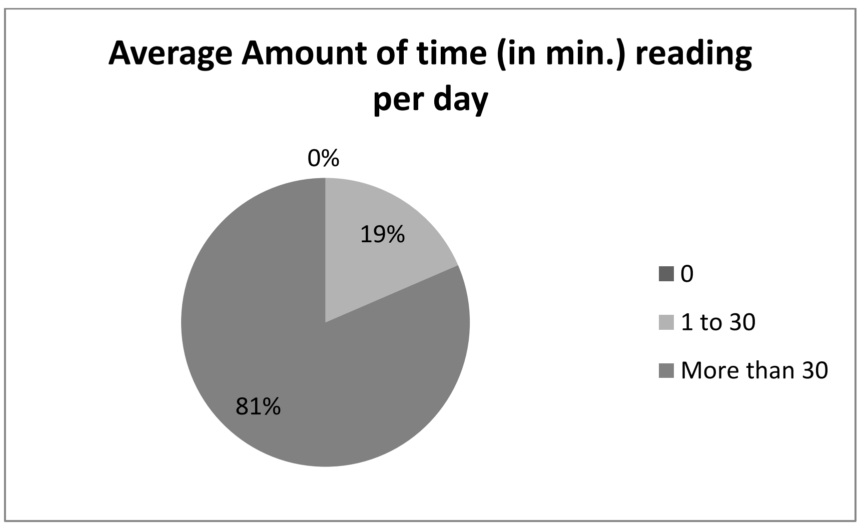
| | Age Range | | | |
|---|---|---|---|---|
| | 18 - 20 | 21 - 29 | 30 - 40 | 41 – 50 |
| **Percent** | **0.04** | **0.7** | **0.2** | **0.04** |
| **Number** | **1** | **20** | **5** | **1** |



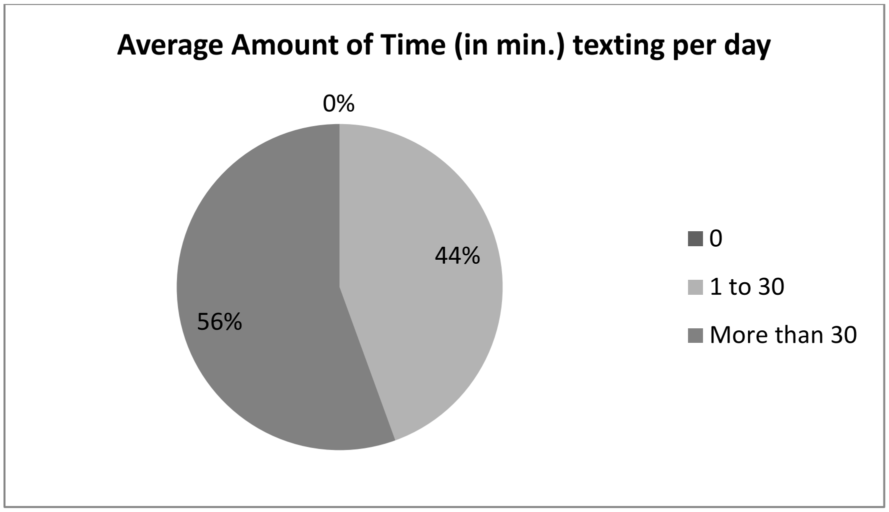

| | Average Amount of time (in minutes) walking per day | | | |
|---|---|---|---|---|
| | 0 | 1 to 30 | More than 30 and less than 60 | 60 or more |
| **Percent** | **0** | **0.2** | **0.5** | **0.3** |
| **Number** | **0** | **6** | **13** | **8** |



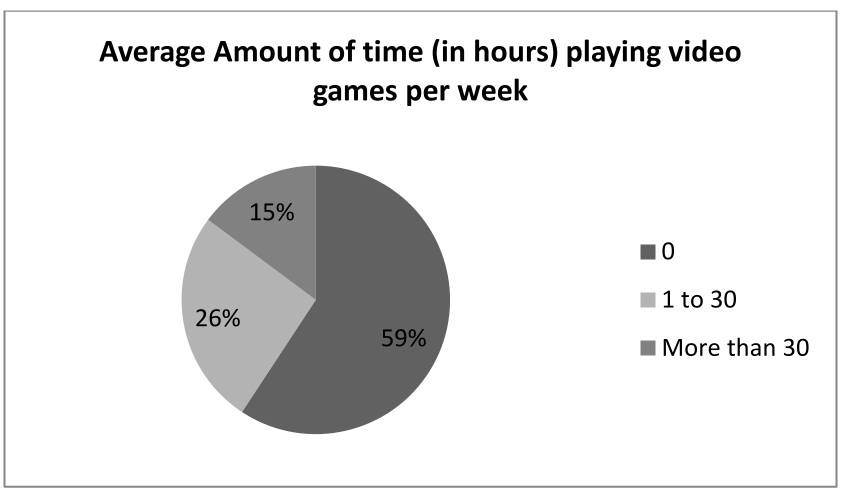

| | Average Amount of time (in minutes) reading per day | | |
|---|---|---|---|
| | **0** | **1 to 30** | **More than 30** |
| **Percent** | **0** | **0.2** | **0.8** |
| **Number** | **0** | **5** | **22** |



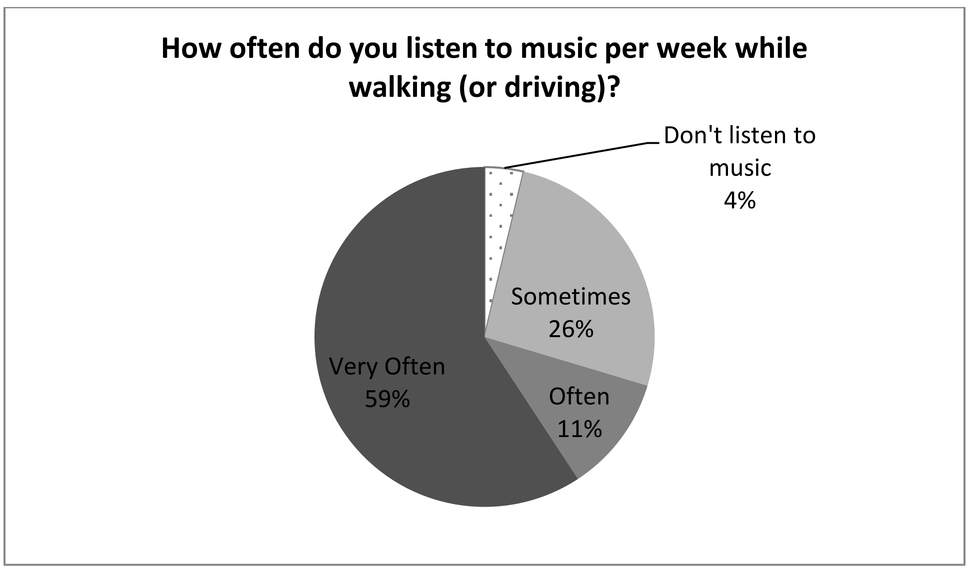

| | Average Amount of time (in minutes) texting per day | | |
|---|---|---|---|
| | **0** | **1 to 30** | **More than 30** |
| **Percent** | **0** | **0.4** | **0.6** |
| **Number** | **0** | **12** | **15** |



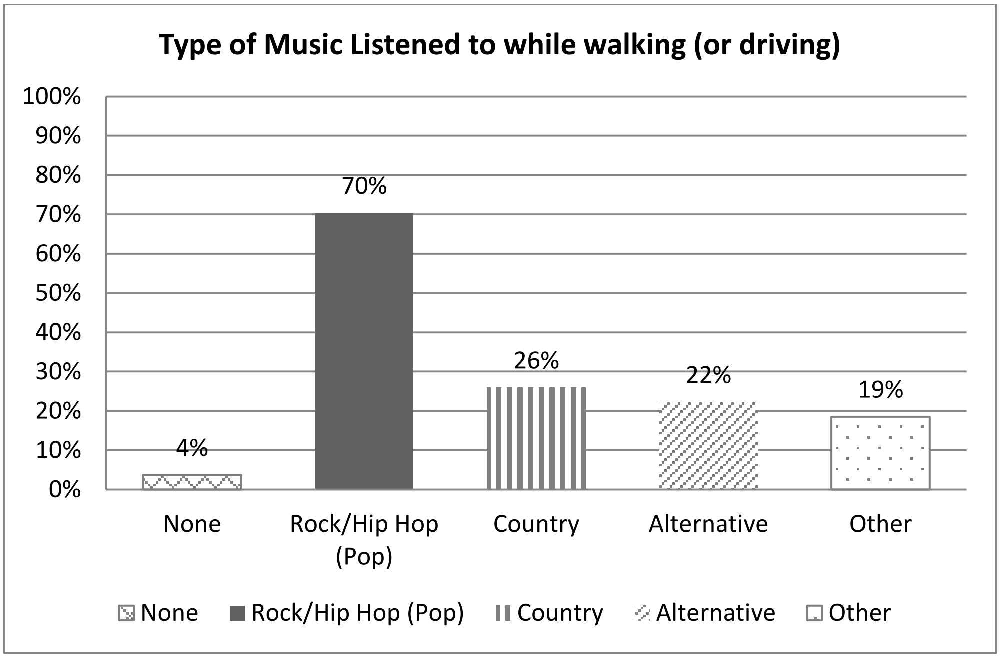

| | Average Amount of time (in hours) playing video games per week | | |
|---|---|---|---|
| | 0 | 1 to 30 | More than 30 |
| Percent | 0.6 | 0.3 | 0.1 |
| Number | 16 | 7 | 4 |



| | How often do you listen to music per week while walking (or driving)? | | | |
|---|---|---|---|---|
| | Don't listen to music | Sometimes | Often | Very Often |
| Percent | 0.04 | 0.3 | 0.1 | 0.6 |
| Number | 1 | 7 | 3 | 16 |




| | What type of music do you listen to while walking (or driving)? | | | | |
|---|---|---|---|---|---|
| | None | Rock/Hip Hop (Pop) | Country | Alternative | Other |
| Percent | 0.04 | 0.7 | 0.3 | 0.2 | 0.2 |
| Number | 1 | 19 | 7 | 6 | 5 |

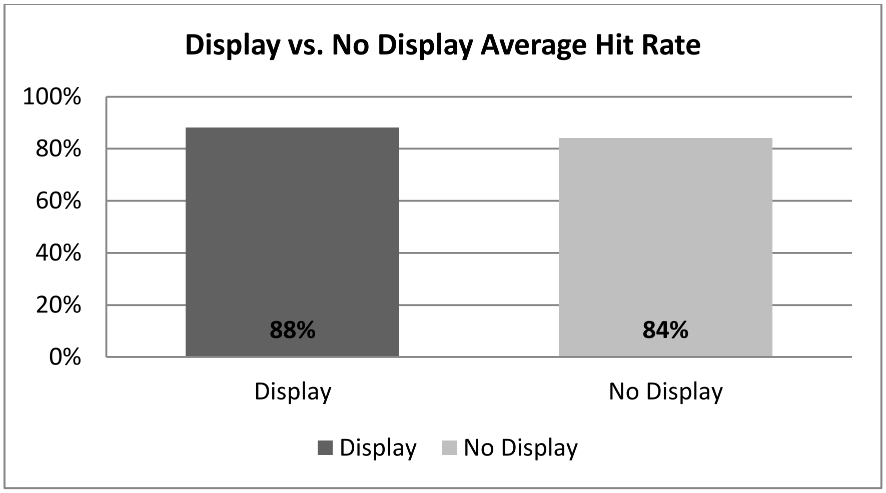

Type of Music Listened to while walking (or driving)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
4%
70%
26%
22%
19%
None
Rock/Hip Hop (Pop)
Country
Alternative
Other
None
Rock/Hip Hop (Pop)
Country
Alternative
Other

APPENDIX E

RAW DATA/GRAPHS/STATISTICAL OUTPUTS

***No Display vs. Display***

| | No Display | Display |
|---|---|---|
| **1** | 0.66 | 0.77 |
| **2** | 0.91 | 0.91 |
| **3** | 0.91 | 0.95 |
| **4** | 0.69 | 0.73 |
| **5** | 0.88 | 0.83 |
| **6** | 0.91 | 1.00 |
| **7** | 0.72 | 0.91 |
| **8** | 0.84 | 0.77 |
| **9** | 0.88 | 0.97 |
| **10** | 0.94 | 1.00 |
| **11** | 0.91 | 1.00 |
| **12** | 0.84 | 0.77 |
| **13** | 0.78 | 0.83 |
| **14** | 0.84 | 0.95 |
| **15** | 0.64 | 0.81 |
| **16** | 0.94 | 0.97 |
| **17** | 0.97 | 0.98 |
| **18** | 0.81 | 0.67 |
| **19** | 1.00 | 0.98 |
| **20** | 0.81 | 0.78 |
| **21** | 0.63 | 0.70 |
| **22** | 0.91 | 0.94 |
| **23** | 0.81 | 0.97 |
| **24** | 0.91 | 1.00 |
| **25** | 0.63 | 0.69 |
| **26** | 0.97 | 0.95 |
| **27** | 0.84 | 0.95 |
| **Averages** | 0.84 | 0.88 |




**Paired Samples Statistics**

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pair 1 | No_Display | .8363 | 27 | .11014 | .02120 |
| | Display | .8807 | 27 | .11063 | .02129 |

**Paired Samples Correlations**

| | | N | Correlation | Sig. |
|---|---|---|---|---|
| Pair 1 | No_Display & Display | 27 | .749 | .000 |

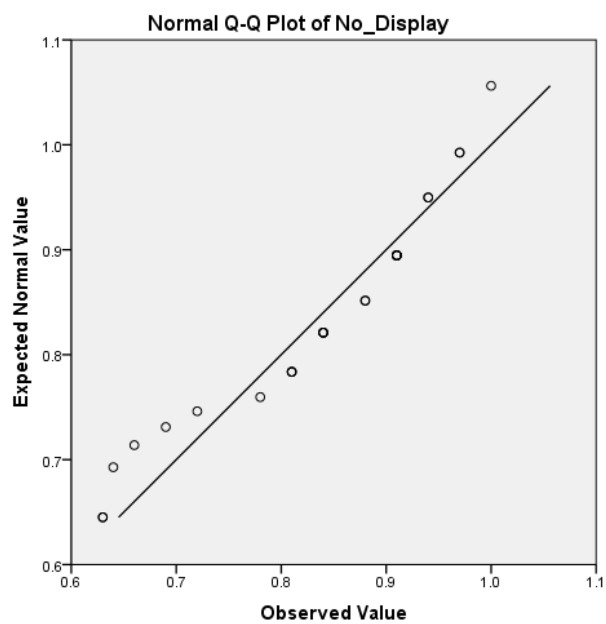
**Paired Samples Test**

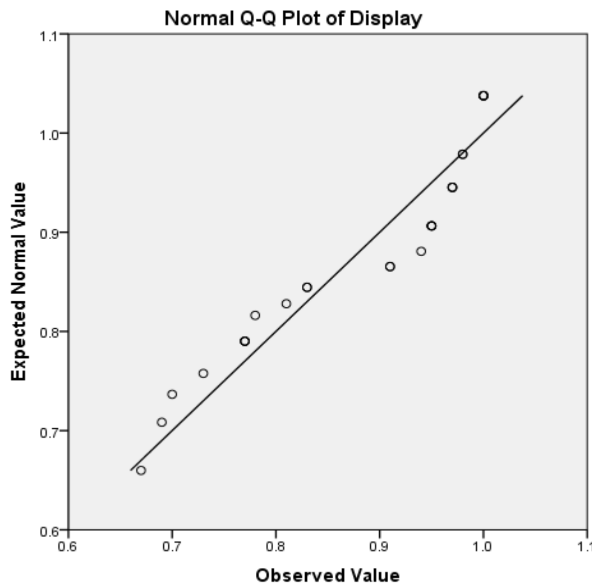
| | Paired Differences | | | |
|---|---|---|---|---|
| | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference |

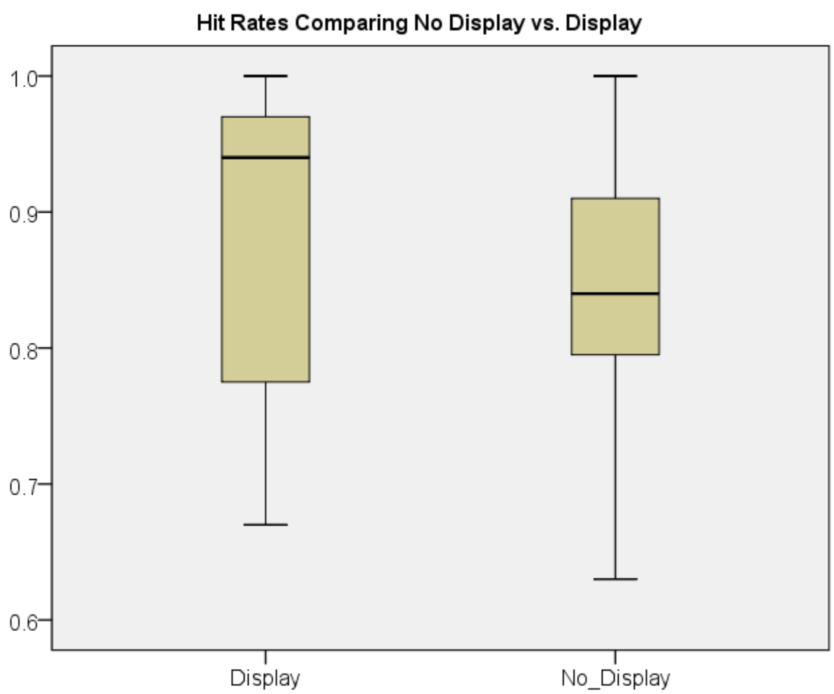
| | | | | | Lower |
|---|---|---|---|---|---|
| Pair 1 | No_Display - Display | -.04444 | .07827 | .01506 | -.07541 |

**Paired Samples Test**

| | | Paired Differences | t | Df | Sig. (2-tailed) |
|---|---|---|---|---|---|
| | | 95% Confidence Interval of the Difference | | | |
| | | Upper | | | |
| Pair 1 | No_Display - Display | -.01348 | -2.951 | 26 | .007 |




Normal Q-Q Plot of Display
Expected Normal Value
Observed Value
0.6
0.7
0.8
0.9
1.0
1.1

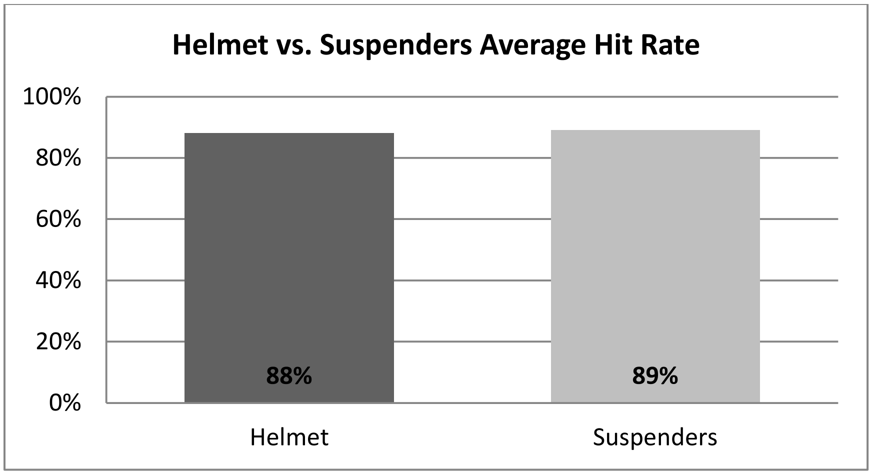

Hit Rates Comparing No Display vs. Display
1.0
0.9
0.8
0.7
0.6
Display
No_Display

APPENDIX F

RAW DATA/GRAPHS/STATISTICAL OUTPUTS

***Helmet vs. Suspenders***

| | Suspenders | Helmet |
|---|---|---|
| **1** | 0.78 | 0.75 |
| **2** | 0.97 | 0.84 |
| **3** | 0.97 | 0.94 |
| **4** | 0.66 | 0.81 |
| **5** | 0.94 | 0.72 |
| **6** | 1.00 | 1.00 |
| **7** | 0.94 | 0.88 |
| **8** | 0.75 | 0.78 |
| **9** | 0.94 | 1.00 |
| **10** | 1.00 | 1.00 |
| **11** | 1.00 | 1.00 |
| **12** | 0.75 | 0.78 |
| **13** | 0.81 | 0.84 |
| **14** | 0.97 | 0.94 |
| **15** | 0.72 | 0.91 |
| **16** | 1.00 | 0.94 |
| **17** | 0.97 | 1.00 |
| **18** | 0.75 | 0.59 |
| **19** | 0.97 | 1.00 |
| **20** | 0.75 | 0.81 |
| **21** | 0.69 | 0.72 |
| **22** | 0.94 | 0.94 |
| **23** | 1.00 | 0.94 |
| **24** | 1.00 | 1.00 |
| **25** | 0.72 | 0.66 |
| **26** | 0.97 | 0.94 |
| **27** | 0.97 | 0.94 |
| **Averages** | 0.89 | 0.88 |




**Paired Samples Statistics**

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pair 1 | Suspenders | .8863 | 27 | .12004 | .02310 |
| | Helmet | .8767 | 27 | .11770 | .02265 |

**Paired Samples Correlations**

| | | N | Correlation | Sig. |
|---|---|---|---|---|
| Pair 1 | Suspenders & Helmet | 27 | .757 | .000 |

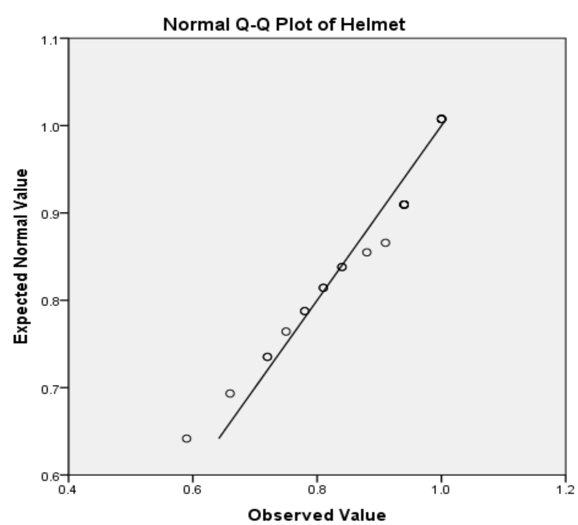
**Paired Samples Test**

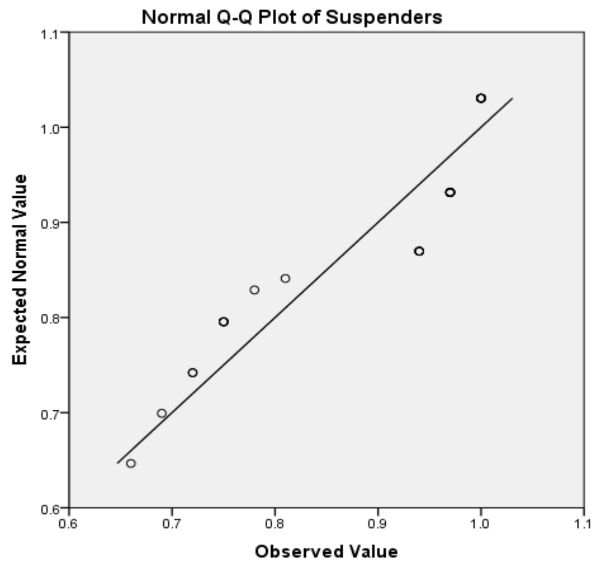
| | Paired Differences |
|---|---|

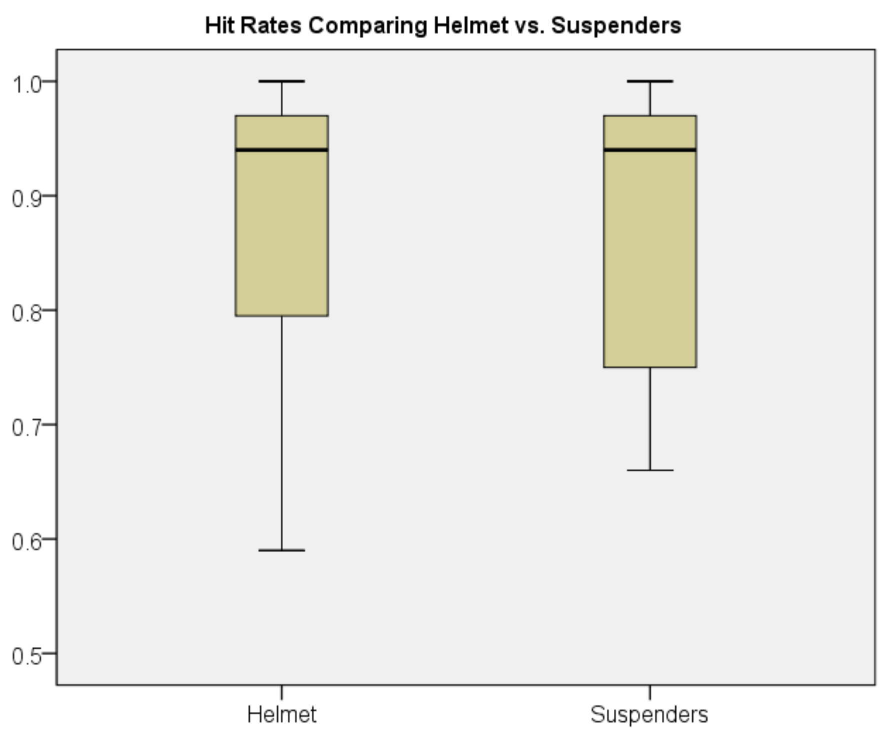
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference |
|---|---|---|---|---|---|
| | | | | | Lower |
| Pair 1 | Suspenders - Helmet | .00963 | .08286 | .01595 | -.02315 |

**Paired Samples Test**

| | | Paired Differences | t | Df | Sig. (2-tailed) |
|---|---|---|---|---|---|
| | | 95% Confidence Interval of the Difference | | | |
| | | Upper | | | |
| Pair 1 | Suspenders - Helmet | .04241 | .604 | 26 | .551 |



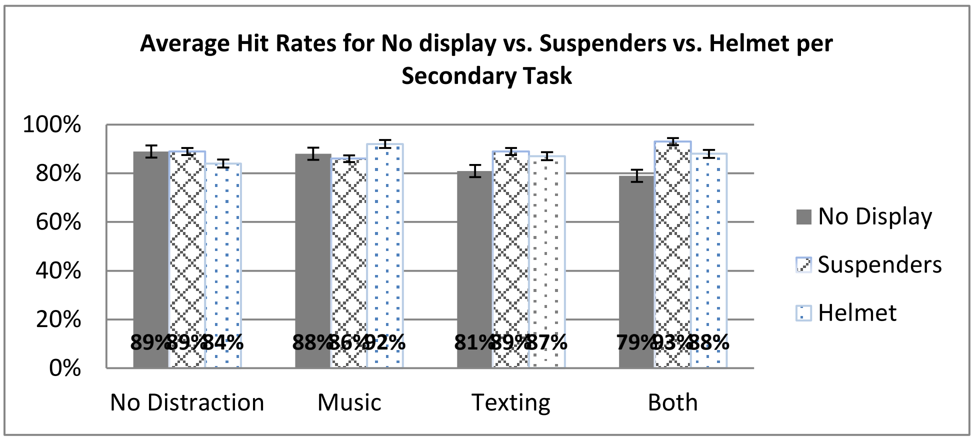

Normal Q-Q Plot of Suspenders
Expected Normal Value
Observed Value
0.6
0.7
0.8
0.9
1.0
1.1

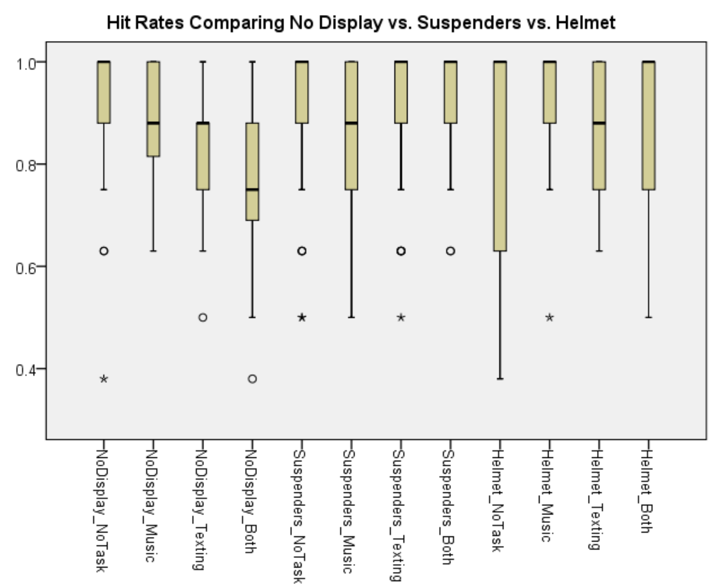

Hit Rates Comparing Helmet vs. Suspenders
1.0
0.9
0.8
0.7
0.6
0.5
Helmet
Suspenders

APPENDIX G

RAW DATA/GRAPHS/STATISTICAL OUTPUTS

***No Display vs. Suspenders vs. Helmet per Secondary Task***



**Mauchly's Test of Sphericity**

**Measure: HitRate**

| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Epsilon[b] Greenhouse-Geisser |
|---|---|---|---|---|---|
| display | .953 | 1.216 | 2 | .544 | .955 |
| task | .594 | 12.886 | 5 | .025 | .734 |
| display * task | .232 | 34.791 | 20 | .022 | .742 |

**Mauchly's Test of Sphericity[a]**

Measure: HitRate

| Within Subjects Effect | Epsilon Huynh-Feldt | Epsilon Lower-bound |
|---|---|---|
| display | 1.000 | .500 |
| task | .805 | .333 |
| display * task | .915 | .167 |

**Multivariate Tests[a]**

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| display | Pillai's Trace | .267 | 4.561[b] | 2.000 | 25.000 | .020 |
| | Wilks' Lambda | .733 | 4.561[b] | 2.000 | 25.000 | .020 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Hotelling's Trace | .365 | 4.561[b] | 2.000 | 25.000 | .020 |
| | Roy's Largest Root | .365 | 4.561[b] | 2.000 | 25.000 | .020 |
| task | Pillai's Trace | .152 | 1.434[b] | 3.000 | 24.000 | .258 |
| | Wilks' Lambda | .848 | 1.434[b] | 3.000 | 24.000 | .258 |
| | Hotelling's Trace | .179 | 1.434[b] | 3.000 | 24.000 | .258 |
| | Roy's Largest Root | .179 | 1.434[b] | 3.000 | 24.000 | .258 |
| display * task | Pillai's Trace | .612 | 5.509[b] | 6.000 | 21.000 | .001 |
| | Wilks' Lambda | .388 | 5.509[b] | 6.000 | 21.000 | .001 |
| | Hotelling's Trace | 1.574 | 5.509[b] | 6.000 | 21.000 | .001 |
| | Roy's Largest Root | 1.574 | 5.509[b] | 6.000 | 21.000 | .001 |

**Pairwise Comparisons**

Measure: HitRate

| (I) display | (J) display | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] |
|---|---|---|---|---|---|

| | | | | | Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|
| 1 | 2 | -.046* | .015 | .005 | -.078 | -.015 |
| | 3 | -.031 | .017 | .074 | -.066 | .003 |
| 2 | 1 | .046* | .015 | .005 | .015 | .078 |
| | 3 | .015 | .014 | .297 | -.014 | .044 |
| 3 | 1 | .031 | .017 | .074 | -.003 | .066 |
| | 2 | -.015 | .014 | .297 | -.044 | .014 |

**Pairwise Comparisons**

Measure: HitRate

| | | | | | | 95% Confidence Interval for Difference[b] |
|---|---|---|---|---|---|---|
| task | (I) display | (J) display | Mean Difference (I-J) | Std. Error | Sig.[b] | Lower Bound |
| 1 | 1 | 2 | .005 | .029 | .857 | -.053 |
| | | 3 | .056 | .031 | .078 | -.007 |
| | 2 | 1 | -.005 | .029 | .857 | -.064 |
| | | 3 | .051 | .035 | .152 | -.020 |
| | 3 | 1 | -.056 | .031 | .078 | -.119 |
| | | 2 | -.051 | .035 | .152 | -.122 |
| 2 | 1 | 2 | .029 | .023 | .231 | -.019 |
| | | 3 | -.036 | .024 | .139 | -.085 |
| | 2 | 1 | -.029 | .023 | .231 | -.076 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 3 | -.065* | .026 | .020 | -.119 |
| | 3 | 1 | .036 | .024 | .139 | -.013 |
| | | 2 | .065* | .026 | .020 | .011 |
| 3 | 1 | 2 | -.082* | .037 | .035 | -.158 |
| | | 3 | -.055 | .038 | .159 | -.133 |
| | 2 | 1 | .082* | .037 | .035 | .006 |
| | | 3 | .027 | .026 | .298 | -.026 |
| | 3 | 1 | .055 | .038 | .159 | -.023 |
| | | 2 | -.027 | .026 | .298 | -.080 |
| 4 | 1 | 2 | -.137* | .029 | .000 | -.197 |
| | | 3 | -.091* | .034 | .013 | -.162 |
| | 2 | 1 | .137* | .029 | .000 | .078 |
| | | 3 | .046 | .034 | .185 | -.024 |
| | 3 | 1 | .091* | .034 | .013 | .020 |
| | | 2 | -.046 | .034 | .185 | -.116 |

**Pairwise Comparisons**

Measure: HitRate

| display | (I) task | (J) task | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| 1 | 1 | 2 | .009 | .026 | .728 | -.045 | .063 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 3 | .083* | .036 | .030 | .008 | .157 |
| | | 4 | .106* | .037 | .008 | .031 | .181 |
| | 2 | 1 | -.009 | .026 | .728 | -.063 | .045 |
| | | 3 | .073* | .030 | .023 | .011 | .136 |
| | | 4 | .097* | .026 | .001 | .043 | .150 |
| | 3 | 1 | -.083* | .036 | .030 | -.157 | -.008 |
| | | 2 | -.073* | .030 | .023 | -.136 | -.011 |
| | | 4 | .023 | .038 | .540 | -.054 | .101 |
| | 4 | 1 | -.106* | .037 | .008 | -.181 | -.031 |
| | | 2 | -.097* | .026 | .001 | -.150 | -.043 |
| | | 3 | -.023 | .038 | .540 | -.101 | .054 |
| 2 | 1 | 2 | .033 | .030 | .292 | -.030 | .095 |
| | | 3 | -.005 | .038 | .901 | -.084 | .074 |
| | | 4 | -.037 | .034 | .296 | -.107 | .034 |
| | 2 | 1 | -.033 | .030 | .292 | -.095 | .030 |
| | | 3 | -.037 | .030 | .226 | -.099 | .025 |
| | | 4 | -.069* | .025 | .010 | -.121 | -.018 |
| | 3 | 1 | .005 | .038 | .901 | -.074 | .084 |
| | | 2 | .037 | .030 | .226 | -.025 | .099 |
| | | 4 | -.032 | .028 | .272 | -.090 | .027 |
| | 4 | 1 | .037 | .034 | .296 | -.034 | .107 |
| | | 2 | .069* | .025 | .010 | .018 | .121 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 3 | .032 | .028 | .272 | -.027 | .090 |
| 3 | 1 | 2 | -.083 | .041 | .052 | -.167 | .001 |
| | | 3 | -.029 | .034 | .409 | -.098 | .041 |
| | | 4 | -.041 | .039 | .291 | -.121 | .038 |
| | 2 | 1 | .083 | .041 | .052 | -.001 | .167 |
| | | 3 | .055* | .026 | .046 | .001 | .109 |
| | | 4 | .042 | .035 | .246 | -.031 | .114 |
| | 3 | 1 | .029 | .034 | .409 | -.041 | .098 |
| | | 2 | -.055* | .026 | .046 | -.109 | -.001 |
| | | 4 | -.013 | .034 | .702 | -.082 | .056 |
| | 4 | 1 | .041 | .039 | .291 | -.038 | .121 |
| | | 2 | -.042 | .035 | .246 | -.114 | .031 |
| | | 3 | .013 | .034 | .702 | -.056 | .082 |

APPENDIX H

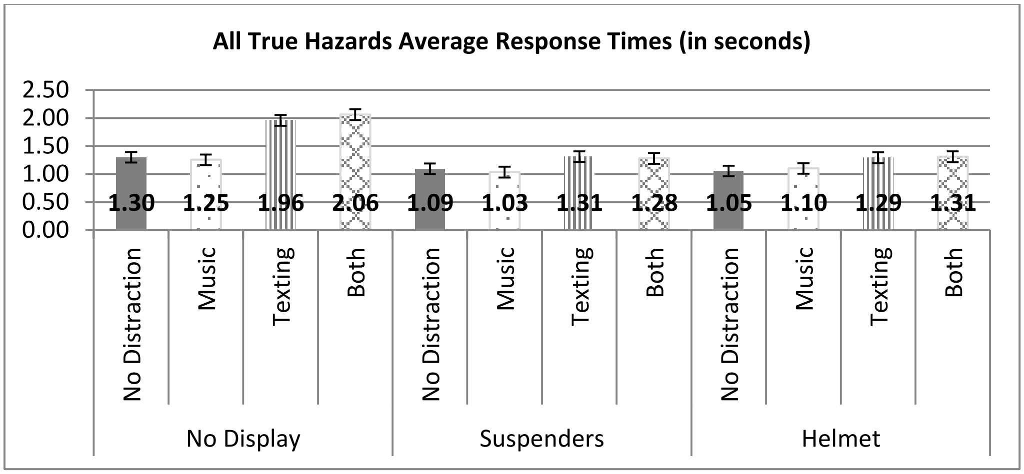
RAW DATA/GRAPHS/STATISTICAL OUTPUTS

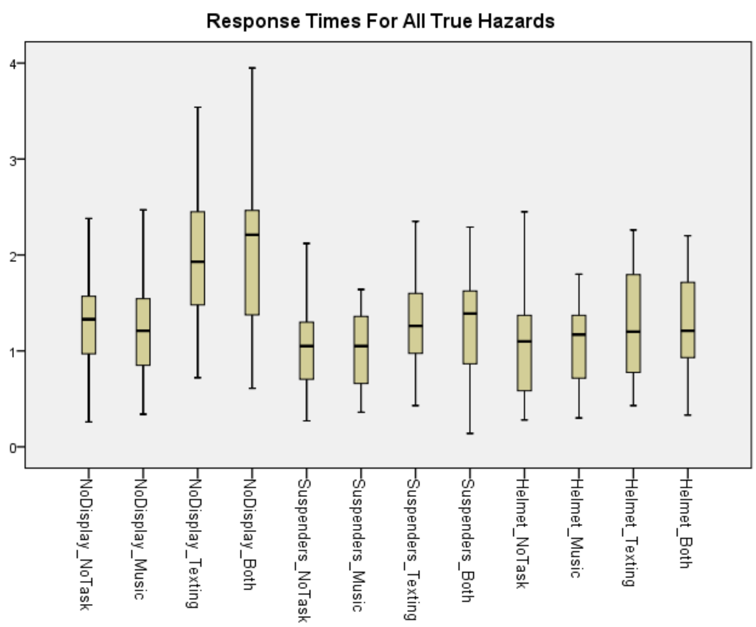
***All True Hazards***

| | N1 | N2 | N3 | N4 | S1 | S2 | S3 | S4 | H1 | H2 | H3 | H4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 1.85 | 2.47 | 2.47 | 2.33 | 2.12 | 1.64 | 2.35 | 1.57 | 1.10 | 1.80 | 1.33 | 2.20 |
| **2** | 2.38 | 2.26 | 2.38 | 3.01 | 1.24 | 1.46 | 1.98 | 1.98 | 2.45 | 1.69 | 2.17 | 1.85 |
| **3** | 1.29 | 0.78 | 1.88 | 2.15 | 0.64 | 0.69 | 1.52 | 1.40 | 0.63 | 0.67 | 0.98 | 1.76 |
| **4** | 1.54 | 1.41 | 2.70 | 2.63 | 1.23 | 1.35 | 1.85 | 2.29 | 1.41 | 1.13 | 2.26 | 1.68 |
| **5** | 1.19 | 1.74 | 2.05 | 3.00 | 1.27 | 1.37 | 1.21 | 1.39 | 1.85 | 1.41 | 1.88 | 1.16 |
| **6** | 1.51 | 0.70 | 1.49 | 2.08 | 1.05 | 0.90 | 0.85 | 0.70 | 1.54 | 1.44 | 1.57 | 1.02 |
| **7** | 1.21 | 1.43 | 2.92 | 2.46 | 0.78 | 1.05 | 1.63 | 1.79 | 1.25 | 1.17 | 2.08 | 1.57 |
| **8** | 2.11 | 1.21 | 1.49 | 3.32 | 0.82 | 0.97 | 1.89 | 1.77 | 1.37 | 1.06 | 1.30 | 1.77 |
| **9** | 1.60 | 1.55 | 2.48 | 3.28 | 1.55 | 1.55 | 2.05 | 1.93 | 1.28 | 1.32 | 1.71 | 1.74 |
| **10** | 0.88 | 0.85 | 2.19 | 0.84 | 0.77 | 0.52 | 0.99 | 0.92 | 0.28 | 0.55 | 0.74 | 0.61 |
| **11** | 1.33 | 0.85 | 2.43 | 2.00 | 1.31 | 1.09 | 1.49 | 1.43 | 1.29 | 1.28 | 0.59 | 1.34 |
| **12** | 0.92 | 1.42 | 1.93 | 3.95 | 1.19 | 0.89 | 1.01 | 1.23 | 0.92 | 0.72 | 1.08 | 1.69 |
| **13** | 0.86 | 0.83 | 0.72 | 1.05 | 0.43 | 0.50 | 0.73 | 1.57 | 0.40 | 0.71 | 0.71 | 0.87 |
| **14** | 1.20 | 1.54 | 1.85 | 2.44 | 0.89 | 1.29 | 1.57 | 1.16 | 1.28 | 1.38 | 1.20 | 1.17 |
| **15** | 1.98 | 1.68 | 2.81 | 2.28 | 2.11 | 1.52 | 1.97 | 2.27 | 1.89 | 1.65 | 1.99 | 2.20 |
| **16** | 0.89 | 1.09 | 0.85 | 0.79 | 0.56 | 0.56 | 0.62 | 0.49 | 0.43 | 0.60 | 0.46 | 0.79 |
| **17** | 1.37 | 1.19 | 3.54 | 0.95 | 1.02 | 1.58 | 1.26 | 0.58 | 0.66 | 1.22 | 0.94 | 1.21 |
| **18** | 1.41 | 1.23 | 1.47 | 1.51 | 1.13 | 1.16 | 1.44 | 1.50 | 1.00 | 1.34 | 1.01 | 1.09 |
| **19** | 1.02 | 0.92 | 1.93 | 1.75 | 0.57 | 0.62 | 0.98 | 1.52 | 0.57 | 0.54 | 1.37 | 1.11 |
| **20** | 1.36 | 1.82 | 1.52 | 2.21 | 0.50 | 0.63 | 0.73 | 0.78 | 0.92 | 1.07 | 0.74 | 0.90 |
| **21** | 1.74 | 1.23 | 1.69 | 1.84 | 1.29 | 1.31 | 1.50 | 0.94 | 1.11 | 1.21 | 2.11 | 1.62 |
| **22** | 0.72 | 1.18 | 1.40 | 2.47 | 0.94 | 0.85 | 0.97 | 1.05 | 0.60 | 1.08 | 1.70 | 1.45 |
| **23** | 1.05 | 1.17 | 1.10 | 2.24 | 1.49 | 1.09 | 1.15 | 1.15 | 0.50 | 1.36 | 1.01 | 0.96 |
| **24** | 0.39 | 0.34 | 1.96 | 0.78 | 0.27 | 0.36 | 0.43 | 0.14 | 0.47 | 0.30 | 0.81 | 0.33 |
| **25** | 1.70 | 1.82 | 2.83 | 2.42 | 1.90 | 1.37 | 1.32 | 1.68 | 1.45 | 1.56 | 1.99 | 2.09 |
| **26** | 1.33 | 0.57 | 1.46 | 1.24 | 1.96 | 0.95 | 0.99 | 0.81 | 1.37 | 0.71 | 0.70 | 0.44 |
| **27** | 0.26 | 0.57 | 1.32 | 0.61 | 0.51 | 0.63 | 0.92 | 0.50 | 0.46 | 0.73 | 0.43 | 0.70 |

| Display | Task | Average Response Times |
|---|---|---|
| No Display | No Distraction | 1.30 |
| | Music | 1.25 |
| | Texting | 1.96 |
| | Both | 2.06 |
| Suspenders | No Distraction | 1.09 |
| | Music | 1.03 |
| | Texting | 1.31 |

| | | |
|---|---|---|
| | Both | 1.28 |
| Helmet | No Distraction | 1.05 |
| | Music | 1.10 |
| | Texting | 1.29 |
| | Both | 1.31 |



**Mauchly's Test of Sphericity[a]**

Measure: ResponseTime

| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Epsilon[b] |
|---|---|---|---|---|---|
| | | | | | Greenhouse-Geisser |
| display | .929 | 1.850 | 2 | .397 | .933 |
| task | .722 | 8.051 | 5 | .154 | .833 |
| display * task | .168 | 42.476 | 20 | .003 | .629 |

**Mauchly's Test of Sphericity[a]**

Measure: ResponseTime

| Within Subjects Effect | Epsilon | |
|---|---|---|
| | Huynh-Feldt | Lower-bound |
| Display | 1.000 | .500 |
| Task | .929 | .333 |
| display * task | .749 | .167 |

**Multivariate Tests[a]**

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| display | Pillai's Trace | .825 | 58.762[b] | 2.000 | 25.000 | .000 |
| | Wilks' Lambda | .175 | 58.762[b] | 2.000 | 25.000 | .000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Hotelling's Trace | 4.701 | 58.762[b] | 2.000 | 25.000 | .000 |
| | Roy's Largest Root | 4.701 | 58.762[b] | 2.000 | 25.000 | .000 |
| task | Pillai's Trace | .673 | 16.440[b] | 3.000 | 24.000 | .000 |
| | Wilks' Lambda | .327 | 16.440[b] | 3.000 | 24.000 | .000 |
| | Hotelling's Trace | 2.055 | 16.440[b] | 3.000 | 24.000 | .000 |
| | Roy's Largest Root | 2.055 | 16.440[b] | 3.000 | 24.000 | .000 |
| dispnlay * task | Pillai's Trace | .648 | 6.434[b] | 6.000 | 21.000 | .001 |
| | Wilks' Lambda | .352 | 6.434[b] | 6.000 | 21.000 | .001 |
| | Hotelling's Trace | 1.838 | 6.434[b] | 6.000 | 21.000 | .001 |
| | Roy's Largest Root | 1.838 | 6.434[b] | 6.000 | 21.000 | .001 |

**Pairwise Comparisons**

Measure: ResponseTime

| (I) display | (J) display | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| 1 | 2 | .463* | .052 | .000 | .356 | .571 |
| | 3 | .454* | .043 | .000 | .366 | .543 |
| 2 | 1 | -.463* | .052 | .000 | -.571 | -.356 |
| | 3 | -.009 | .044 | .837 | -.099 | .081 |
| 3 | 1 | -.454* | .043 | .000 | -.543 | -.366 |
| | 2 | .009 | .044 | .837 | -.081 | .099 |

**Pairwise Comparisons**

Measure: ResponseTime

| (I) task | (J) task | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| 1 | 2 | .020 | .050 | .684 | -.082 | .123 |
| | 3 | -.370* | .067 | .000 | -.507 | -.234 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 4 | -.400* | .081 | .000 | -.565 | -.234 |
| 2 | 1 | -.020 | .050 | .684 | -.123 | .082 |
| | 3 | -.391* | .061 | .000 | -.517 | -.265 |
| | 4 | -.420* | .079 | .000 | -.583 | -.258 |
| 3 | 1 | .370* | .067 | .000 | .234 | .507 |
| | 2 | .391* | .061 | .000 | .265 | .517 |
| | 4 | -.029 | .076 | .705 | -.186 | .128 |
| 4 | 1 | .400* | .081 | .000 | .234 | .565 |
| | 2 | .420* | .079 | .000 | .258 | .583 |
| | 3 | .029 | .076 | .705 | -.128 | .186 |

**Pairwise Comparisons**

Measure: ResponseTime

| task | (I) display | (J) display | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] |
|---|---|---|---|---|---|---|
| | | | | | | Lower Bound |
| 1 | 1 | 2 | .206* | .088 | .027 | .025 |
| | | 3 | .245* | .067 | .001 | .106 |
| | 2 | 1 | -.206* | .088 | .027 | -.386 |
| | | 3 | .039 | .094 | .681 | -.155 |
| | 3 | 1 | -.245* | .067 | .001 | -.383 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 2 | -.039 | .094 | .681 | -.233 |
| 2 | 1 | 2 | .220* | .070 | .004 | .076 |
| | | 3 | .154* | .065 | .025 | .020 |
| | 2 | 1 | -.220* | .070 | .004 | -.365 |
| | | 3 | -.067 | .040 | .107 | -.149 |
| | 3 | 1 | -.154* | .065 | .025 | -.287 |
| | | 2 | .067 | .040 | .107 | -.015 |
| 3 | 1 | 2 | .647* | .112 | .000 | .416 |
| | | 3 | .667* | .124 | .000 | .412 |
| | 2 | 1 | -.647* | .112 | .000 | -.877 |
| | | 3 | .020 | .096 | .837 | -.178 |
| | 3 | 1 | -.667* | .124 | .000 | -.921 |
| | | 2 | -.020 | .096 | .837 | -.218 |
| 4 | 1 | 2 | .781* | .132 | .000 | .511 |
| | | 3 | .752* | .122 | .000 | .501 |
| | 2 | 1 | -.781* | .132 | .000 | -1.051 |
| | | 3 | -.029 | .074 | .699 | -.181 |
| | 3 | 1 | -.752* | .122 | .000 | -1.004 |
| | | 2 | .029 | .074 | .699 | -.123 |

**Pairwise Comparisons**

Measure: ResponseTime

| display | (I) task | (J) task | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| 1 | 1 | 2 | .046 | .081 | .577 | -.121 | .213 |
| | | 3 | -.658* | .126 | .000 | -.918 | -.399 |
| | | 4 | -.761* | .143 | .000 | -1.055 | -.466 |
| | 2 | 1 | -.046 | .081 | .577 | -.213 | .121 |
| | | 3 | -.704* | .127 | .000 | -.965 | -.443 |
| | | 4 | -.807* | .134 | .000 | -1.082 | -.532 |
| | 3 | 1 | .658* | .126 | .000 | .399 | .918 |
| | | 2 | .704* | .127 | .000 | .443 | .965 |
| | | 4 | -.103 | .186 | .586 | -.485 | .280 |
| | 4 | 1 | .761* | .143 | .000 | .466 | 1.055 |
| | | 2 | .807* | .134 | .000 | .532 | 1.082 |
| | | 3 | .103 | .186 | .586 | -.280 | .485 |
| 2 | 1 | 2 | .061 | .064 | .350 | -.071 | .192 |
| | | 3 | -.217* | .087 | .020 | -.396 | -.038 |
| | | 4 | -.185 | .108 | .099 | -.408 | .037 |
| | 2 | 1 | -.061 | .064 | .350 | -.192 | .071 |
| | | 3 | -.278* | .057 | .000 | -.395 | -.160 |
| | | 4 | -.246* | .091 | .012 | -.433 | -.059 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 3 | 1 | .217* | .087 | .020 | .038 | .396 |
| | | 2 | .278* | .057 | .000 | .160 | .395 |
| | | 4 | .032 | .070 | .653 | -.112 | .176 |
| | 4 | 1 | .185 | .108 | .099 | -.037 | .408 |
| | | 2 | .246* | .091 | .012 | .059 | .433 |
| | | 3 | -.032 | .070 | .653 | -.176 | .112 |
| 3 | 1 | 2 | -.045 | .072 | .538 | -.194 | .104 |
| | | 3 | -.236* | .087 | .011 | -.414 | -.058 |
| | | 4 | -.253* | .098 | .016 | -.454 | -.052 |
| | 2 | 1 | .045 | .072 | .538 | -.104 | .194 |
| | | 3 | -.191* | .091 | .045 | -.377 | -.005 |
| | | 4 | -.208* | .077 | .012 | -.367 | -.050 |
| | 3 | 1 | .236* | .087 | .011 | .058 | .414 |
| | | 2 | .191* | .091 | .045 | .005 | .377 |
| | | 4 | -.017 | .085 | .843 | -.192 | .158 |
| | 4 | 1 | .253* | .098 | .016 | .052 | .454 |
| | | 2 | .208* | .077 | .012 | .050 | .367 |
| | | 3 | .017 | .085 | .843 | -.158 | .192 |

APPENDIX I

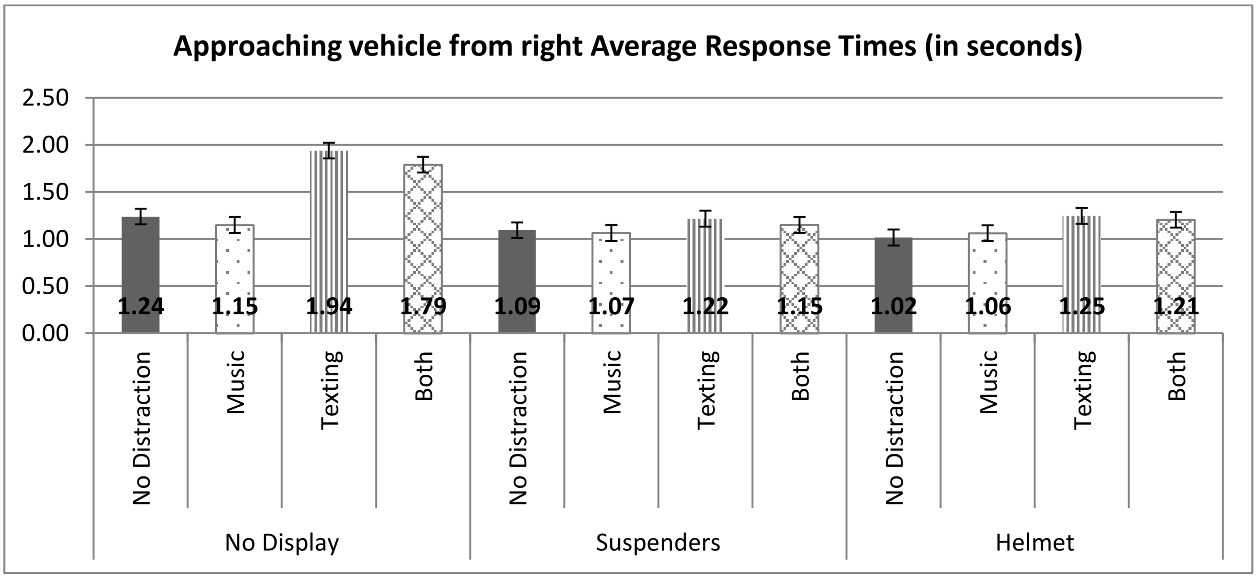
RAW DATA/GRAPHS/STATISTICAL OUTPUTS

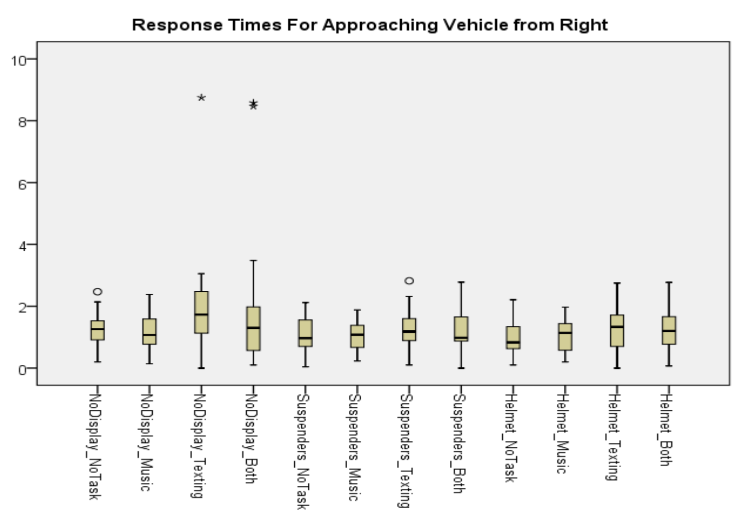
***Approaching vehicle from right***

| | N1 | N2 | N3 | N4 | S1 | S2 | S3 | S4 | H1 | H2 | H3 | H4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 1.49 | 2.38 | 2.39 | 1.66 | 0.80 | 0.74 | 1.20 | 0.95 | 0.63 | 1.38 | 1.42 | 0.07 |
| **2** | 2.14 | 2.05 | 1.73 | 1.80 | 0.90 | 1.27 | 1.17 | 1.64 | 2.21 | 1.14 | 2.45 | 2.24 |
| **3** | 0.91 | 0.81 | 2.23 | 1.00 | 0.65 | 0.60 | 0.90 | 2.05 | 0.77 | 0.63 | 1.05 | 1.83 |
| **4** | 1.12 | 1.42 | 2.24 | 1.26 | 1.60 | 1.14 | 1.74 | 2.78 | 1.65 | 0.94 | 2.75 | 1.20 |
| **5** | 0.92 | 2.25 | 2.63 | 2.10 | 0.74 | 1.88 | 0.97 | 1.04 | 1.09 | 1.94 | 1.50 | 1.52 |
| **6** | 1.22 | 0.14 | 1.00 | 1.30 | 1.49 | 0.90 | 1.18 | 0.97 | 1.67 | 1.32 | 1.97 | 1.08 |
| **7** | 0.97 | 1.46 | 2.88 | 2.25 | 0.80 | 0.83 | 1.97 | 1.69 | 0.83 | 0.89 | 1.64 | 0.87 |
| **8** | 1.52 | 1.04 | 0.07 | 8.47 | 0.04 | 1.08 | 1.70 | 1.67 | 1.25 | 1.37 | 0.43 | 2.77 |
| **9** | 1.90 | 1.57 | 2.90 | 2.70 | 1.29 | 1.82 | 2.32 | 2.30 | 1.24 | 1.22 | 1.75 | 1.37 |
| **10** | 1.53 | 0.34 | 3.05 | 0.15 | 1.57 | 1.07 | 0.88 | 0.92 | 0.10 | 0.20 | 0.00 | 1.52 |
| **11** | 1.38 | 0.80 | 1.55 | 0.90 | 1.54 | 0.69 | 1.31 | 1.03 | 1.70 | 1.65 | 0.72 | 0.74 |
| **12** | 1.07 | 0.37 | 0.00 | 8.58 | 1.82 | 0.49 | 1.11 | 0.89 | 1.89 | 1.13 | 0.03 | 2.37 |
| **13** | 0.24 | 0.77 | 0.17 | 0.27 | 0.78 | 1.50 | 2.23 | 1.07 | 0.53 | 0.35 | 0.48 | 0.80 |
| **14** | 1.14 | 1.05 | 2.53 | 3.48 | 1.23 | 1.80 | 1.85 | 0.98 | 1.33 | 1.77 | 1.33 | 0.96 |
| **15** | 2.47 | 1.38 | 3.03 | 2.46 | 1.89 | 1.34 | 2.82 | 2.00 | 2.15 | 1.27 | 1.87 | 1.73 |
| **16** | 1.40 | 1.94 | 0.34 | 0.10 | 0.44 | 0.35 | 0.27 | 0.48 | 0.31 | 0.66 | 0.24 | 1.33 |
| **17** | 2.00 | 0.30 | 8.75 | 0.82 | 0.95 | 1.87 | 0.40 | 0.49 | 0.84 | 0.72 | 0.68 | 0.80 |
| **18** | 2.07 | 0.27 | 1.26 | 1.35 | 1.08 | 0.70 | 1.27 | 1.55 | 0.93 | 1.45 | 1.29 | 1.10 |
| **19** | 1.53 | 1.12 | 1.33 | 1.52 | 0.54 | 0.61 | 0.33 | 0.97 | 0.64 | 0.52 | 2.00 | 0.20 |
| **20** | 0.87 | 1.80 | 1.62 | 0.10 | 0.52 | 0.38 | 0.47 | 0.03 | 0.57 | 0.43 | 1.27 | 1.70 |
| **21** | 1.55 | 1.07 | 1.55 | 0.93 | 1.25 | 0.65 | 0.94 | 0.98 | 0.82 | 0.53 | 1.68 | 1.77 |
| **22** | 0.59 | 1.80 | 1.29 | 0.37 | 0.97 | 1.10 | 1.30 | 1.23 | 0.48 | 1.43 | 0.90 | 1.42 |
| **23** | 1.26 | 1.33 | 0.75 | 0.77 | 1.95 | 1.80 | 0.67 | 0.00 | 0.30 | 1.55 | 1.35 | 0.27 |
| **24** | 0.20 | 0.39 | 2.42 | 0.37 | 0.15 | 0.23 | 0.94 | 0.23 | 0.80 | 0.26 | 1.65 | 0.44 |
| **25** | 1.37 | 1.61 | 2.30 | 1.86 | 2.12 | 1.43 | 1.35 | 1.99 | 1.35 | 1.97 | 2.03 | 1.63 |
| **26** | 0.35 | 0.77 | 0.20 | 1.62 | 1.77 | 1.17 | 0.10 | 0.87 | 0.63 | 0.42 | 0.80 | 0.10 |
| **27** | 0.24 | 0.78 | 2.17 | 0.13 | 0.66 | 1.32 | 1.50 | 0.25 | 0.73 | 1.55 | 0.37 | 0.72 |

| **Display** | **Task** | **Average Response Times** |
|---|---|---|
| No Display | No Distraction | 1.24 |
| | Music | 1.15 |
| | Texting | 1.94 |
| | Both | 1.79 |
| Suspenders | No Distraction | 1.09 |
| | Music | 1.07 |
| | Texting | 1.22 |
| | Both | 1.15 |
| Helmet | No Distraction | 1.02 |
| | Music | 1.06 |

| | | |
|---|---|---|
| | Texting | 1.25 |
| | Both | 1.21 |



**Measure: ResponseTime**

| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Epsilon[b] |
|---|---|---|---|---|---|
| | | | | | Greenhouse-Geisser |
| display | .706 | 8.699 | 2 | .013 | .773 |
| task | .359 | 25.331 | 5 | .000 | .602 |
| display * task | .013 | 102.933 | 20 | .000 | .399 |

**Mauchly's Test of Sphericity[a]**

Measure: ResponseTime

| Within Subjects Effect | Epsilon | |
|---|---|---|
| | Huynh-Feldt | Lower-bound |
| Display | .812 | .500 |
| Task | .645 | .333 |
| display * task | .443 | .167 |

**Multivariate Tests[a]**

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| display | Pillai's Trace | .326 | 6.051[b] | 2.000 | 25.000 | .007 |
| | Wilks' Lambda | .674 | 6.051[b] | 2.000 | 25.000 | .007 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Hotelling's Trace | .484 | 6.051[b] | 2.000 | 25.000 | .007 |
| | Roy's Largest Root | .484 | 6.051[b] | 2.000 | 25.000 | .007 |
| task | Pillai's Trace | .373 | 4.767[b] | 3.000 | 24.000 | .010 |
| | Wilks' Lambda | .627 | 4.767[b] | 3.000 | 24.000 | .010 |
| | Hotelling's Trace | .596 | 4.767[b] | 3.000 | 24.000 | .010 |
| | Roy's Largest Root | .596 | 4.767[b] | 3.000 | 24.000 | .010 |
| display * task | Pillai's Trace | .191 | .828[b] | 6.000 | 21.000 | .561 |
| | Wilks' Lambda | .809 | .828[b] | 6.000 | 21.000 | .561 |
| | Hotelling's Trace | .237 | .828[b] | 6.000 | 21.000 | .561 |
| | Roy's Largest Root | .237 | .828[b] | 6.000 | 21.000 | .561 |

**Pairwise Comparisons**

Measure: ResponseTime

| (I) display | (J) display | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| 1 | 2 | .397* | .125 | .004 | .141 | .654 |
| | 3 | .397* | .113 | .002 | .164 | .629 |
| 2 | 1 | -.397* | .125 | .004 | -.654 | -.141 |
| | 3 | -.001 | .073 | .991 | -.151 | .150 |
| 3 | 1 | -.397* | .113 | .002 | -.629 | -.164 |
| | 2 | .001 | .073 | .991 | -.150 | .151 |

**Pairwise Comparisons**

Measure: ResponseTime

| (I) task | (J) task | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| 1 | 2 | .024 | .096 | .802 | -.173 | .222 |
| | 3 | -.352* | .127 | .010 | -.612 | -.092 |
| | 4 | -.265 | .166 | .122 | -.606 | .076 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | 1 | -.024 | .096 | .802 | -.222 | .173 |
| | 3 | -.376* | .132 | .008 | -.647 | -.105 |
| | 4 | -.290 | .189 | .137 | -.678 | .099 |
| 3 | 1 | .352* | .127 | .010 | .092 | .612 |
| | 2 | .376* | .132 | .008 | .105 | .647 |
| | 4 | .086 | .232 | .712 | -.390 | .563 |
| 4 | 1 | .265 | .166 | .122 | -.076 | .606 |
| | 2 | .290 | .189 | .137 | -.099 | .678 |
| | 3 | -.086 | .232 | .712 | -.563 | .390 |

**Pairwise Comparisons**

Measure: ResponseTime

| task | (I) display | (J) display | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] |
|---|---|---|---|---|---|---|
| | | | | | | Lower Bound |
| 1 | 1 | 2 | .145 | .137 | .301 | -.138 |
| | | 3 | .223 | .122 | .079 | -.027 |
| | 2 | 1 | -.145 | .137 | .301 | -.427 |
| | | 3 | .078 | .126 | .541 | -.181 |
| | 3 | 1 | -.223 | .122 | .079 | -.472 |
| | | 2 | -.078 | .126 | .541 | -.336 |
| 2 | 1 | 2 | .083 | .146 | .572 | -.216 |

| display | (I) task | (J) task | Mean Difference (I-J) | Std. Error | Sig.[b] | Lower Bound |
|---|---|---|---|---|---|---|
| | | 3 | .086 | .135 | .529 | -.191 |
| | 2 | 1 | -.083 | .146 | .572 | -.383 |
| | | 3 | .003 | .104 | .980 | -.211 |
| | 3 | 1 | -.086 | .135 | .529 | -.363 |
| | | 2 | -.003 | .104 | .980 | -.216 |
| 3 | 1 | 2 | .722* | .344 | .046 | .015 |
| | | 3 | .694* | .335 | .048 | .005 |
| | 2 | 1 | -.722* | .344 | .046 | -1.429 |
| | | 3 | -.028 | .167 | .868 | -.372 |
| | 3 | 1 | -.694* | .335 | .048 | -1.382 |
| | | 2 | .028 | .167 | .868 | -.315 |
| 4 | 1 | 2 | .640 | .396 | .119 | -.175 |
| | | 3 | .584 | .356 | .113 | -.148 |
| | 2 | 1 | -.640 | .396 | .119 | -1.454 |
| | | 3 | -.056 | .149 | .711 | -.361 |
| | 3 | 1 | -.584 | .356 | .113 | -1.316 |
| | | 2 | .056 | .149 | .711 | -.250 |

**Pairwise Comparisons**

Measure: ResponseTime

| display | (I) task | (J) task | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | .090 | .158 | .573 | -.235 | .416 |
| | | 3 | -.701* | .303 | .029 | -1.324 | -.079 |
| | | 4 | -.551 | .404 | .185 | -1.382 | .280 |
| | 2 | 1 | -.090 | .158 | .573 | -.416 | .235 |
| | | 3 | -.791* | .353 | .034 | -1.517 | -.066 |
| | | 4 | -.641 | .437 | .155 | -1.540 | .258 |
| | 3 | 1 | .701* | .303 | .029 | .079 | 1.324 |
| | | 2 | .791* | .353 | .034 | .066 | 1.517 |
| | | 4 | .150 | .578 | .797 | -1.038 | 1.339 |
| | 4 | 1 | .551 | .404 | .185 | -.280 | 1.382 |
| | | 2 | .641 | .437 | .155 | -.258 | 1.540 |
| | | 3 | -.150 | .578 | .797 | -1.339 | 1.038 |
| 2 | 1 | 2 | .029 | .119 | .810 | -.216 | .273 |
| | | 3 | -.124 | .154 | .427 | -.440 | .192 |
| | | 4 | -.056 | .152 | .716 | -.368 | .256 |
| | 2 | 1 | -.029 | .119 | .810 | -.273 | .216 |
| | | 3 | -.153 | .131 | .254 | -.423 | .117 |
| | | 4 | -.085 | .152 | .582 | -.397 | .228 |
| | 3 | 1 | .124 | .154 | .427 | -.192 | .440 |
| | | 2 | .153 | .131 | .254 | -.117 | .423 |
| | | 4 | .068 | .118 | .570 | -.175 | .312 |
| | 4 | 1 | .056 | .152 | .716 | -.256 | .368 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2 | .085 | .152 | .582 | -.228 | .397 |
| | | 3 | -.068 | .118 | .570 | -.312 | .175 |
| 3 | 1 | 2 | -.046 | .113 | .686 | -.279 | .187 |
| | | 3 | -.230 | .135 | .100 | -.507 | .047 |
| | | 4 | -.189 | .130 | .158 | -.457 | .078 |
| | 2 | 1 | .046 | .113 | .686 | -.187 | .279 |
| | | 3 | -.184 | .158 | .255 | -.508 | .141 |
| | | 4 | -.143 | .159 | .376 | -.469 | .183 |
| | 3 | 1 | .230 | .135 | .100 | -.047 | .507 |
| | | 2 | .184 | .158 | .255 | -.141 | .508 |
| | | 4 | .041 | .201 | .841 | -.371 | .453 |
| | 4 | 1 | .189 | .130 | .158 | -.078 | .457 |
| | | 2 | .143 | .159 | .376 | -.183 | .469 |
| | | 3 | -.041 | .201 | .841 | -.453 | .371 |

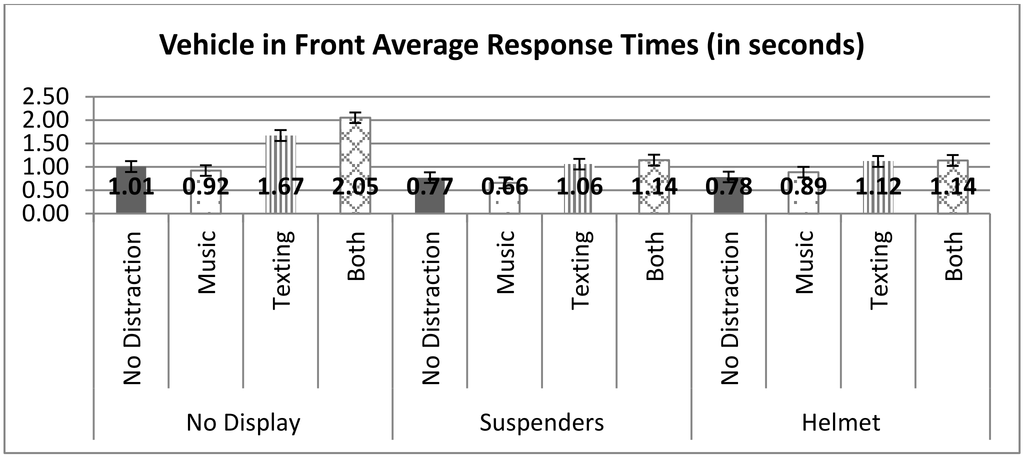
APPENDIX J

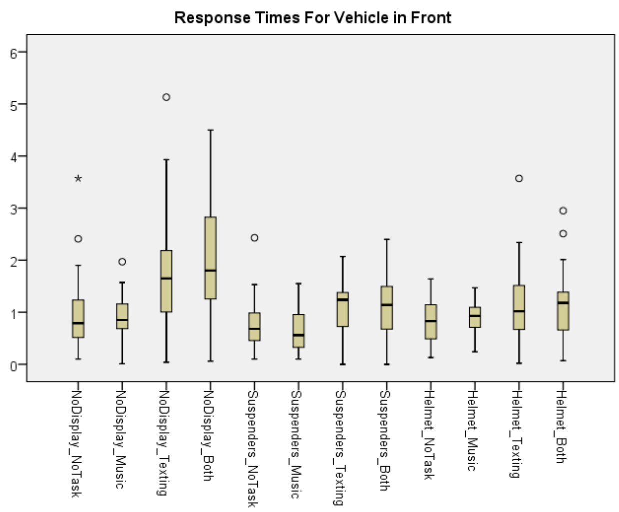
RAW DATA/GRAPHS/STATISTICAL OUTPUTS

***Vehicle in front***

| | N1 | N2 | N3 | N4 | S1 | S2 | S3 | S4 | H1 | H2 | H3 | H4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.79 | 0.85 | 1.88 | 1.17 | 0.70 | 0.53 | 1.24 | 1.08 | 0.62 | 0.85 | 1.29 | 0.91 |
| **2** | 1.29 | 0.87 | 2.23 | 4.27 | 0.85 | 1.14 | 1.35 | 1.14 | 0.84 | 1.19 | 1.40 | 1.22 |
| **3** | 0.77 | 0.64 | 1.00 | 2.19 | 0.68 | 0.74 | 2.07 | 1.18 | 0.39 | 0.47 | 1.02 | 2.95 |
| **4** | 1.84 | 1.24 | 5.13 | 4.50 | 1.18 | 1.14 | 1.87 | 1.83 | 1.28 | 1.18 | 2.23 | 1.88 |
| **5** | 0.84 | 1.57 | 1.72 | 3.43 | 0.63 | 0.13 | 1.27 | 1.28 | 1.64 | 0.96 | 1.60 | 0.51 |
| **6** | 3.57 | 0.64 | 2.18 | 2.21 | 0.57 | 0.30 | 0.72 | 0.59 | 0.96 | 1.07 | 0.63 | 0.70 |
| **7** | 1.30 | 1.19 | 2.67 | 4.10 | 0.56 | 0.56 | 1.53 | 2.02 | 0.53 | 1.13 | 1.30 | 1.42 |
| **8** | 2.41 | 0.44 | 1.30 | 1.80 | 0.73 | 0.10 | 0.00 | 1.46 | 1.28 | 0.75 | 1.52 | 1.02 |
| **9** | 1.17 | 1.15 | 2.02 | 3.05 | 0.87 | 1.55 | 1.62 | 1.55 | 1.20 | 1.08 | 1.41 | 1.28 |
| **10** | 0.62 | 0.84 | 1.05 | 1.47 | 0.23 | 0.94 | 0.36 | 0.00 | 0.14 | 0.73 | 0.85 | 0.07 |
| **11** | 0.72 | 0.73 | 3.93 | 1.56 | 1.40 | 0.50 | 0.13 | 0.76 | 1.27 | 0.95 | 0.84 | 1.27 |
| **12** | 0.26 | 1.17 | 2.19 | 2.60 | 1.10 | 0.40 | 0.11 | 1.90 | 0.75 | 0.24 | 0.74 | 2.01 |
| **13** | 0.50 | 0.92 | 1.65 | 1.77 | 0.10 | 0.28 | 0.35 | 2.40 | 0.27 | 0.53 | 0.24 | 0.86 |
| **14** | 0.53 | 1.41 | 0.90 | 2.41 | 0.77 | 0.67 | 1.38 | 1.01 | 1.19 | 1.34 | 1.55 | 1.23 |
| **15** | 1.22 | 1.11 | 1.99 | 1.60 | 2.43 | 1.21 | 1.32 | 1.53 | 1.37 | 1.47 | 1.51 | 1.78 |
| **16** | 0.33 | 0.69 | 1.01 | 0.91 | 0.47 | 0.43 | 0.73 | 0.43 | 0.83 | 0.93 | 0.71 | 0.13 |
| **17** | 0.50 | 0.76 | 0.20 | 0.91 | 0.63 | 0.35 | 0.94 | 0.42 | 0.54 | 0.84 | 0.26 | 0.48 |
| **18** | 1.15 | 1.39 | 0.33 | 0.20 | 0.68 | 1.16 | 1.33 | 1.37 | 1.10 | 0.86 | 1.00 | 1.18 |
| **19** | 0.70 | 0.68 | 1.80 | 1.77 | 0.44 | 0.60 | 1.10 | 2.29 | 0.48 | 0.51 | 1.20 | 1.28 |
| **20** | 1.11 | 1.00 | 1.25 | 3.70 | 0.34 | 0.27 | 0.86 | 1.05 | 0.13 | 0.69 | 0.82 | 0.64 |
| **21** | 1.90 | 1.15 | 1.64 | 1.34 | 1.20 | 1.29 | 1.70 | 0.99 | 0.86 | 1.20 | 3.57 | 1.35 |
| **22** | 1.20 | 0.81 | 0.20 | 3.12 | 0.47 | 0.66 | 0.93 | 0.93 | 0.50 | 0.87 | 2.34 | 1.57 |
| **23** | 0.57 | 0.84 | 0.04 | 1.93 | 1.45 | 0.79 | 1.29 | 1.18 | 0.96 | 1.02 | 0.20 | 0.96 |
| **24** | 0.32 | 0.34 | 3.14 | 0.06 | 0.28 | 0.29 | 0.35 | 0.11 | 0.20 | 0.40 | 0.02 | 0.41 |
| **25** | 1.25 | 1.97 | 2.28 | 1.84 | 1.53 | 0.97 | 1.38 | 1.38 | 1.07 | 1.10 | 1.55 | 2.51 |
| **26** | 0.10 | 0.44 | 1.10 | 0.97 | 0.38 | 0.52 | 1.85 | 0.53 | 0.53 | 0.48 | 0.20 | 0.38 |
| **27** | 0.26 | 0.01 | 0.24 | 0.50 | 0.13 | 0.25 | 0.79 | 0.49 | 0.20 | 1.09 | 0.17 | 0.68 |

| Display | Task | Average Response Times |
|---|---|---|
| No Display | No Distraction | 1.01 |
| | Music | 0.92 |
| | Texting | 1.67 |
| | Both | 2.05 |
| Suspenders | No Distraction | 0.77 |
| | Music | 0.66 |
| | Texting | 1.06 |
| | Both | 1.14 |
| Helmet | No Distraction | 0.78 |
| | Music | 0.89 |
| | Texting | 1.12 |
| | Both | 1.14 |




## Mauchly's Test of Sphericity[a]

Measure: ResponseTime

| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Epsilon[b] Greenhouse-Geisser |
|---|---|---|---|---|---|
| display | .532 | 15.794 | 2 | .000 | .681 |
| task | .650 | 10.647 | 5 | .059 | .793 |
| display * task | .142 | 46.366 | 20 | .001 | .645 |

**Mauchly's Test of Sphericity[a]**

Measure: ResponseTime

| Within Subjects Effect | Epsilon | |
|---|---|---|
| | Huynh-Feldt | Lower-bound |
| display | .706 | .500 |
| task | .878 | .333 |
| display * task | .771 | .167 |

**Multivariate Tests[a]**

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| display | Pillai's Trace | .461 | 10.678[b] | 2.000 | 25.000 | .000 |
| | Wilks' Lambda | .539 | 10.678[b] | 2.000 | 25.000 | .000 |
| | Hotelling's Trace | .854 | 10.678[b] | 2.000 | 25.000 | .000 |
| | Roy's Largest Root | .854 | 10.678[b] | 2.000 | 25.000 | .000 |
| task | Pillai's Trace | .602 | 12.080[b] | 3.000 | 24.000 | .000 |
| | Wilks' Lambda | .398 | 12.080[b] | 3.000 | 24.000 | .000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Hotelling's Trace | 1.510 | 12.080[b] | 3.000 | 24.000 | .000 |
| | Roy's Largest Root | 1.510 | 12.080[b] | 3.000 | 24.000 | .000 |
| display * task | Pillai's Trace | .451 | 2.877[b] | 6.000 | 21.000 | .033 |
| | Wilks' Lambda | .549 | 2.877[b] | 6.000 | 21.000 | .033 |
| | Hotelling's Trace | .822 | 2.877[b] | 6.000 | 21.000 | .033 |
| | Roy's Largest Root | .822 | 2.877[b] | 6.000 | 21.000 | .033 |

**Pairwise Comparisons**

Measure: ResponseTime

| (I) display | (J) display | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| 1 | 2 | .504* | .108 | .000 | .282 | .727 |
| | 3 | .432* | .098 | .000 | .231 | .632 |
| 2 | 1 | -.504* | .108 | .000 | -.727 | -.282 |
| | 3 | -.073 | .052 | .170 | -.179 | .033 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | 1 | -.432* | .098 | .000 | -.632 | -.231 |
| | 2 | .073 | .052 | .170 | -.033 | .179 |

**Pairwise Comparisons**

Measure: ResponseTime

| (I) task | (J) task | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| 1 | 2 | .032 | .068 | .641 | -.108 | .172 |
| | 3 | -.428* | .096 | .000 | -.625 | -.231 |
| | 4 | -.590* | .122 | .000 | -.842 | -.339 |
| 2 | 1 | -.032 | .068 | .641 | -.172 | .108 |
| | 3 | -.460* | .091 | .000 | -.646 | -.274 |
| | 4 | -.622* | .115 | .000 | -.859 | -.385 |
| 3 | 1 | .428* | .096 | .000 | .231 | .625 |
| | 2 | .460* | .091 | .000 | .274 | .646 |
| | 4 | -.162 | .109 | .148 | -.386 | .062 |
| 4 | 1 | .590* | .122 | .000 | .339 | .842 |
| | 2 | .622* | .115 | .000 | .385 | .859 |
| | 3 | .162 | .109 | .148 | -.062 | .386 |

**Pairwise Comparisons**

Measure: ResponseTime

| task | (I) display | (J) display | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] |
|---|---|---|---|---|---|---|
| | | | | | | Lower Bound |
| 1 | 1 | 2 | .238 | .158 | .144 | -.087 |
| | | 3 | .226 | .137 | .111 | -.056 |
| | 2 | 1 | -.238 | .158 | .144 | -.562 |
| | | 3 | -.012 | .077 | .874 | -.170 |
| | 3 | 1 | -.226 | .137 | .111 | -.507 |
| | | 2 | .012 | .077 | .874 | -.145 |
| 2 | 1 | 2 | .262* | .082 | .004 | .093 |
| | | 3 | .034 | .079 | .671 | -.129 |
| | 2 | 1 | -.262* | .082 | .004 | -.432 |
| | | 3 | -.228* | .070 | .003 | -.373 |
| | 3 | 1 | -.034 | .079 | .671 | -.197 |
| | | 2 | .228* | .070 | .003 | .083 |
| 3 | 1 | 2 | .611* | .250 | .021 | .098 |
| | | 3 | .552* | .241 | .030 | .056 |
| | 2 | 1 | -.611* | .250 | .021 | -1.125 |
| | | 3 | -.059 | .148 | .692 | -.364 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 3 | 1 | -.552* | .241 | .030 | -1.047 |
| | | 2 | .059 | .148 | .692 | -.245 |
| 4 | 1 | 2 | .907* | .208 | .000 | .479 |
| | | 3 | .915* | .227 | .000 | .448 |
| | 2 | 1 | -.907* | .208 | .000 | -1.334 |
| | | 3 | .008 | .122 | .947 | -.243 |
| | 3 | 1 | -.915* | .227 | .000 | -1.382 |
| | | 2 | -.008 | .122 | .947 | -.259 |

**Pairwise Comparisons**

Measure: ResponseTime

| display | (I) task | (J) task | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| 1 | 1 | 2 | .088 | .155 | .577 | -.232 | .407 |
| | | 3 | -.661* | .232 | .008 | -1.138 | -.184 |
| | | 4 | -1.043* | .231 | .000 | -1.519 | -.567 |
| | 2 | 1 | -.088 | .155 | .577 | -.407 | .232 |
| | | 3 | -.749* | .222 | .002 | -1.205 | -.293 |
| | | 4 | -1.131* | .214 | .000 | -1.571 | -.690 |
| | 3 | 1 | .661* | .232 | .008 | .184 | 1.138 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2 | .749* | .222 | .002 | .293 | 1.205 |
| | | 4 | -.382 | .255 | .147 | -.906 | .143 |
| | 4 | 1 | 1.043* | .231 | .000 | .567 | 1.519 |
| | | 2 | 1.131* | .214 | .000 | .690 | 1.571 |
| | | 3 | .382 | .255 | .147 | -.143 | .906 |
| 2 | 1 | 2 | .112 | .088 | .215 | -.069 | .294 |
| | | 3 | -.288* | .130 | .036 | -.555 | -.021 |
| | | 4 | -.374* | .136 | .010 | -.653 | -.095 |
| | 2 | 1 | -.112 | .088 | .215 | -.294 | .069 |
| | | 3 | -.400* | .091 | .000 | -.587 | -.213 |
| | | 4 | -.486* | .131 | .001 | -.755 | -.218 |
| | 3 | 1 | .288* | .130 | .036 | .021 | .555 |
| | | 2 | .400* | .091 | .000 | .213 | .587 |
| | | 4 | -.086 | .148 | .565 | -.391 | .218 |
| | 4 | 1 | .374* | .136 | .010 | .095 | .653 |
| | | 2 | .486* | .131 | .001 | .218 | .755 |
| | | 3 | .086 | .148 | .565 | -.218 | .391 |
| 3 | 1 | 2 | -.104 | .070 | .149 | -.247 | .039 |
| | | 3 | -.335* | .138 | .023 | -.619 | -.050 |
| | | 4 | -.354* | .137 | .016 | -.636 | -.071 |
| | 2 | 1 | .104 | .070 | .149 | -.039 | .247 |
| | | 3 | -.231 | .134 | .096 | -.506 | .044 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 4 | -.250 | .139 | .083 | -.535 | .035 |
| 3 | 1 | .335* | .138 | .023 | .050 | .619 |
| | 2 | .231 | .134 | .096 | -.044 | .506 |
| | 4 | -.019 | .153 | .903 | -.333 | .295 |
| 4 | 1 | .354* | .137 | .016 | .071 | .636 |
| | 2 | .250 | .139 | .083 | -.035 | .535 |
| | 3 | .019 | .153 | .903 | -.295 | .333 |

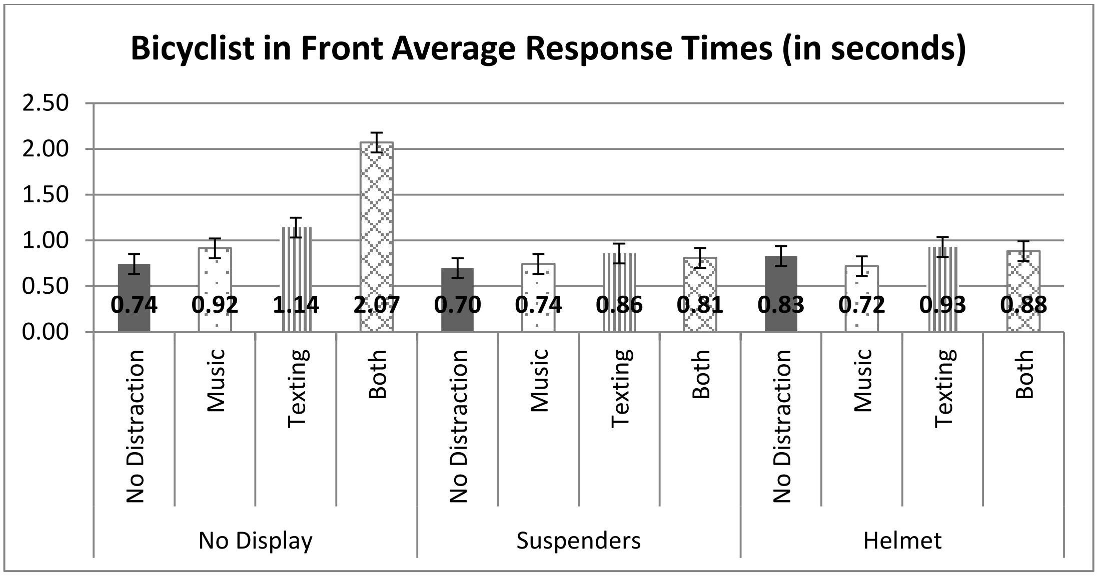
APPENDIX K

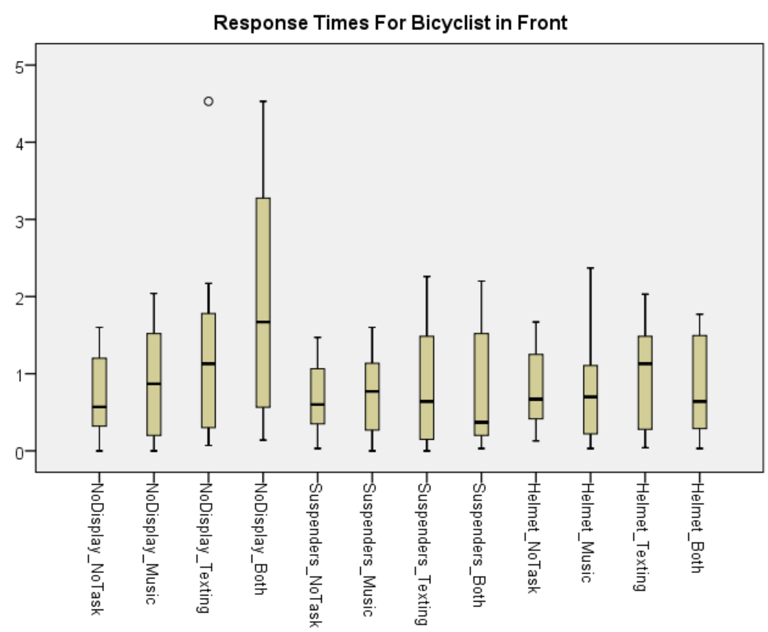
RAW DATA/GRAPHS/STATISTICAL OUTPUTS

***Bicyclist in front***

| | N1 | N2 | N3 | N4 | S1 | S2 | S3 | S4 | H1 | H2 | H3 | H4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.47 | 0.73 | 1.14 | 1.97 | 0.97 | 0.87 | 1.27 | 0.74 | 0.67 | 0.77 | 0.07 | 1.44 |
| **2** | 0.97 | 0.97 | 2.03 | 2.27 | 0.10 | 0.27 | 1.70 | 1.84 | 0.64 | 0.70 | 1.37 | 0.24 |
| **3** | 1.23 | 0.87 | 1.03 | 4.53 | 0.47 | 0.14 | 1.13 | 0.07 | 0.43 | 0.60 | 0.37 | 1.24 |
| **4** | 0.37 | 1.37 | 0.24 | 3.54 | 1.37 | 1.17 | 2.13 | 1.93 | 1.30 | 0.03 | 1.47 | 1.77 |
| **5** | 0.00 | 1.33 | 4.53 | 4.53 | 1.17 | 0.10 | 0.17 | 1.74 | 1.20 | 2.37 | 1.50 | 0.44 |
| **6** | 1.07 | 0.37 | 0.30 | 1.54 | 0.54 | 0.76 | 0.44 | 0.10 | 1.63 | 0.97 | 1.13 | 1.46 |
| **7** | 0.20 | 0.20 | 1.20 | 3.01 | 0.37 | 0.53 | 0.80 | 0.30 | 1.67 | 1.33 | 1.57 | 1.70 |
| **8** | 1.60 | 1.17 | 2.10 | 0.70 | 0.57 | 1.17 | 2.04 | 1.97 | 1.67 | 0.34 | 1.60 | 1.67 |
| **9** | 1.14 | 1.80 | 2.17 | 4.53 | 1.47 | 0.54 | 1.14 | 1.34 | 1.23 | 1.03 | 1.77 | 1.67 |
| **10** | 0.34 | 0.64 | 1.13 | 0.27 | 0.97 | 0.97 | 1.27 | 1.20 | 0.37 | 0.17 | 0.53 | 0.20 |
| **11** | 0.57 | 0.16 | 0.30 | 4.53 | 1.30 | 1.60 | 2.10 | 2.20 | 0.47 | 0.67 | 0.10 | 1.77 |
| **12** | 0.13 | 1.73 | 0.27 | 1.20 | 0.27 | 1.27 | 1.74 | 1.90 | 0.20 | 1.20 | 0.04 | 0.17 |
| **13** | 0.10 | 0.17 | 0.07 | 1.90 | 0.23 | 0.17 | 0.00 | 0.37 | 0.27 | 0.17 | 0.06 | 0.20 |
| **14** | 0.57 | 2.04 | 0.73 | 0.17 | 1.13 | 1.10 | 1.10 | 0.33 | 1.27 | 1.14 | 1.40 | 1.53 |
| **15** | 1.17 | 1.63 | 2.00 | 1.94 | 1.20 | 1.17 | 0.10 | 1.57 | 1.04 | 1.30 | 1.67 | 1.43 |
| **16** | 0.40 | 1.37 | 0.14 | 0.23 | 0.74 | 0.27 | 0.64 | 0.10 | 0.70 | 1.07 | 0.33 | 0.64 |
| **17** | 0.30 | 0.03 | 1.80 | 0.43 | 0.43 | 0.60 | 0.03 | 0.13 | 0.27 | 0.73 | 1.36 | 0.07 |
| **18** | 1.57 | 0.03 | 1.30 | 1.67 | 1.14 | 1.24 | 1.70 | 0.37 | 0.64 | 1.24 | 0.23 | 0.34 |
| **19** | 0.53 | 0.60 | 1.27 | 1.57 | 0.60 | 0.77 | 0.10 | 0.43 | 0.40 | 0.27 | 1.07 | 0.43 |
| **20** | 1.23 | 1.44 | 1.27 | 0.14 | 0.03 | 1.10 | 0.20 | 0.30 | 1.16 | 0.13 | 0.33 | 0.64 |
| **21** | 1.50 | 1.60 | 1.00 | 4.53 | 0.76 | 1.43 | 2.26 | 0.03 | 1.43 | 1.30 | 0.44 | 0.90 |
| **22** | 1.33 | 0.57 | 1.76 | 1.57 | 0.97 | 0.00 | 0.07 | 1.47 | 0.80 | 0.07 | 1.73 | 1.60 |
| **23** | 0.13 | 0.20 | 0.13 | 4.50 | 0.07 | 0.07 | 0.33 | 0.20 | 0.43 | 0.30 | 1.27 | 0.03 |
| **24** | 0.34 | 0.00 | 0.37 | 1.54 | 0.20 | 0.27 | 0.00 | 0.23 | 0.37 | 0.03 | 0.04 | 0.34 |
| **25** | 1.43 | 2.03 | 1.94 | 2.50 | 1.00 | 0.97 | 0.13 | 0.74 | 1.37 | 1.00 | 2.03 | 1.33 |
| **26** | 1.07 | 0.00 | 0.23 | 0.37 | 0.33 | 0.43 | 0.17 | 0.07 | 0.67 | 0.37 | 1.37 | 0.20 |
| **27** | 0.27 | 1.66 | 0.37 | 0.20 | 0.40 | 1.10 | 0.43 | 0.20 | 0.13 | 0.10 | 0.20 | 0.36 |

| Display | Task | Average Response Times |
|---|---|---|
| No Display | No Distraction | 0.74 |
| | Music | 0.92 |
| | Texting | 1.14 |
| | Both | 2.07 |
| Suspenders | No Distraction | 0.70 |
| | Music | 0.74 |
| | Texting | 0.86 |
| | Both | 0.81 |
| Helmet | No Distraction | 0.83 |
| | Music | 0.72 |
| | Texting | 0.93 |
| | Both | 0.88 |


Bicyclist in Front Average Response Times (in seconds)
2.50
2.00
1.50
1.00
0.50
0.00
0.74
0.92
1.14
2.07
0.70
0.74
0.86
0.81
0.83
0.72
0.93
0.88
No Distraction
Music
Texting
Both
No Display
Suspenders
Helmet


Response Times For Bicyclist in Front
5
4
3
2
1
0
NoDisplay_NoTask
NoDisplay_Music
NoDisplay_Texting
NoDisplay_Both
Suspenders_NoTask
Suspenders_Music
Suspenders_Texting
Suspenders_Both
Helmet_NoTask
Helmet_Music
Helmet_Texting
Helmet_Both

**Mauchly's Test of Sphericity[a]**

Measure: ResponseTime

| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Epsilon[b] |
|---|---|---|---|---|---|
| | | | | | Greenhouse-Geisser |
| display | .924 | 1.963 | 2 | .375 | .930 |
| task | .486 | 17.820 | 5 | .003 | .672 |
| display * task | .074 | 61.779 | 20 | .000 | .526 |

**Mauchly's Test of Sphericity[a]**

Measure: ResponseTime

| Within Subjects Effect | Epsilon | |
|---|---|---|
| | Huynh-Feldt | Lower-bound |
| display | .999 | .500 |
| task | .728 | .333 |
| display * task | .607 | .167 |

**Multivariate Tests[a]**

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| display | Pillai's Trace | .440 | 9.824[b] | 2.000 | 25.000 | .001 |
| | Wilks' Lambda | .560 | 9.824[b] | 2.000 | 25.000 | .001 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Hotelling's Trace | .786 | 9.824[b] | 2.000 | 25.000 | .001 |
| | Roy's Largest Root | .786 | 9.824[b] | 2.000 | 25.000 | .001 |
| task | Pillai's Trace | .395 | 5.212[b] | 3.000 | 24.000 | .006 |
| | Wilks' Lambda | .605 | 5.212[b] | 3.000 | 24.000 | .006 |
| | Hotelling's Trace | .652 | 5.212[b] | 3.000 | 24.000 | .006 |
| | Roy's Largest Root | .652 | 5.212[b] | 3.000 | 24.000 | .006 |
| display * task | Pillai's Trace | .531 | 3.968[b] | 6.000 | 21.000 | .008 |
| | Wilks' Lambda | .469 | 3.968[b] | 6.000 | 21.000 | .008 |
| | Hotelling's Trace | 1.134 | 3.968[b] | 6.000 | 21.000 | .008 |
| | Roy's Largest Root | 1.134 | 3.968[b] | 6.000 | 21.000 | .008 |

**Pairwise Comparisons**

Measure: ResponseTime

| (I) display | (J) display | Mean Difference (I- | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] |
|---|---|---|---|---|---|

| | | J) | | | Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|
| 1 | 2 | .440* | .115 | .001 | .203 | .676 |
| | 3 | .377* | .091 | .000 | .190 | .565 |
| 2 | 1 | -.440* | .115 | .001 | -.676 | -.203 |
| | 3 | -.063 | .099 | .535 | -.267 | .142 |
| 3 | 1 | -.377* | .091 | .000 | -.565 | -.190 |
| | 2 | .063 | .099 | .535 | -.142 | .267 |

**Pairwise Comparisons**

Measure: ResponseTime

| (I) task | (J) task | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| 1 | 2 | -.036 | .074 | .630 | -.189 | .116 |
| | 3 | -.220* | .076 | .008 | -.376 | -.063 |
| | 4 | -.498* | .129 | .001 | -.763 | -.232 |
| 2 | 1 | .036 | .074 | .630 | -.116 | .189 |
| | 3 | -.184 | .093 | .059 | -.374 | .007 |
| | 4 | -.461* | .145 | .004 | -.758 | -.164 |
| 3 | 1 | .220* | .076 | .008 | .063 | .376 |
| | 2 | .184 | .093 | .059 | -.007 | .374 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 4 | -.278* | .121 | .029 | -.526 | -.030 |
| 4 | 1 | .498* | .129 | .001 | .232 | .763 |
| | 2 | .461* | .145 | .004 | .164 | .758 |
| | 3 | .278* | .121 | .029 | .030 | .526 |

**Pairwise Comparisons**

Measure: ResponseTime

| task | (I) display | (J) display | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] |
|---|---|---|---|---|---|---|
| | | | | | | Lower Bound |
| 1 | 1 | 2 | .046 | .119 | .704 | -.198 |
| | | 3 | -.089 | .103 | .396 | -.301 |
| | 2 | 1 | -.046 | .119 | .704 | -.289 |
| | | 3 | -.134 | .105 | .211 | -.350 |
| | 3 | 1 | .089 | .103 | .396 | -.123 |
| | | 2 | .134 | .105 | .211 | -.081 |
| 2 | 1 | 2 | .171 | .133 | .207 | -.101 |
| | | 3 | .197 | .143 | .182 | -.098 |
| | 2 | 1 | -.171 | .133 | .207 | -.444 |
| | | 3 | .025 | .136 | .854 | -.254 |
| | 3 | 1 | -.197 | .143 | .182 | -.491 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 2 | -.025 | .136 | .854 | -.305 |
| 3 | 1 | 2 | .283 | .253 | .274 | -.237 |
| | | 3 | .214 | .165 | .206 | -.125 |
| | 2 | 1 | -.283 | .253 | .274 | -.803 |
| | | 3 | -.069 | .216 | .753 | -.514 |
| | 3 | 1 | -.214 | .165 | .206 | -.553 |
| | | 2 | .069 | .216 | .753 | -.376 |
| 4 | 1 | 2 | 1.260* | .308 | .000 | .627 |
| | | 3 | 1.188* | .295 | .000 | .581 |
| | 2 | 1 | -1.260* | .308 | .000 | -1.892 |
| | | 3 | -.072 | .157 | .651 | -.394 |
| | 3 | 1 | -1.188* | .295 | .000 | -1.794 |
| | | 2 | .072 | .157 | .651 | -.251 |

**Pairwise Comparisons**

Measure: ResponseTime

| display | (I) task | (J) task | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| 1 | 1 | 2 | -.173 | .151 | .262 | -.484 | .137 |
| | | 3 | -.400* | .194 | .050 | -.799 | -6.663E-5 |
| | | 4 | -1.328* | .322 | .000 | -1.990 | -.666 |
| | 2 | 1 | .173 | .151 | .262 | -.137 | .484 |
| | | 3 | -.226 | .200 | .268 | -.637 | .185 |
| | | 4 | -1.154* | .334 | .002 | -1.841 | -.468 |
| | 3 | 1 | .400* | .194 | .050 | 6.663E-5 | .799 |
| | | 2 | .226 | .200 | .268 | -.185 | .637 |
| | | 4 | -.928* | .322 | .008 | -1.590 | -.266 |
| | 4 | 1 | 1.328* | .322 | .000 | .666 | 1.990 |
| | | 2 | 1.154* | .334 | .002 | .468 | 1.841 |
| | | 3 | .928* | .322 | .008 | .266 | 1.590 |
| 2 | 1 | 2 | -.047 | .100 | .639 | -.253 | .158 |
| | | 3 | -.163 | .148 | .281 | -.466 | .141 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 4 | -.114 | .132 | .396 | -.385 | .157 |
| | 2 | 1 | .047 | .100 | .639 | -.158 | .253 |
| | | 3 | -.115 | .124 | .361 | -.370 | .139 |
| | | 4 | -.066 | .151 | .663 | -.376 | .243 |
| | 3 | 1 | .163 | .148 | .281 | -.141 | .466 |
| | | 2 | .115 | .124 | .361 | -.139 | .370 |
| | | 4 | .049 | .155 | .755 | -.269 | .367 |
| | 4 | 1 | .114 | .132 | .396 | -.157 | .385 |
| | | 2 | .066 | .151 | .663 | -.243 | .376 |
| | | 3 | -.049 | .155 | .755 | -.367 | .269 |
| 3 | 1 | 2 | .112 | .113 | .329 | -.119 | .344 |
| | | 3 | -.097 | .108 | .377 | -.319 | .125 |
| | | 4 | -.051 | .093 | .587 | -.242 | .140 |
| | 2 | 1 | -.112 | .113 | .329 | -.344 | .119 |
| | | 3 | -.209 | .151 | .178 | -.520 | .101 |
| | | 4 | -.163 | .154 | .299 | -.480 | .154 |
| | 3 | 1 | .097 | .108 | .377 | -.125 | .319 |
| | | 2 | .209 | .151 | .178 | -.101 | .520 |
| | | 4 | .046 | .142 | .750 | -.247 | .339 |
| | 4 | 1 | .051 | .093 | .587 | -.140 | .242 |
| | | 2 | .163 | .154 | .299 | -.154 | .480 |
| | | 3 | -.046 | .142 | .750 | -.339 | .247 |

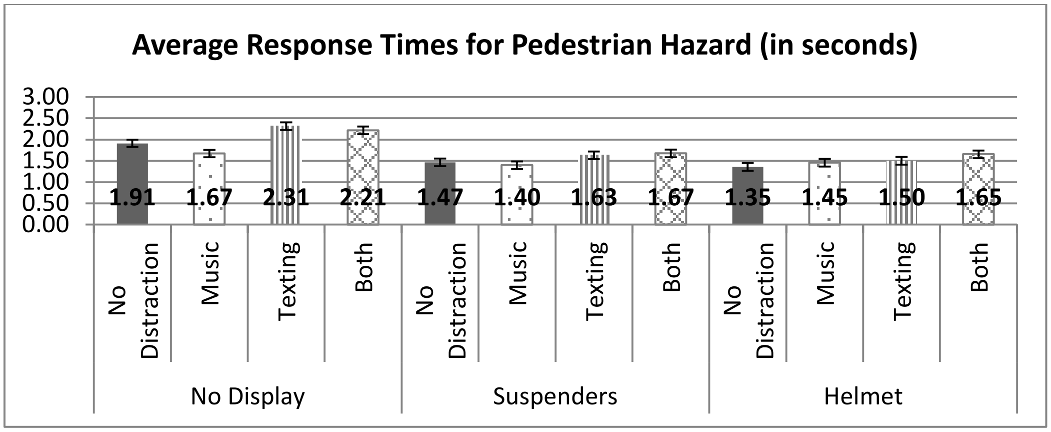
APPENDIX L

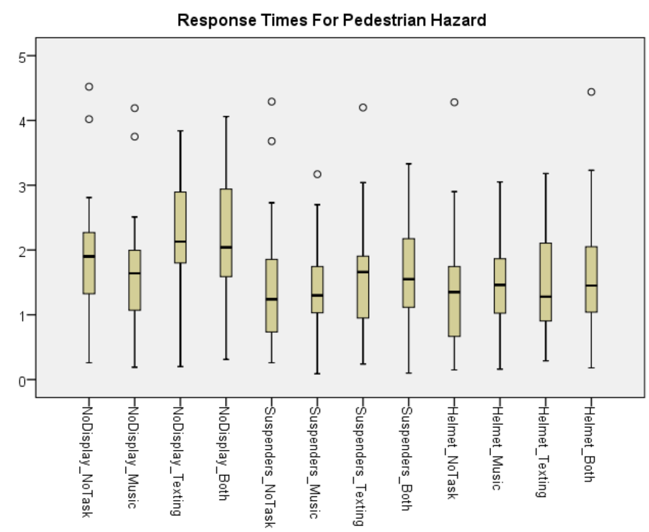
RAW DATA/GRAPHS/STATISTICAL OUTPUTS

***Pedestrian Hazard***

| | N1 | N2 | N3 | N4 | S1 | S2 | S3 | S4 | H1 | H2 | H3 | H4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 4.52 | 4.19 | 3.37 | 3.51 | 4.29 | 3.17 | 4.20 | 3.33 | 1.89 | 3.05 | 1.92 | 4.44 |
| **2** | 4.02 | 3.75 | 3.18 | 4.06 | 2.73 | 2.70 | 2.98 | 2.65 | 4.28 | 2.70 | 2.76 | 3.23 |
| **3** | 1.86 | 0.76 | 2.51 | 1.71 | 0.65 | 0.97 | 1.31 | 1.55 | 0.89 | 0.79 | 1.15 | 1.09 |
| **4** | 2.10 | 1.47 | 3.32 | 3.08 | 1.11 | 1.69 | 1.87 | 2.83 | 1.37 | 1.79 | 2.22 | 1.62 |
| **5** | 2.59 | 1.66 | 1.36 | 2.79 | 2.03 | 1.70 | 1.90 | 1.51 | 2.90 | 1.37 | 2.43 | 2.15 |
| **6** | 1.25 | 1.06 | 1.53 | 2.40 | 1.24 | 1.15 | 0.93 | 0.92 | 2.04 | 1.94 | 2.09 | 0.91 |
| **7** | 1.83 | 2.37 | 3.69 | 1.94 | 1.30 | 1.79 | 1.76 | 2.20 | 1.78 | 1.41 | 3.18 | 1.91 |
| **8** | 2.51 | 1.64 | 1.96 | 1.77 | 1.24 | 1.09 | 2.66 | 2.25 | 1.48 | 1.30 | 1.28 | 1.63 |
| **9** | 2.10 | 2.00 | 2.91 | 3.28 | 2.08 | 1.70 | 2.47 | 2.15 | 1.35 | 1.92 | 1.77 | 2.84 |
| **10** | 0.90 | 1.09 | 2.72 | 0.89 | 0.54 | 0.35 | 1.04 | 1.12 | 0.49 | 0.81 | 0.95 | 0.51 |
| **11** | 1.97 | 1.43 | 2.10 | 1.96 | 1.16 | 1.50 | 1.91 | 1.79 | 1.31 | 1.46 | 0.33 | 1.45 |
| **12** | 2.17 | 1.92 | 2.86 | 2.69 | 1.14 | 1.32 | 0.97 | 1.11 | 0.64 | 0.80 | 2.12 | 1.30 |
| **13** | 1.68 | 1.07 | 0.20 | 0.31 | 0.26 | 0.09 | 0.24 | 1.74 | 0.34 | 1.62 | 1.31 | 1.32 |
| **14** | 1.68 | 1.99 | 1.85 | 2.58 | 0.77 | 1.42 | 1.66 | 1.95 | 1.35 | 1.24 | 0.73 | 1.24 |
| **15** | 2.44 | 2.19 | 3.49 | 2.43 | 2.53 | 2.34 | 3.04 | 3.33 | 2.36 | 2.07 | 3.00 | 3.02 |
| **16** | 1.10 | 0.69 | 1.09 | 1.09 | 0.66 | 1.12 | 0.62 | 0.76 | 0.32 | 0.28 | 0.39 | 0.92 |
| **17** | 1.90 | 2.31 | 2.88 | 1.40 | 1.41 | 2.55 | 2.28 | 1.14 | 0.85 | 2.00 | 1.28 | 2.46 |
| **18** | 1.40 | 1.79 | 2.11 | 2.04 | 1.46 | 1.30 | 1.65 | 1.94 | 1.14 | 1.62 | 1.15 | 1.33 |
| **19** | 1.06 | 1.07 | 2.79 | 2.04 | 0.70 | 0.58 | 1.36 | 1.45 | 0.71 | 0.73 | 1.18 | 1.47 |
| **20** | 1.99 | 2.51 | 1.72 | 3.11 | 0.95 | 0.83 | 0.86 | 0.92 | 1.45 | 1.98 | 0.29 | 0.64 |
| **21** | 1.84 | 1.24 | 2.08 | 1.75 | 1.52 | 1.94 | 1.75 | 1.27 | 1.60 | 1.42 | 1.99 | 1.95 |
| **22** | 0.49 | 1.55 | 1.80 | 2.82 | 1.21 | 1.30 | 1.13 | 0.85 | 0.69 | 1.31 | 1.32 | 1.34 |
| **23** | 2.02 | 1.99 | 2.13 | 3.06 | 1.68 | 1.16 | 1.82 | 1.81 | 0.15 | 1.81 | 0.86 | 1.50 |
| **24** | 0.70 | 0.41 | 0.54 | 1.38 | 0.41 | 0.50 | 0.28 | 0.10 | 0.48 | 0.39 | 1.03 | 0.18 |
| **25** | 2.37 | 1.91 | 3.84 | 3.15 | 2.30 | 1.89 | 1.80 | 2.29 | 1.71 | 1.78 | 2.41 | 2.30 |
| **26** | 2.81 | 0.84 | 2.64 | 1.47 | 3.68 | 1.27 | 0.70 | 1.30 | 2.62 | 1.52 | 0.54 | 0.99 |
| **27** | 0.26 | 0.19 | 1.80 | 1.03 | 0.52 | 0.28 | 0.80 | 0.92 | 0.39 | 0.16 | 0.80 | 0.90 |

| Display | Task | Average Response Times |
|---|---|---|
| No Display | No Distraction | 1.91 |
| | Music | 1.67 |
| | Texting | 2.31 |
| | Both | 2.21 |
| Suspenders | No Distraction | 1.47 |
| | Music | 1.40 |
| | Texting | 1.63 |
| | Both | 1.67 |
| Helmet | No Distraction | 1.35 |
| | Music | 1.45 |
| | Texting | 1.50 |
| | Both | 1.65 |




**Mauchly's Test of Sphericity[a]**

Measure: ResponseTime

| Within Subjects Effect | Mauchly's W | Approx. Chi-Square | df | Sig. | Epsilon[b] Greenhouse-Geisser |
|---|---|---|---|---|---|
| display | .957 | 1.107 | 2 | .575 | .958 |
| task | .581 | 13.432 | 5 | .020 | .747 |

| | | | | | |
|---|---|---|---|---|---|
| display * task | .379 | 23.047 | 20 | .291 | .793 |

**Mauchly's Test of Sphericity[a]**

Measure: ResponseTime

| Within Subjects Effect | Epsilon | |
|---|---|---|
| | Huynh-Feldt | Lower-bound |
| display | 1.000 | .500 |
| task | .821 | .333 |
| display * task | .992 | .167 |

**Multivariate Tests[a]**

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| display | Pillai's Trace | .697 | 28.724[b] | 2.000 | 25.000 | .000 |
| | Wilks' Lambda | .303 | 28.724[b] | 2.000 | 25.000 | .000 |
| | Hotelling's Trace | 2.298 | 28.724[b] | 2.000 | 25.000 | .000 |
| | Roy's Largest Root | 2.298 | 28.724[b] | 2.000 | 25.000 | .000 |
| task | Pillai's Trace | .499 | 7.963[b] | 3.000 | 24.000 | .001 |
| | Wilks' Lambda | .501 | 7.963[b] | 3.000 | 24.000 | .001 |
| | Hotelling's Trace | .995 | 7.963[b] | 3.000 | 24.000 | .001 |
| | Roy's Largest Root | .995 | 7.963[b] | 3.000 | 24.000 | .001 |

| | | | | | | |
|---|---|---|---|---|---|---|
| display * task | Pillai's Trace | .416 | 2.495[b] | 6.000 | 21.000 | .056 |
| | Wilks' Lambda | .584 | 2.495[b] | 6.000 | 21.000 | .056 |
| | Hotelling's Trace | .713 | 2.495[b] | 6.000 | 21.000 | .056 |
| | Roy's Largest Root | .713 | 2.495[b] | 6.000 | 21.000 | .056 |

**Pairwise Comparisons**

Measure: ResponseTime

| (I) display | (J) display | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| 1 | 2 | .485* | .069 | .000 | .344 | .627 |
| | 3 | .536* | .080 | .000 | .371 | .701 |
| 2 | 1 | -.485* | .069 | .000 | -.627 | -.344 |
| | 3 | .051 | .069 | .469 | -.091 | .192 |
| 3 | 1 | -.536* | .080 | .000 | -.701 | -.371 |
| | 2 | -.051 | .069 | .469 | -.192 | .091 |

**Pairwise Comparisons**

Measure: ResponseTime

| (I) task | (J) task | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| 1 | 2 | .070 | .097 | .477 | -.129 | .268 |
| | 3 | -.237 | .124 | .066 | -.492 | .017 |
| | 4 | -.270* | .104 | .016 | -.484 | -.055 |
| 2 | 1 | -.070 | .097 | .477 | -.268 | .129 |
| | 3 | -.307* | .094 | .003 | -.501 | -.113 |
| | 4 | -.340* | .067 | .000 | -.477 | -.202 |
| 3 | 1 | .237 | .124 | .066 | -.017 | .492 |
| | 2 | .307* | .094 | .003 | .113 | .501 |
| | 4 | -.032 | .075 | .668 | -.185 | .121 |
| 4 | 1 | .270* | .104 | .016 | .055 | .484 |
| | 2 | .340* | .067 | .000 | .202 | .477 |
| | 3 | .032 | .075 | .668 | -.121 | .185 |

**Pairwise Comparisons**

Measure: ResponseTime

| task | (I) display | (J) display | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] Lower Bound |
|---|---|---|---|---|---|---|
| 1 | 1 | 2 | .444* | .113 | .001 | .211 |
| | | 3 | .555* | .140 | .000 | .268 |
| | 2 | 1 | -.444* | .113 | .001 | -.677 |
| | | 3 | .111 | .150 | .466 | -.197 |
| | 3 | 1 | -.555* | .140 | .000 | -.842 |
| | | 2 | -.111 | .150 | .466 | -.418 |
| 2 | 1 | 2 | .274* | .108 | .017 | .052 |
| | | 3 | .216* | .097 | .036 | .015 |
| | 2 | 1 | -.274* | .108 | .017 | -.495 |
| | | 3 | -.058 | .101 | .569 | -.265 |
| | 3 | 1 | -.216* | .097 | .036 | -.416 |
| | | 2 | .058 | .101 | .569 | -.149 |
| 3 | 1 | 2 | .684* | .154 | .000 | .369 |
| | | 3 | .814* | .163 | .000 | .480 |
| | 2 | 1 | -.684* | .154 | .000 | -1.000 |
| | | 3 | .130 | .171 | .453 | -.221 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 3 | 1 | -.814* | .163 | .000 | -1.149 |
| | | 2 | -.130 | .171 | .453 | -.481 |
| 4 | 1 | 2 | .539* | .164 | .003 | .202 |
| | | 3 | .559* | .165 | .002 | .220 |
| | 2 | 1 | -.539* | .164 | .003 | -.877 |
| | | 3 | .020 | .113 | .861 | -.213 |
| | 3 | 1 | -.559* | .165 | .002 | -.899 |
| | | 2 | -.020 | .113 | .861 | -.253 |

**Pairwise Comparisons**

Measure: ResponseTime

| display | (I) task | (J) task | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| 1 | 1 | 2 | .240 | .117 | .050 | -3.773E-5 | .479 |
| | | 3 | -.404* | .183 | .036 | -.781 | -.027 |
| | | 4 | -.303 | .163 | .074 | -.638 | .032 |
| | 2 | 1 | -.240 | .117 | .050 | -.479 | 3.773E-5 |
| | | 3 | -.644* | .170 | .001 | -.993 | -.294 |
| | | 4 | -.543* | .130 | .000 | -.810 | -.275 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 3 | 1 | .404* | .183 | .036 | .027 | .781 |
| | | 2 | .644* | .170 | .001 | .294 | .993 |
| | | 4 | .101 | .178 | .574 | -.264 | .466 |
| | 4 | 1 | .303 | .163 | .074 | -.032 | .638 |
| | | 2 | .543* | .130 | .000 | .275 | .810 |
| | | 3 | -.101 | .178 | .574 | -.466 | .264 |
| 2 | 1 | 2 | .069 | .124 | .582 | -.186 | .324 |
| | | 3 | -.164 | .148 | .277 | -.467 | .140 |
| | | 4 | -.208 | .159 | .202 | -.534 | .119 |
| | 2 | 1 | -.069 | .124 | .582 | -.324 | .186 |
| | | 3 | -.233* | .096 | .023 | -.431 | -.035 |
| | | 4 | -.277* | .126 | .037 | -.537 | -.017 |
| | 3 | 1 | .164 | .148 | .277 | -.140 | .467 |
| | | 2 | .233* | .096 | .023 | .035 | .431 |
| | | 4 | -.044 | .102 | .668 | -.253 | .165 |
| | 4 | 1 | .208 | .159 | .202 | -.119 | .534 |
| | | 2 | .277* | .126 | .037 | .017 | .537 |
| | | 3 | .044 | .102 | .668 | -.165 | .253 |
| 3 | 1 | 2 | -.100 | .145 | .498 | -.398 | .199 |
| | | 3 | -.144 | .161 | .377 | -.475 | .186 |
| | | 4 | -.299 | .174 | .098 | -.656 | .059 |
| | 2 | 1 | .100 | .145 | .498 | -.199 | .398 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 3 | -.045 | .157 | .778 | -.368 | .278 |
| | 4 | -.199 | .120 | .108 | -.445 | .047 |
| 3 | 1 | .144 | .161 | .377 | -.186 | .475 |
| | 2 | .045 | .157 | .778 | -.278 | .368 |
| | 4 | -.154 | .152 | .321 | -.467 | .159 |
| 4 | 1 | .299 | .174 | .098 | -.059 | .656 |
| | 2 | .199 | .120 | .108 | -.047 | .445 |
| | 3 | .154 | .152 | .321 | -.159 | .467 |

# APPENDIX M

# RAW DATA/GRAPHS/STATISTICAL OUTPUTS

## ***Signal Detection Theory***

| HIT RATES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **N1** | **N2** | **N3** | **N4** | **S1** | **S2** | **S3** | **S4** | **H1** | **H2** | **H3** | **H4** |
| **1** | 0.63 | 0.75 | 0.50 | 0.75 | 0.63 | 0.88 | 0.63 | 1.00 | 0.63 | 0.75 | 0.88 | 0.75 |
| **2** | 0.88 | 0.88 | 1.00 | 0.88 | 1.00 | 1.00 | 0.88 | 1.00 | 0.63 | 1.00 | 1.00 | 0.75 |
| **3** | 1.00 | 1.00 | 0.88 | 0.75 | 1.00 | 1.00 | 0.88 | 1.00 | 1.00 | 1.00 | 0.88 | 0.88 |
| **4** | 1.00 | 0.63 | 0.63 | 0.50 | 0.63 | 0.63 | 0.63 | 0.75 | 1.00 | 0.50 | 0.75 | 1.00 |
| **5** | 1.00 | 1.00 | 0.88 | 0.63 | 0.88 | 0.88 | 1.00 | 1.00 | 0.38 | 0.88 | 0.63 | 1.00 |
| **6** | 1.00 | 1.00 | 0.75 | 0.88 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **7** | 0.75 | 0.75 | 0.75 | 0.63 | 1.00 | 0.75 | 1.00 | 1.00 | 1.00 | 0.88 | 0.88 | 0.75 |
| **8** | 0.88 | 0.75 | 0.88 | 0.88 | 1.00 | 0.50 | 0.63 | 0.88 | 0.75 | 0.88 | 0.63 | 0.88 |
| **9** | 1.00 | 0.88 | 0.88 | 0.75 | 1.00 | 0.75 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **10** | 1.00 | 1.00 | 0.88 | 0.88 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **11** | 1.00 | 1.00 | 0.75 | 0.88 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **12** | 0.88 | 1.00 | 0.88 | 0.63 | 0.50 | 0.63 | 1.00 | 0.88 | 0.63 | 0.75 | 0.88 | 0.88 |
| **13** | 0.75 | 0.88 | 0.75 | 0.75 | 0.88 | 0.75 | 0.88 | 0.75 | 0.63 | 0.88 | 0.88 | 1.00 |
| **14** | 0.88 | 1.00 | 0.88 | 0.63 | 1.00 | 1.00 | 0.88 | 1.00 | 1.00 | 1.00 | 1.00 | 0.75 |
| **15** | 0.88 | 1.00 | 0.63 | 1.00 | 0.75 | 0.75 | 1.00 | 1.00 | 0.75 | 1.00 | 0.88 | 1.00 |
| **16** | 1.00 | 0.88 | 1.00 | 0.88 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.88 | 1.00 | 0.88 |
| **17** | 1.00 | 1.00 | 0.88 | 1.00 | 0.88 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **18** | 0.63 | 0.88 | 1.00 | 0.75 | 0.50 | 0.75 | 0.75 | 1.00 | 0.50 | 0.75 | 0.63 | 0.50 |
| **19** | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.88 | 1.00 | 1.00 | 1.00 | 1.00 |
| **20** | 0.88 | 0.75 | 1.00 | 0.63 | 1.00 | 0.75 | 0.63 | 0.63 | 0.63 | 0.88 | 0.75 | 1.00 |
| **21** | 0.88 | 0.63 | 0.63 | 0.38 | 0.88 | 0.63 | 0.50 | 0.75 | 0.75 | 0.88 | 0.63 | 0.63 |
| **22** | 1.00 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | 1.00 | 1.00 | 1.00 | 1.00 | 0.75 | 1.00 |
| **23** | 0.88 | 0.88 | 0.75 | 0.75 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.88 | 0.88 |
| **24** | 1.00 | 1.00 | 0.63 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **25** | 0.38 | 0.63 | 0.75 | 0.75 | 0.63 | 0.63 | 1.00 | 0.63 | 0.38 | 1.00 | 0.75 | 0.50 |
| **26** | 1.00 | 1.00 | 0.88 | 1.00 | 1.00 | 1.00 | 0.88 | 1.00 | 1.00 | 1.00 | 0.75 | 1.00 |
| **27** | 1.00 | 0.88 | 0.63 | 0.88 | 1.00 | 1.00 | 1.00 | 0.88 | 1.00 | 1.00 | 1.00 | 0.75 |

| NORMSINV(Hit Rate) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **N1** | **N2** | **N3** | **N4** | **S1** | **S2** | **S3** | **S4** | **H1** | **H2** | **H3** | **H4** |
| **1** | 0.33 | 0.67 | 0.00 | 0.67 | 0.33 | 1.17 | 0.33 | 1.55 | 0.33 | 0.67 | 1.17 | 0.67 |
| **2** | 1.17 | 1.17 | 1.55 | 1.17 | 1.55 | 1.55 | 1.17 | 1.55 | 0.33 | 1.55 | 1.55 | 0.67 |
| **3** | 1.17 | 1.55 | 1.17 | 0.44 | 1.55 | 1.55 | 1.17 | 1.55 | 1.55 | 1.55 | 1.17 | 1.17 |
| **4** | 1.55 | 0.33 | 0.33 | 0.00 | 0.33 | 0.33 | 0.33 | 0.67 | 1.55 | 0.00 | 0.67 | 1.55 |
| **5** | 1.55 | 1.55 | 1.17 | 0.33 | 1.17 | 1.17 | 1.55 | 1.55 | -0.31 | 1.17 | 0.33 | 1.55 |
| **6** | 1.55 | 1.55 | 0.67 | 1.17 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 |
| **7** | 0.67 | 0.67 | 0.67 | 0.33 | 1.55 | 0.67 | 1.55 | 1.55 | 1.55 | 1.17 | 1.17 | 0.67 |
| **8** | 1.17 | 0.67 | 1.17 | 1.17 | 1.55 | 0.00 | 0.33 | 1.17 | 0.67 | 1.17 | 0.33 | 1.17 |
| **9** | 1.55 | 1.17 | 1.17 | 0.44 | 1.55 | 0.67 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 |
| **10** | 1.55 | 1.55 | 1.17 | 1.17 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 |
| **11** | 1.55 | 1.55 | 0.67 | 1.17 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 |
| **12** | 1.17 | 1.55 | 1.17 | 0.33 | 0.00 | 0.33 | 1.55 | 1.17 | 0.33 | 0.67 | 1.17 | 1.17 |
| **13** | 0.67 | 1.17 | 0.67 | 0.44 | 1.17 | 0.67 | 1.17 | 0.67 | 0.33 | 1.17 | 1.17 | 1.55 |
| **14** | 1.17 | 1.55 | 1.17 | 0.33 | 1.55 | 1.55 | 1.17 | 1.55 | 1.55 | 1.55 | 1.55 | 0.67 |
| **15** | 1.17 | 1.55 | 0.33 | 1.55 | 0.67 | 0.67 | 1.55 | 1.55 | 0.67 | 1.55 | 1.17 | 1.55 |
| **16** | 1.55 | 1.17 | 1.55 | 1.17 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.17 | 1.55 | 1.17 |
| **17** | 1.55 | 1.55 | 1.17 | 1.55 | 1.17 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 |
| **18** | 0.33 | 1.17 | 1.55 | 0.44 | 0.00 | 0.67 | 0.67 | 1.55 | 0.00 | 0.67 | 0.33 | 0.00 |
| **19** | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.17 | 1.55 | 1.55 | 1.55 | 1.55 |
| **20** | 1.17 | 0.67 | 1.55 | 0.33 | 1.55 | 0.67 | 0.33 | 0.33 | 0.33 | 1.17 | 0.67 | 1.55 |
| **21** | 1.17 | 0.33 | 0.33 | -0.31 | 1.17 | 0.33 | 0.00 | 0.67 | 0.67 | 1.17 | 0.33 | 0.33 |
| **22** | 1.55 | 1.17 | 1.17 | 1.17 | 1.17 | 1.17 | 1.55 | 1.55 | 1.55 | 1.55 | 0.67 | 1.55 |
| **23** | 1.17 | 1.17 | 0.67 | 0.44 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.17 | 1.17 |
| **24** | 1.55 | 1.55 | 0.33 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 |
| **25** | -0.31 | 0.33 | 0.67 | 0.44 | 0.33 | 0.33 | 1.55 | 0.33 | -0.31 | 1.55 | 0.67 | 0.00 |
| **26** | 1.55 | 1.55 | 1.17 | 1.55 | 1.55 | 1.55 | 1.17 | 1.55 | 1.55 | 1.55 | 0.67 | 1.55 |
| **27** | 1.55 | 1.17 | 0.33 | 1.17 | 1.55 | 1.55 | 1.55 | 1.17 | 1.55 | 1.55 | 1.55 | 0.67 |

| FALSE ALARM RATES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **N1** | **N2** | **N3** | **N4** | **S1** | **S2** | **S3** | **S4** | **H1** | **H2** | **H3** | **H4** |
| **1** | 0.00 | 0.00 | 0.17 | 0.00 | 0.00 | 0.17 | 0.00 | 0.00 | 0.17 | 0.00 | 0.17 | 0.17 |
| **2** | 0.00 | 0.00 | 0.00 | 0.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **3** | 0.00 | 0.00 | 0.33 | 0.17 | 0.33 | 0.33 | 0.17 | 0.67 | 0.17 | 0.00 | 0.33 | 0.33 |
| **4** | 0.00 | 0.00 | 0.33 | 0.00 | 0.17 | 0.17 | 0.00 | 0.33 | 0.33 | 0.00 | 0.00 | 0.00 |
| **5** | 0.33 | 0.33 | 0.17 | 0.33 | 0.33 | 0.17 | 0.33 | 0.17 | 0.00 | 0.17 | 0.00 | 0.50 |
| **6** | 0.00 | 0.50 | 0.33 | 0.00 | 0.33 | 0.33 | 0.17 | 0.17 | 0.00 | 0.17 | 0.17 | 0.17 |
| **7** | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 | 0.17 | 0.50 | 0.17 | 0.00 | 0.17 | 0.00 | 0.00 |
| **8** | 0.33 | 0.00 | 0.33 | 0.33 | 0.33 | 0.00 | 0.00 | 0.33 | 0.33 | 0.50 | 0.17 | 0.33 |
| **9** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **10** | 0.17 | 0.33 | 0.00 | 0.50 | 1.00 | 0.83 | 0.67 | 0.00 | 1.00 | 0.67 | 0.83 | 0.83 |
| **11** | 0.33 | 0.33 | 0.33 | 0.17 | 0.17 | 0.00 | 0.00 | 0.00 | 0.33 | 0.17 | 0.50 | 0.17 |
| **12** | 0.67 | 0.33 | 0.67 | 0.50 | 0.83 | 0.83 | 0.33 | 0.00 | 0.67 | 0.67 | 0.50 | 0.33 |
| **13** | 0.33 | 0.83 | 0.83 | 0.83 | 0.67 | 0.83 | 0.83 | 0.33 | 0.83 | 0.67 | 0.83 | 0.83 |
| **14** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 | 0.33 | 0.00 | 0.00 | 0.33 | 0.00 | 0.17 |
| **15** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 | 0.17 | 0.00 | 0.17 |
| **16** | 0.67 | 0.50 | 0.33 | 0.50 | 1.00 | 1.00 | 0.50 | 0.67 | 0.83 | 0.67 | 0.67 | 1.00 |
| **17** | 0.50 | 0.33 | 0.67 | 0.33 | 0.17 | 0.67 | 0.17 | 0.50 | 0.33 | 0.50 | 0.17 | 0.17 |
| **18** | 0.17 | 0.50 | 0.00 | 0.17 | 0.00 | 0.17 | 0.00 | 0.17 | 0.00 | 0.00 | 0.17 | 0.17 |
| **19** | 0.00 | 0.00 | 0.17 | 0.00 | 0.17 | 0.33 | 0.33 | 0.00 | 0.50 | 0.33 | 0.00 | 0.33 |
| **20** | 0.67 | 0.00 | 0.17 | 0.17 | 0.50 | 0.83 | 0.67 | 0.50 | 0.67 | 0.33 | 0.50 | 0.17 |
| **21** | 0.33 | 0.17 | 0.00 | 0.17 | 0.17 | 0.33 | 0.00 | 0.50 | 0.33 | 0.17 | 0.17 | 0.33 |
| **22** | 0.33 | 0.17 | 0.00 | 0.17 | 0.33 | 0.00 | 0.50 | 0.17 | 0.00 | 0.17 | 0.17 | 0.00 |
| **23** | 0.33 | 0.67 | 0.67 | 0.33 | 0.50 | 0.50 | 0.50 | 0.83 | 0.67 | 0.50 | 0.50 | 0.33 |
| **24** | 0.83 | 0.50 | 0.50 | 0.67 | 0.83 | 0.67 | 1.00 | 1.00 | 1.00 | 0.67 | 1.00 | 0.83 |
| **25** | 0.17 | 0.00 | 0.00 | 0.00 | 0.33 | 0.17 | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 | 0.00 |
| **26** | 0.83 | 0.33 | 0.50 | 0.17 | 0.50 | 0.33 | 0.50 | 0.50 | 0.17 | 0.67 | 0.33 | 0.67 |
| **27** | 1.00 | 0.33 | 0.83 | 1.00 | 0.67 | 0.83 | 0.17 | 0.67 | 0.67 | 0.83 | 0.83 | 0.67 |

| NORMSINV(False Alarm) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **N1** | **N2** | **N3** | **N4** | **S1** | **S2** | **S3** | **S4** | **H1** | **H2** | **H3** | **H4** |
| **1** | -1.41 | -1.41 | -0.95 | -1.41 | -1.41 | -0.95 | -1.41 | -1.41 | -0.95 | -1.41 | -0.95 | -0.95 |
| **2** | -1.41 | -1.41 | -1.41 | -0.95 | -1.41 | -1.41 | -1.41 | -1.41 | -1.41 | -1.41 | -1.41 | -1.41 |
| **3** | -1.41 | -1.41 | -0.44 | -0.95 | -0.44 | -0.44 | -0.95 | 0.44 | -0.95 | -1.41 | -0.44 | -0.44 |
| **4** | -1.41 | -1.41 | -0.44 | -1.41 | -0.95 | -0.95 | -1.41 | -0.44 | -0.44 | -1.41 | -1.41 | -1.41 |
| **5** | -0.44 | -0.44 | -0.95 | -0.44 | -0.44 | -0.95 | -0.44 | -0.95 | -1.41 | -0.95 | -1.41 | 0.00 |
| **6** | -1.41 | 0.00 | -0.44 | -1.41 | -0.44 | -0.44 | -0.95 | -0.95 | -1.41 | -0.95 | -0.95 | -0.95 |
| **7** | -1.41 | -1.41 | -1.41 | -1.41 | -0.44 | -0.95 | 0.00 | -0.95 | -1.41 | -0.95 | -1.41 | -1.41 |
| **8** | -0.44 | -1.41 | -0.44 | -0.44 | -0.44 | -1.41 | -1.41 | -0.44 | -0.44 | -1.41 | -0.95 | -0.44 |
| **9** | -1.41 | -1.41 | -1.41 | -1.41 | -1.41 | -1.41 | -1.41 | -1.41 | -1.41 | -1.41 | -1.41 | -1.41 |
| **10** | -0.95 | -0.44 | -1.41 | -1.41 | 1.41 | 0.95 | 0.44 | -1.41 | 1.41 | 0.44 | 0.95 | 0.95 |
| **11** | -0.44 | -0.44 | -0.44 | -0.95 | -0.95 | -1.41 | -1.41 | -1.41 | -0.44 | -0.95 | 0.00 | -0.95 |
| **12** | 0.44 | -0.44 | 0.44 | -1.41 | 0.95 | 0.95 | -0.44 | -1.41 | 0.44 | 0.44 | 0.00 | -0.44 |
| **13** | -0.44 | 0.95 | 0.95 | 0.95 | 0.44 | 0.95 | 0.95 | -0.44 | 0.95 | 0.44 | 0.95 | 0.95 |
| **14** | -1.41 | -1.41 | -1.41 | -1.41 | -1.41 | -0.44 | -0.44 | -1.41 | -1.41 | -0.44 | -1.41 | -0.95 |
| **15** | -1.41 | -1.41 | -1.41 | 1.41 | -1.41 | -1.41 | -1.41 | -1.41 | -0.44 | -0.95 | -1.41 | -0.95 |
| **16** | 0.44 | 0.00 | -0.44 | -1.41 | 1.41 | 1.41 | 0.00 | 0.44 | 0.95 | 0.44 | 0.44 | 1.41 |
| **17** | 0.00 | -0.44 | 0.44 | -0.44 | -0.95 | 0.44 | -0.95 | 0.00 | -0.44 | -1.41 | -0.95 | -0.95 |
| **18** | -0.95 | 0.00 | -1.41 | -0.95 | -1.41 | -0.95 | -1.41 | -0.95 | -1.41 | -1.41 | -0.95 | -0.95 |
| **19** | -1.41 | -1.41 | -0.95 | -1.41 | -0.95 | -0.44 | -0.44 | -1.41 | 0.00 | -0.44 | -1.41 | -0.44 |
| **20** | 0.44 | -1.41 | -0.95 | -0.95 | 0.00 | 0.95 | 0.44 | 0.00 | 0.44 | -0.44 | 0.00 | -0.95 |
| **21** | -0.44 | -0.95 | -1.41 | -0.95 | -0.95 | -0.44 | -1.41 | 0.00 | -0.44 | -0.95 | -0.95 | -0.44 |
| **22** | -0.44 | -0.95 | -1.41 | -0.95 | -0.44 | -1.41 | 0.00 | -0.95 | -1.41 | -0.95 | -0.95 | -1.41 |
| **23** | -0.44 | 0.44 | 0.44 | -0.44 | -1.41 | 0.00 | 0.00 | 0.95 | 0.44 | -1.41 | 0.00 | -0.44 |
| **24** | 0.95 | 0.00 | -1.41 | 0.44 | 0.95 | 0.44 | 1.41 | 1.41 | 1.41 | 0.44 | 1.41 | 0.95 |
| **25** | -0.95 | -1.41 | -1.41 | -1.41 | -0.44 | -0.95 | -1.41 | -1.41 | -1.41 | -0.44 | -1.41 | -1.41 |
| **26** | 0.95 | -0.44 | -1.41 | -0.95 | -1.41 | -0.44 | 0.00 | 0.00 | -0.95 | 0.44 | -0.44 | 0.44 |
| **27** | 1.41 | -0.44 | 0.95 | 1.41 | 0.44 | 0.95 | -0.95 | 0.44 | 0.44 | 0.95 | 0.95 | 0.44 |

| SENSITIVITY (d') RATES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **N1** | **N2** | **N3** | **N4** | **S1** | **S2** | **S3** | **S4** | **H1** | **H2** | **H3** | **H4** |
| **1** | 1.74 | 2.08 | 0.95 | 2.08 | 1.74 | 2.13 | 1.74 | 2.96 | 1.29 | 2.08 | 2.13 | 1.63 |
| **2** | 2.58 | 2.58 | 2.96 | 2.13 | 2.96 | 2.96 | 2.58 | 2.96 | 1.74 | 2.96 | 2.96 | 2.08 |
| **3** | 2.58 | 2.96 | 1.61 | 1.39 | 1.99 | 1.99 | 2.13 | 1.99 | 2.51 | 2.96 | 1.61 | 1.61 |
| **4** | 2.96 | 1.74 | 0.77 | 1.41 | 1.29 | 1.29 | 1.74 | 1.11 | 1.99 | 1.41 | 2.08 | 2.96 |
| **5** | 1.99 | 1.99 | 2.13 | 0.77 | 1.61 | 2.13 | 1.99 | 2.51 | 1.71 | 2.13 | 1.74 | 1.55 |
| **6** | 2.96 | 1.55 | 1.11 | 2.58 | 1.99 | 1.99 | 2.51 | 2.51 | 2.96 | 2.51 | 2.51 | 2.51 |
| **7** | 2.08 | 2.08 | 2.08 | 1.74 | 1.99 | 1.63 | 1.55 | 2.51 | 2.96 | 2.13 | 2.58 | 2.08 |
| **8** | 1.61 | 2.08 | 1.61 | 1.61 | 1.99 | 1.41 | 1.74 | 1.61 | 1.11 | 2.58 | 1.29 | 1.61 |
| **9** | 2.96 | 2.58 | 2.58 | 1.84 | 2.96 | 2.08 | 2.96 | 2.96 | 2.96 | 2.96 | 2.96 | 2.96 |
| **10** | 2.51 | 1.99 | 2.58 | 2.58 | 2.96 | 2.51 | 1.99 | 2.96 | 2.96 | 1.99 | 2.51 | 2.51 |
| **11** | 1.99 | 1.99 | 1.11 | 2.13 | 2.51 | 2.96 | 2.96 | 2.96 | 1.99 | 2.51 | 1.55 | 2.51 |
| **12** | 1.61 | 1.99 | 1.61 | 1.74 | 0.95 | 1.29 | 1.99 | 2.58 | 0.77 | 1.11 | 1.17 | 1.61 |
| **13** | 1.11 | 2.13 | 1.63 | 1.39 | 1.61 | 1.63 | 2.13 | 1.11 | 1.29 | 1.61 | 2.13 | 2.51 |
| **14** | 2.58 | 2.96 | 2.58 | 1.74 | 2.96 | 1.99 | 1.61 | 2.96 | 2.96 | 1.99 | 2.96 | 1.63 |
| **15** | 2.58 | 2.96 | 1.74 | 2.96 | 2.08 | 2.08 | 2.96 | 2.96 | 1.11 | 2.51 | 2.58 | 2.51 |
| **16** | 1.99 | 1.17 | 1.99 | 2.58 | 2.96 | 2.96 | 1.55 | 1.99 | 2.51 | 1.61 | 1.99 | 2.58 |
| **17** | 1.55 | 1.99 | 1.61 | 1.99 | 2.13 | 1.99 | 2.51 | 1.55 | 1.99 | 2.96 | 2.51 | 2.51 |
| **18** | 1.29 | 1.17 | 2.96 | 1.39 | 1.41 | 1.63 | 2.08 | 2.51 | 1.41 | 2.08 | 1.29 | 0.95 |
| **19** | 2.96 | 2.96 | 2.51 | 2.96 | 2.51 | 1.99 | 1.99 | 2.58 | 1.55 | 1.99 | 2.96 | 1.99 |
| **20** | 1.61 | 2.08 | 2.51 | 1.29 | 1.55 | 1.63 | 0.77 | 0.33 | 0.77 | 1.61 | 0.67 | 2.51 |
| **21** | 1.61 | 1.29 | 1.74 | 1.26 | 2.13 | 0.77 | 1.41 | 0.67 | 1.11 | 2.13 | 1.29 | 0.77 |
| **22** | 1.99 | 2.13 | 2.58 | 2.13 | 1.61 | 2.58 | 1.55 | 2.51 | 2.96 | 2.51 | 1.63 | 2.96 |
| **23** | 1.61 | 1.61 | 1.11 | 0.88 | 2.96 | 1.55 | 1.55 | 2.51 | 1.99 | 2.96 | 1.17 | 1.61 |
| **24** | 2.51 | 1.55 | 1.74 | 1.99 | 2.51 | 1.99 | 2.96 | 2.96 | 2.96 | 1.99 | 2.96 | 2.51 |
| **25** | 1.26 | 1.74 | 2.08 | 1.84 | 0.77 | 1.29 | 2.96 | 1.74 | 1.71 | 1.99 | 2.08 | 1.41 |
| **26** | 2.51 | 1.99 | 2.58 | 2.51 | 2.96 | 1.99 | 1.17 | 1.55 | 2.51 | 1.99 | 1.11 | 1.99 |
| **27** | 2.96 | 1.61 | 1.29 | 2.58 | 1.99 | 2.51 | 2.51 | 1.61 | 1.99 | 2.51 | 2.51 | 1.11 |
| **Average** | **2.14** | **2.04** | **1.92** | **1.91** | **2.12** | **1.96** | **2.06** | **2.19** | **1.99** | **2.21** | **2.03** | **2.04** |

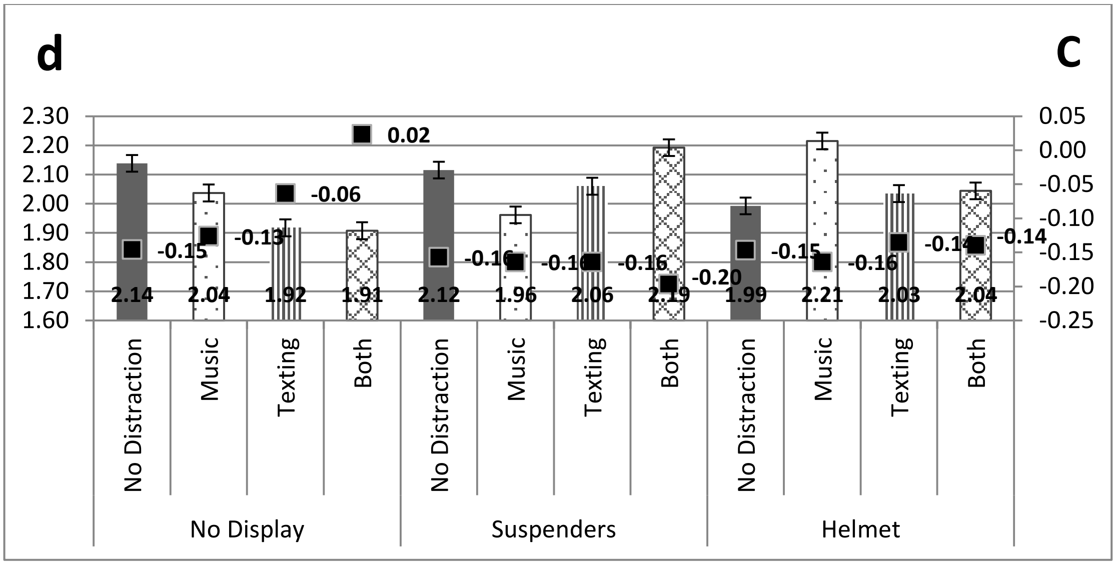
| Beta (natural log) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **N1** | **N2** | **N3** | **N4** | **S1** | **S2** | **S3** | **S4** | **H1** | **H2** | **H3** | **H4** |
| **1** | 0.93 | 0.76 | 0.46 | 0.76 | 0.93 | -0.24 | 0.93 | -0.22 | 0.40 | 0.76 | -0.24 | 0.23 |
| **2** | 0.30 | 0.30 | -0.22 | -0.24 | -0.22 | -0.22 | 0.30 | -0.22 | 0.93 | -0.22 | -0.22 | 0.76 |
| **3** | 0.30 | -0.22 | -0.59 | 0.36 | -1.11 | -1.11 | -0.24 | -1.99 | -0.75 | -0.22 | -0.59 | -0.59 |
| **4** | -0.22 | 0.93 | 0.04 | 0.99 | 0.40 | 0.40 | 0.93 | -0.13 | -1.11 | 0.99 | 0.76 | -0.22 |
| **5** | -1.11 | -1.11 | -0.24 | 0.04 | -0.59 | -0.24 | -1.11 | -0.75 | 1.46 | -0.24 | 0.93 | -1.21 |
| **6** | -0.22 | -1.21 | -0.13 | 0.30 | -1.11 | -1.11 | -0.75 | -0.75 | -0.22 | -0.75 | -0.75 | -0.75 |
| **7** | 0.76 | 0.76 | 0.76 | 0.93 | -1.11 | 0.23 | -1.21 | -0.75 | -0.22 | -0.24 | 0.30 | 0.76 |
| **8** | -0.59 | 0.76 | -0.59 | -0.59 | -1.11 | 0.99 | 0.93 | -0.59 | -0.13 | 0.30 | 0.40 | -0.59 |
| **9** | -0.22 | 0.30 | 0.30 | 0.89 | -0.22 | 0.76 | -0.22 | -0.22 | -0.22 | -0.22 | -0.22 | -0.22 |
| **10** | -0.75 | -1.11 | 0.30 | 0.30 | -4.38 | -3.15 | -1.99 | -0.22 | -4.38 | -1.99 | -3.15 | -3.15 |
| **11** | -1.11 | -1.11 | -0.13 | -0.24 | -0.75 | -0.22 | -0.22 | -0.22 | -1.11 | -0.75 | -1.21 | -0.75 |
| **12** | -1.30 | -1.11 | -1.30 | 0.93 | -0.46 | -0.83 | -1.11 | 0.30 | -0.30 | -0.62 | -0.69 | -0.59 |
| **13** | -0.13 | -2.27 | -1.33 | -0.97 | -1.30 | -1.33 | -2.27 | -0.13 | -0.83 | -1.30 | -2.27 | -3.15 |
| **14** | 0.30 | -0.22 | 0.30 | 0.93 | -0.22 | -1.11 | -0.59 | -0.22 | -0.22 | -1.11 | -0.22 | 0.23 |
| **15** | 0.30 | -0.22 | 0.93 | -4.38 | 0.76 | 0.76 | -0.22 | -0.22 | -0.13 | -0.75 | 0.30 | -0.75 |
| **16** | -1.99 | -0.69 | -1.11 | 0.30 | -4.38 | -4.38 | -1.21 | -1.99 | -3.15 | -1.30 | -1.99 | -3.33 |
| **17** | -1.21 | -1.11 | -1.30 | -1.11 | -0.24 | -1.99 | -0.75 | -1.21 | -1.11 | -0.22 | -0.75 | -0.75 |
| **18** | 0.40 | -0.69 | -0.22 | 0.36 | 0.99 | 0.23 | 0.76 | -0.75 | 0.99 | 0.76 | 0.40 | 0.46 |
| **19** | -0.22 | -0.22 | -0.75 | -0.22 | -0.75 | -1.11 | -1.11 | 0.30 | -1.21 | -1.11 | -0.22 | -1.11 |
| **20** | -1.30 | 0.76 | -0.75 | 0.40 | -1.21 | -1.33 | -0.30 | -0.06 | -0.30 | -0.59 | -0.23 | -0.75 |
| **21** | -0.59 | 0.40 | 0.93 | 0.79 | -0.24 | 0.04 | 0.99 | -0.23 | -0.13 | -0.24 | 0.40 | 0.04 |
| **22** | -1.11 | -0.24 | 0.30 | -0.24 | -0.59 | 0.30 | -1.21 | -0.75 | -0.22 | -0.75 | 0.23 | -0.22 |
| **23** | -0.59 | -1.30 | -0.62 | 0.00 | -0.22 | -1.21 | -1.21 | -3.15 | -1.99 | -0.22 | -0.69 | -0.59 |
| **24** | -3.15 | -1.21 | 0.93 | -1.99 | -3.15 | -1.99 | -4.38 | -4.38 | -4.38 | -1.99 | -4.38 | -3.15 |
| **25** | 0.79 | 0.93 | 0.76 | 0.89 | 0.04 | 0.40 | -0.22 | 0.93 | 1.46 | -1.11 | 0.76 | 0.99 |
| **26** | -3.15 | -1.11 | 0.30 | -0.75 | -0.22 | -1.11 | -0.69 | -1.21 | -0.75 | -1.99 | -0.13 | -1.99 |
| **27** | -4.38 | -0.59 | -0.83 | -3.33 | -1.99 | -3.15 | -0.75 | -1.30 | -1.99 | -3.15 | -3.15 | -0.62 |

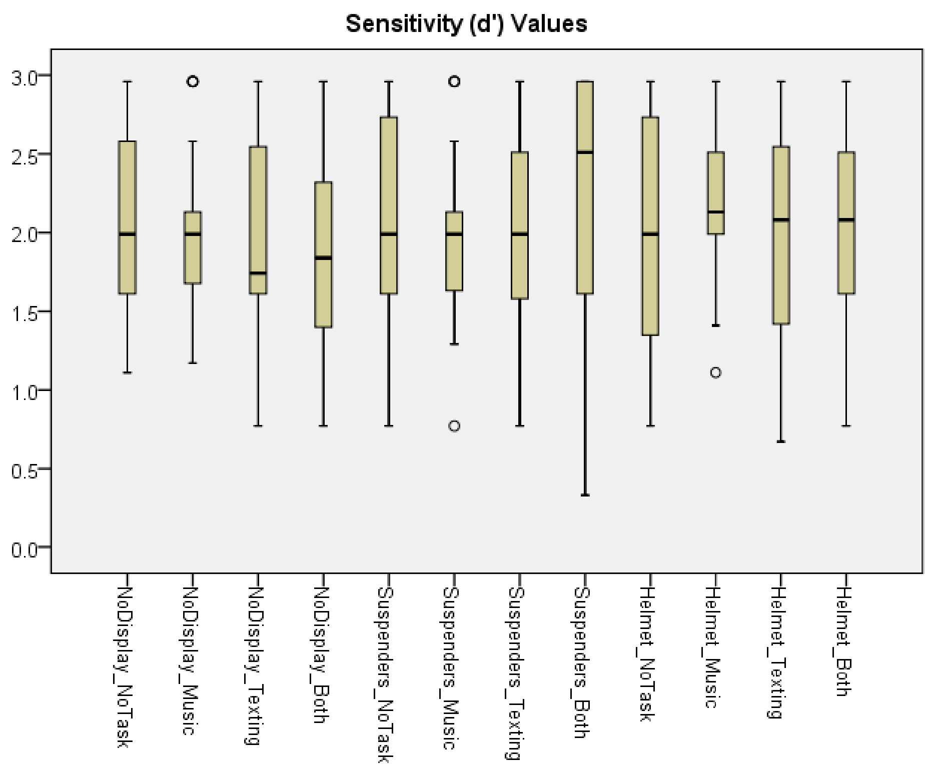
| Beta (ratio) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **N1** | **N2** | **N3** | **N4** | **S1** | **S2** | **S3** | **S4** | **H1** | **H2** | **H3** | **H4** |
| **1** | 2.54 | 2.14 | 1.58 | 2.14 | 2.54 | 0.79 | 2.54 | 0.80 | 1.49 | 2.14 | 0.79 | 1.26 |
| **2** | 1.35 | 1.35 | 0.80 | 0.79 | 0.80 | 0.80 | 1.35 | 0.80 | 2.54 | 0.80 | 0.80 | 2.14 |
| **3** | 1.35 | 0.80 | 0.55 | 1.43 | 0.33 | 0.33 | 0.79 | 0.14 | 0.47 | 0.80 | 0.55 | 0.55 |
| **4** | 0.80 | 2.54 | 1.04 | 2.68 | 1.49 | 1.49 | 2.54 | 0.88 | 0.33 | 2.68 | 2.14 | 0.80 |
| **5** | 0.33 | 0.33 | 0.79 | 1.04 | 0.55 | 0.79 | 0.33 | 0.47 | 4.32 | 0.79 | 2.54 | 0.30 |
| **6** | 0.80 | 0.30 | 0.88 | 1.35 | 0.33 | 0.33 | 0.47 | 0.47 | 0.80 | 0.47 | 0.47 | 0.47 |
| **7** | 2.14 | 2.14 | 2.14 | 2.54 | 0.33 | 1.26 | 0.30 | 0.47 | 0.80 | 0.79 | 1.35 | 2.14 |
| **8** | 0.55 | 2.14 | 0.55 | 0.55 | 0.33 | 2.68 | 2.54 | 0.55 | 0.88 | 1.35 | 1.49 | 0.55 |
| **9** | 0.80 | 1.35 | 1.35 | 2.44 | 0.80 | 2.14 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| **10** | 0.47 | 0.33 | 1.35 | 1.35 | 0.01 | 0.04 | 0.14 | 0.80 | 0.01 | 0.14 | 0.04 | 0.04 |
| **11** | 0.33 | 0.33 | 0.88 | 0.79 | 0.47 | 0.80 | 0.80 | 0.80 | 0.33 | 0.47 | 0.30 | 0.47 |
| **12** | 0.27 | 0.33 | 0.27 | 2.54 | 0.63 | 0.44 | 0.33 | 1.35 | 0.74 | 0.54 | 0.50 | 0.55 |
| **13** | 0.88 | 0.10 | 0.27 | 0.38 | 0.27 | 0.27 | 0.10 | 0.88 | 0.44 | 0.27 | 0.10 | 0.04 |
| **14** | 1.35 | 0.80 | 1.35 | 2.54 | 0.80 | 0.33 | 0.55 | 0.80 | 0.80 | 0.33 | 0.80 | 1.26 |
| **15** | 1.35 | 0.80 | 2.54 | 0.01 | 2.14 | 2.14 | 0.80 | 0.80 | 0.88 | 0.47 | 1.35 | 0.47 |
| **16** | 0.14 | 0.50 | 0.33 | 1.35 | 0.01 | 0.01 | 0.30 | 0.14 | 0.04 | 0.27 | 0.14 | 0.04 |
| **17** | 0.30 | 0.33 | 0.27 | 0.33 | 0.79 | 0.14 | 0.47 | 0.30 | 0.33 | 0.80 | 0.47 | 0.47 |
| **18** | 1.49 | 0.50 | 0.80 | 1.43 | 2.68 | 1.26 | 2.14 | 0.47 | 2.68 | 2.14 | 1.49 | 1.58 |
| **19** | 0.80 | 0.80 | 0.47 | 0.80 | 0.47 | 0.33 | 0.33 | 1.35 | 0.30 | 0.33 | 0.80 | 0.33 |
| **20** | 0.27 | 2.14 | 0.47 | 1.49 | 0.30 | 0.27 | 0.74 | 0.95 | 0.74 | 0.55 | 0.80 | 0.47 |
| **21** | 0.55 | 1.49 | 2.54 | 2.21 | 0.79 | 1.04 | 2.68 | 0.80 | 0.88 | 0.79 | 1.49 | 1.04 |
| **22** | 0.33 | 0.79 | 1.35 | 0.79 | 0.55 | 1.35 | 0.30 | 0.47 | 0.80 | 0.47 | 1.26 | 0.80 |
| **23** | 0.55 | 0.27 | 0.54 | 1.00 | 0.80 | 0.30 | 0.30 | 0.04 | 0.14 | 0.80 | 0.50 | 0.55 |
| **24** | 0.04 | 0.30 | 2.54 | 0.14 | 0.04 | 0.14 | 0.01 | 0.01 | 0.01 | 0.14 | 0.01 | 0.04 |
| **25** | 2.21 | 2.54 | 2.14 | 2.44 | 1.04 | 1.49 | 0.80 | 2.54 | 4.32 | 0.33 | 2.14 | 2.68 |
| **26** | 0.04 | 0.33 | 1.35 | 0.47 | 0.80 | 0.33 | 0.50 | 0.30 | 0.47 | 0.14 | 0.88 | 0.14 |
| **27** | 0.01 | 0.55 | 0.44 | 0.04 | 0.14 | 0.04 | 0.47 | 0.27 | 0.14 | 0.04 | 0.04 | 0.54 |

| Criterion C | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **N1** | **N2** | **N3** | **N4** | **S1** | **S2** | **S3** | **S4** | **H1** | **H2** | **H3** | **H4** |
| **1** | 0.54 | 0.37 | 0.48 | 0.37 | 0.54 | -0.11 | 0.54 | -0.07 | 0.31 | 0.37 | -0.11 | 0.14 |
| **2** | 0.12 | 0.12 | -0.07 | -0.11 | -0.07 | -0.07 | 0.12 | -0.07 | 0.54 | -0.07 | -0.07 | 0.37 |
| **3** | 0.12 | -0.07 | -0.37 | 0.26 | -0.56 | -0.56 | -0.11 | -1.00 | -0.30 | -0.07 | -0.37 | -0.37 |
| **4** | -0.07 | 0.54 | 0.05 | 0.70 | 0.31 | 0.31 | 0.54 | -0.12 | -0.56 | 0.70 | 0.37 | -0.07 |
| **5** | -0.56 | -0.56 | -0.11 | 0.05 | -0.37 | -0.11 | -0.56 | -0.30 | 0.86 | -0.11 | 0.54 | -0.78 |
| **6** | -0.07 | -0.78 | -0.12 | 0.12 | -0.56 | -0.56 | -0.30 | -0.30 | -0.07 | -0.30 | -0.30 | -0.30 |
| **7** | 0.37 | 0.37 | 0.37 | 0.54 | -0.56 | 0.14 | -0.78 | -0.30 | -0.07 | -0.11 | 0.12 | 0.37 |
| **8** | -0.37 | 0.37 | -0.37 | -0.37 | -0.56 | 0.70 | 0.54 | -0.37 | -0.12 | 0.12 | 0.31 | -0.37 |
| **9** | -0.07 | 0.12 | 0.12 | 0.48 | -0.07 | 0.37 | -0.07 | -0.07 | -0.07 | -0.07 | -0.07 | -0.07 |
| **10** | -0.30 | -0.56 | 0.12 | 0.12 | -1.48 | -1.25 | -1.00 | -0.07 | -1.48 | -1.00 | -1.25 | -1.25 |
| **11** | -0.56 | -0.56 | -0.12 | -0.11 | -0.30 | -0.07 | -0.07 | -0.07 | -0.56 | -0.30 | -0.78 | -0.30 |
| **12** | -0.81 | -0.56 | -0.81 | 0.54 | -0.48 | -0.64 | -0.56 | 0.12 | -0.39 | -0.56 | -0.59 | -0.37 |
| **13** | -0.12 | -1.06 | -0.81 | -0.70 | -0.81 | -0.81 | -1.06 | -0.12 | -0.64 | -0.81 | -1.06 | -1.25 |
| **14** | 0.12 | -0.07 | 0.12 | 0.54 | -0.07 | -0.56 | -0.37 | -0.07 | -0.07 | -0.56 | -0.07 | 0.14 |
| **15** | 0.12 | -0.07 | 0.54 | -1.48 | 0.37 | 0.37 | -0.07 | -0.07 | -0.12 | -0.30 | 0.12 | -0.30 |
| **16** | -1.00 | -0.59 | -0.56 | 0.12 | -1.48 | -1.48 | -0.78 | -1.00 | -1.25 | -0.81 | -1.00 | -1.29 |
| **17** | -0.78 | -0.56 | -0.81 | -0.56 | -0.11 | -1.00 | -0.30 | -0.78 | -0.56 | -0.07 | -0.30 | -0.30 |
| **18** | 0.31 | -0.59 | -0.07 | 0.26 | 0.70 | 0.14 | 0.37 | -0.30 | 0.70 | 0.37 | 0.31 | 0.48 |
| **19** | -0.07 | -0.07 | -0.30 | -0.07 | -0.30 | -0.56 | -0.56 | 0.12 | -0.78 | -0.56 | -0.07 | -0.56 |
| **20** | -0.81 | 0.37 | -0.30 | 0.31 | -0.78 | -0.81 | -0.39 | -0.17 | -0.39 | -0.37 | -0.34 | -0.30 |
| **21** | -0.37 | 0.31 | 0.54 | 0.63 | -0.11 | 0.05 | 0.70 | -0.34 | -0.12 | -0.11 | 0.31 | 0.05 |
| **22** | -0.56 | -0.11 | 0.12 | -0.11 | -0.37 | 0.12 | -0.78 | -0.30 | -0.07 | -0.30 | 0.14 | -0.07 |
| **23** | -0.37 | -0.81 | -0.56 | 0.00 | -0.07 | -0.78 | -0.78 | -1.25 | -1.00 | -0.07 | -0.59 | -0.37 |
| **24** | -1.25 | -0.78 | 0.54 | -1.00 | -1.25 | -1.00 | -1.48 | -1.48 | -1.48 | -1.00 | -1.48 | -1.25 |
| **25** | 0.63 | 0.54 | 0.37 | 0.48 | 0.05 | 0.31 | -0.07 | 0.54 | 0.86 | -0.56 | 0.37 | 0.70 |
| **26** | -1.25 | -0.56 | 0.12 | -0.30 | -0.07 | -0.56 | -0.59 | -0.78 | -0.30 | -1.00 | -0.12 | -1.00 |
| **27** | -1.48 | -0.37 | -0.64 | -1.29 | -1.00 | -1.25 | -0.30 | -0.81 | -1.00 | -1.25 | -1.25 | -0.56 |

| Normalized C' (Response Bias) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **N1** | **N2** | **N3** | **N4** | **S1** | **S2** | **S3** | **S4** | **H1** | **H2** | **H3** | **H4** |
| **1** | 0.31 | 0.18 | 0.50 | 0.18 | 0.31 | -0.05 | 0.31 | -0.03 | 0.24 | 0.18 | -0.05 | 0.09 |
| **2** | 0.04 | 0.04 | -0.03 | -0.05 | -0.03 | -0.03 | 0.04 | -0.03 | 0.31 | -0.03 | -0.03 | 0.18 |
| **3** | 0.04 | -0.03 | -0.23 | 0.18 | -0.28 | -0.28 | -0.05 | -0.50 | -0.12 | -0.03 | -0.23 | -0.23 |
| **4** | -0.03 | 0.31 | 0.07 | 0.50 | 0.24 | 0.24 | 0.31 | -0.11 | -0.28 | 0.50 | 0.18 | -0.03 |
| **5** | -0.28 | -0.28 | -0.05 | 0.07 | -0.23 | -0.05 | -0.28 | -0.12 | 0.50 | -0.05 | 0.31 | -0.50 |
| **6** | -0.03 | -0.50 | -0.11 | 0.04 | -0.28 | -0.28 | -0.12 | -0.12 | -0.03 | -0.12 | -0.12 | -0.12 |
| **7** | 0.18 | 0.18 | 0.18 | 0.31 | -0.28 | 0.09 | -0.50 | -0.12 | -0.03 | -0.05 | 0.04 | 0.18 |
| **8** | -0.23 | 0.18 | -0.23 | -0.23 | -0.28 | 0.50 | 0.31 | -0.23 | -0.11 | 0.04 | 0.24 | -0.23 |
| **9** | -0.03 | 0.04 | 0.04 | 0.26 | -0.03 | 0.18 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 | -0.03 |
| **10** | -0.12 | -0.28 | 0.04 | 0.04 | -0.50 | -0.50 | -0.50 | -0.03 | -0.50 | -0.50 | -0.50 | -0.50 |
| **11** | -0.28 | -0.28 | -0.11 | -0.05 | -0.12 | -0.03 | -0.03 | -0.03 | -0.28 | -0.12 | -0.50 | -0.12 |
| **12** | -0.50 | -0.28 | -0.50 | 0.31 | -0.50 | -0.50 | -0.28 | 0.04 | -0.50 | -0.50 | -0.50 | -0.23 |
| **13** | -0.11 | -0.50 | -0.50 | -0.50 | -0.50 | -0.50 | -0.50 | -0.11 | -0.50 | -0.50 | -0.50 | -0.50 |
| **14** | 0.04 | -0.03 | 0.04 | 0.31 | -0.03 | -0.28 | -0.23 | -0.03 | -0.03 | -0.28 | -0.03 | 0.09 |
| **15** | 0.04 | -0.03 | 0.31 | -0.50 | 0.18 | 0.18 | -0.03 | -0.03 | -0.11 | -0.12 | 0.04 | -0.12 |
| **16** | -0.50 | -0.50 | -0.28 | 0.04 | -0.50 | -0.50 | -0.50 | -0.50 | -0.50 | -0.50 | -0.50 | -0.50 |
| **17** | -0.50 | -0.28 | -0.50 | -0.28 | -0.05 | -0.50 | -0.12 | -0.50 | -0.28 | -0.03 | -0.12 | -0.12 |
| **18** | 0.24 | -0.50 | -0.03 | 0.18 | 0.50 | 0.09 | 0.18 | -0.12 | 0.50 | 0.18 | 0.24 | 0.50 |
| **19** | -0.03 | -0.03 | -0.12 | -0.03 | -0.12 | -0.28 | -0.28 | 0.04 | -0.50 | -0.28 | -0.03 | -0.28 |
| **20** | -0.50 | 0.18 | -0.12 | 0.24 | -0.50 | -0.50 | -0.50 | -0.50 | -0.50 | -0.23 | -0.50 | -0.12 |
| **21** | -0.23 | 0.24 | 0.31 | 0.50 | -0.05 | 0.07 | 0.50 | -0.50 | -0.11 | -0.05 | 0.24 | 0.07 |
| **22** | -0.28 | -0.05 | 0.04 | -0.05 | -0.23 | 0.04 | -0.50 | -0.12 | -0.03 | -0.12 | 0.09 | -0.03 |
| **23** | -0.23 | -0.50 | -0.50 | 0.00 | -0.03 | -0.50 | -0.50 | -0.50 | -0.50 | -0.03 | -0.50 | -0.23 |
| **24** | -0.50 | -0.50 | 0.31 | -0.50 | -0.50 | -0.50 | -0.50 | -0.50 | -0.50 | -0.50 | -0.50 | -0.50 |
| **25** | 0.50 | 0.31 | 0.18 | 0.26 | 0.07 | 0.24 | -0.03 | 0.31 | 0.50 | -0.28 | 0.18 | 0.50 |
| **26** | -0.50 | -0.28 | 0.04 | -0.12 | -0.03 | -0.28 | -0.50 | -0.50 | -0.12 | -0.50 | -0.11 | -0.50 |
| **27** | -0.50 | -0.23 | -0.50 | -0.50 | -0.50 | -0.50 | -0.12 | -0.50 | -0.50 | -0.50 | -0.50 | -0.50 |
| **Average** | **-0.15** | **-0.13** | **-0.06** | **0.02** | **-0.16** | **-0.16** | **-0.16** | **-0.20** | **-0.15** | **-0.16** | **-0.14** | **-0.14** |

| Display | Task | d' | C |
|---|---|---|---|
| No Display | No Distraction | 2.14 | -0.15 |
| | Music | 2.04 | -0.13 |
| | Texting | 1.92 | -0.06 |
| | Both | 1.91 | 0.02 |
| Suspenders | No Distraction | 2.12 | -0.16 |
| | Music | 1.96 | -0.16 |
| | Texting | 2.06 | -0.16 |
| | Both | 2.19 | -0.20 |
| Helmet | No Distraction | 1.99 | -0.15 |
| | Music | 2.21 | -0.16 |
| | Texting | 2.03 | -0.14 |
| | Both | 2.04 | -0.14 |


d
c
2.30
2.20
2.10
2.00
1.90
1.80
1.70
1.60
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
0.02
-0.06
-0.15
-0.13
-0.16
-0.16
-0.16
-0.20
-0.15
-0.16
-0.14
-0.14
2.14
2.04
1.92
1.91
2.12
1.96
2.06
2.19
1.99
2.21
2.03
2.04
No Distraction
Music
Texting
Both
No Display
Suspenders
Helmet


Sensitivity (d') Values
3.0
2.5
2.0
1.5
1.0
0.5
0.0
NoDisplay_NoTask
NoDisplay_Music
NoDisplay_Texting
NoDisplay_Both
Suspenders_NoTask
Suspenders_Music
Suspenders_Texting
Suspenders_Both
Helmet_NoTask
Helmet_Music
Helmet_Texting
Helmet_Both

**Multivariate Tests[a]**

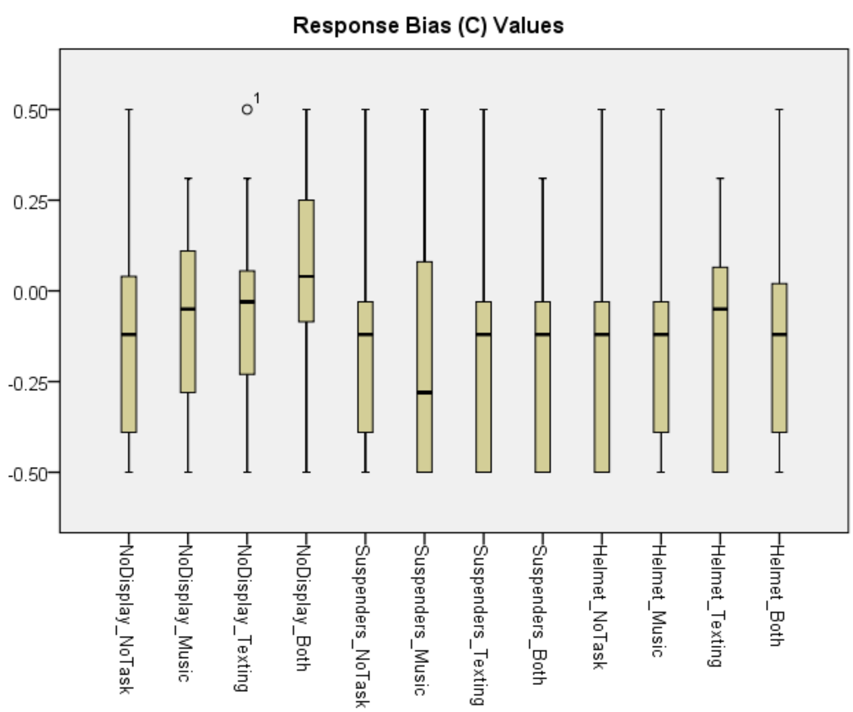
| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| display | Pillai's Trace | .046 | .600[b] | 2.000 | 25.000 | .556 |
| | Wilks' Lambda | .954 | .600[b] | 2.000 | 25.000 | .556 |
| | Hotelling's Trace | .048 | .600[b] | 2.000 | 25.000 | .556 |
| | Roy's Largest Root | .048 | .600[b] | 2.000 | 25.000 | .556 |
| task | Pillai's Trace | .034 | .280[b] | 3.000 | 24.000 | .839 |
| | Wilks' Lambda | .966 | .280[b] | 3.000 | 24.000 | .839 |
| | Hotelling's Trace | .035 | .280[b] | 3.000 | 24.000 | .839 |
| | Roy's Largest Root | .035 | .280[b] | 3.000 | 24.000 | .839 |
| display * task | Pillai's Trace | .322 | 1.662[b] | 6.000 | 21.000 | .180 |
| | Wilks' Lambda | .678 | 1.662[b] | 6.000 | 21.000 | .180 |
| | Hotelling's Trace | .475 | 1.662[b] | 6.000 | 21.000 | .180 |
| | Roy's Largest Root | .475 | 1.662[b] | 6.000 | 21.000 | .180 |

**Pairwise Comparisons**

Measure: ResponseTime

| task | (I) display | (J) display | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] Lower Bound |
|---|---|---|---|---|---|---|
| 1 | 1 | 2 | .023 | .126 | .859 | -.237 |
| | | 3 | .145 | .128 | .267 | -.118 |
| | 2 | 1 | -.023 | .126 | .859 | -.282 |
| | | 3 | .123 | .136 | .374 | -.156 |
| | 3 | 1 | -.145 | .128 | .267 | -.408 |
| | | 2 | -.123 | .136 | .374 | -.401 |
| 2 | 1 | 2 | .074 | .132 | .578 | -.197 |
| | | 3 | -.179 | .120 | .148 | -.424 |
| | 2 | 1 | -.074 | .132 | .578 | -.345 |
| | | 3 | -.253* | .119 | .043 | -.497 |
| | 3 | 1 | .179 | .120 | .148 | -.067 |
| | | 2 | .253* | .119 | .043 | .009 |
| 3 | 1 | 2 | -.142 | .180 | .435 | -.511 |
| | | 3 | -.118 | .170 | .494 | -.467 |
| | 2 | 1 | .142 | .180 | .435 | -.227 |
| | | 3 | .024 | .117 | .836 | -.216 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 3 | 1 | .118 | .170 | .494 | -.231 |
| | | 2 | -.024 | .117 | .836 | -.265 |
| 4 | 1 | 2 | -.284 | .154 | .076 | -.600 |
| | | 3 | -.136 | .136 | .326 | -.416 |
| | 2 | 1 | .284 | .154 | .076 | -.031 |
| | | 3 | .148 | .179 | .416 | -.220 |
| | 3 | 1 | .136 | .136 | .326 | -.144 |
| | | 2 | -.148 | .179 | .416 | -.516 |



**Multivariate Tests[a]**

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| display | Pillai's Trace | .246 | 4.076[b] | 2.000 | 25.000 | .029 |
| | Wilks' Lambda | .754 | 4.076[b] | 2.000 | 25.000 | .029 |
| | Hotelling's Trace | .326 | 4.076[b] | 2.000 | 25.000 | .029 |
| | Roy's Largest Root | .326 | 4.076[b] | 2.000 | 25.000 | .029 |
| task | Pillai's Trace | .160 | 1.521[b] | 3.000 | 24.000 | .235 |
| | Wilks' Lambda | .840 | 1.521[b] | 3.000 | 24.000 | .235 |
| | Hotelling's Trace | .190 | 1.521[b] | 3.000 | 24.000 | .235 |
| | Roy's Largest Root | .190 | 1.521[b] | 3.000 | 24.000 | .235 |
| display * task | Pillai's Trace | .273 | 1.315[b] | 6.000 | 21.000 | .294 |
| | Wilks' Lambda | .727 | 1.315[b] | 6.000 | 21.000 | .294 |
| | Hotelling's Trace | .376 | 1.315[b] | 6.000 | 21.000 | .294 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Roy's Largest Root | .376 | 1.315[b] | 6.000 | 21.000 | .294 |

**Pairwise Comparisons**

Measure: ResponseTime

| (I) display | (J) display | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| 1 | 2 | .092* | .032 | .007 | .027 | .157 |
| | 3 | .068* | .033 | .050 | .000 | .137 |
| 2 | 1 | -.092* | .032 | .007 | -.157 | -.027 |
| | 3 | -.024 | .024 | .334 | -.074 | .026 |
| 3 | 1 | -.068* | .033 | .050 | -.137 | .000 |
| | 2 | .024 | .024 | .334 | -.026 | .074 |

**Pairwise Comparisons**

Measure: ResponseTime

| task | (I) display | (J) display | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] |
|---|---|---|---|---|---|---|
| | | | | | | Lower Bound |
| 1 | 1 | 2 | .010 | .047 | .828 | -.087 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 3 | .001 | .050 | .988 | -.103 |
| | 2 | 1 | -.010 | .047 | .828 | -.107 |
| | | 3 | -.010 | .052 | .853 | -.116 |
| | 3 | 1 | -.001 | .050 | .988 | -.104 |
| | | 2 | .010 | .052 | .853 | -.096 |
| 2 | 1 | 2 | .037 | .048 | .443 | -.061 |
| | | 3 | .038 | .053 | .482 | -.072 |
| | 2 | 1 | -.037 | .048 | .443 | -.136 |
| | | 3 | .001 | .046 | .987 | -.093 |
| | 3 | 1 | -.038 | .053 | .482 | -.148 |
| | | 2 | -.001 | .046 | .987 | -.095 |
| 3 | 1 | 2 | .100 | .066 | .143 | -.036 |
| | | 3 | .072 | .056 | .208 | -.043 |
| | 2 | 1 | -.100 | .066 | .143 | -.236 |
| | | 3 | -.028 | .053 | .597 | -.136 |
| | 3 | 1 | -.072 | .056 | .208 | -.186 |
| | | 2 | .028 | .053 | .597 | -.080 |
| 4 | 1 | 2 | .221* | .064 | .002 | .091 |
| | | 3 | .163* | .054 | .006 | .051 |
| | 2 | 1 | -.221* | .064 | .002 | -.352 |
| | | 3 | -.059 | .053 | .277 | -.168 |
| | 3 | 1 | -.163* | .054 | .006 | -.274 |

| | | | | | |
|---|---|---|---|---|---|
| 2 | .059 | .053 | .277 | -.050 | |

**Pairwise Comparisons**

Measure: ResponseTime

| display | (I) task | (J) task | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | -.021 | .057 | .716 | -.139 | .097 |
| | | 3 | -.083 | .054 | .139 | -.195 | .029 |
| | | 4 | -.170* | .063 | .011 | -.299 | -.042 |
| | 2 | 1 | .021 | .057 | .716 | -.097 | .139 |
| | | 3 | -.062 | .054 | .263 | -.173 | .049 |
| | | 4 | -.149* | .055 | .012 | -.263 | -.035 |
| | 3 | 1 | .083 | .054 | .139 | -.029 | .195 |
| | | 2 | .062 | .054 | .263 | -.049 | .173 |
| | | 4 | -.087 | .066 | .197 | -.223 | .048 |
| | 4 | 1 | .170* | .063 | .011 | .042 | .299 |
| | | 2 | .149* | .055 | .012 | .035 | .263 |
| | | 3 | .087 | .066 | .197 | -.048 | .223 |
| 2 | 1 | 2 | .006 | .051 | .908 | -.099 | .110 |
| | | 3 | .007 | .050 | .894 | -.095 | .109 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 4 | .041 | .058 | .488 | -.078 | .160 |
| | 2 | 1 | -.006 | .051 | .908 | -.110 | .099 |
| | | 3 | .001 | .049 | .988 | -.100 | .102 |
| | | 4 | .035 | .055 | .531 | -.078 | .148 |
| | 3 | 1 | -.007 | .050 | .894 | -.109 | .095 |
| | | 2 | -.001 | .049 | .988 | -.102 | .100 |
| | | 4 | .034 | .067 | .617 | -.104 | .173 |
| | 4 | 1 | -.041 | .058 | .488 | -.160 | .078 |
| | | 2 | -.035 | .055 | .531 | -.148 | .078 |
| | | 3 | -.034 | .067 | .617 | -.173 | .104 |
| 3 | 1 | 2 | .016 | .059 | .784 | -.104 | .137 |
| | | 3 | -.012 | .042 | .778 | -.097 | .074 |
| | | 4 | -.009 | .050 | .866 | -.111 | .094 |
| | 2 | 1 | -.016 | .059 | .784 | -.137 | .104 |
| | | 3 | -.028 | .045 | .540 | -.121 | .065 |
| | | 4 | -.025 | .049 | .617 | -.126 | .076 |
| | 3 | 1 | .012 | .042 | .778 | -.074 | .097 |
| | | 2 | .028 | .045 | .540 | -.065 | .121 |
| | | 4 | .003 | .052 | .949 | -.104 | .110 |
| | 4 | 1 | .009 | .050 | .866 | -.094 | .111 |
| | | 2 | .025 | .049 | .617 | -.076 | .126 |
| | | 3 | -.003 | .052 | .949 | -.110 | .104 |

APPENDIX N

RAW DATA/GRAPHS/STATISTICAL OUTPUTS

**Qualitative Data:**

***Ratings on Performance, Effectiveness, Accuracy, Comfortableness & Mental Effort***

| | Performance | | |
|---|---|---|---|
| | No Display | Suspenders | Helmet |
| **1** | 1 | 5 | 4 |
| **2** | 1 | 3 | 4 |
| **3** | 4 | 4 | 4 |
| **4** | 3 | 5 | 4 |
| **5** | 2 | 5 | 5 |
| **6** | 3 | 4 | 5 |
| **7** | 5 | 4 | 5 |
| **8** | 1 | 5 | 5 |
| **9** | 5 | 5 | 5 |
| **10** | 1 | 3 | 4 |
| **11** | 3 | 4 | 5 |
| **12** | 1 | 3 | 4 |
| **13** | 4 | 4 | 4 |
| **14** | 2 | 5 | 4 |
| **15** | 4 | 3 | 2 |
| **16** | 3 | 5 | 4 |
| **17** | 5 | 5 | 5 |
| **18** | 1 | 4 | 5 |
| **19** | 1 | 5 | 4 |
| **20** | 2 | 5 | 4 |
| **21** | 2 | 3 | 4 |
| **22** | 5 | 4 | 3 |
| **23** | 2 | 5 | 3 |
| **24** | 3 | 4 | 5 |
| **25** | 2 | 4 | 4 |
| **26** | 2 | 5 | 4 |
| **27** | 1 | 5 | 5 |
| **Averages** | **2.56** | **4.30** | **4.22** |

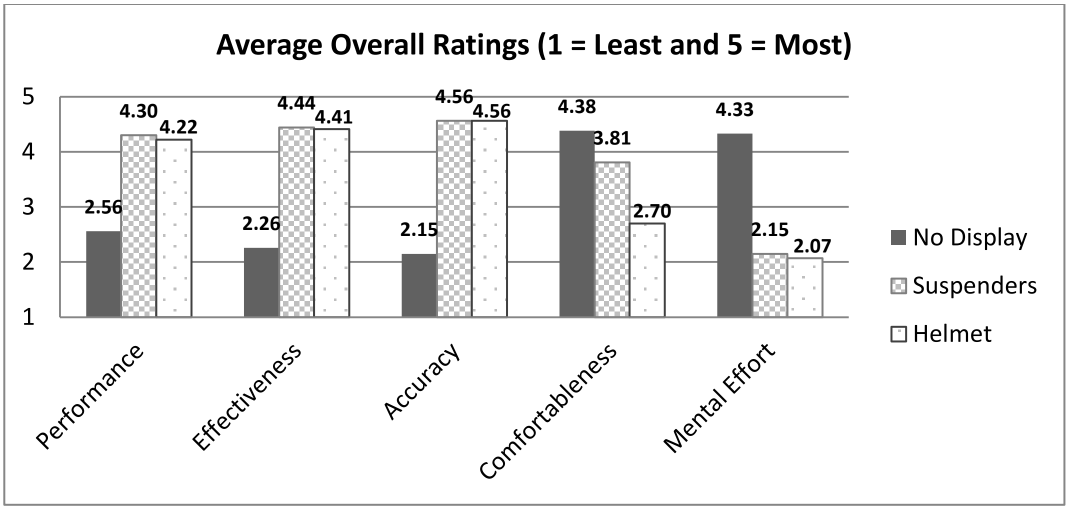
| | Effectiveness | | |
|---|---|---|---|
| | No Display | Suspenders | Helmet |
| **1** | 1 | 5 | 4 |
| **2** | 2 | 4 | 5 |
| **3** | 4 | 5 | 4 |
| **4** | 1 | 5 | 5 |
| **5** | 1 | 4 | 5 |
| **6** | 3 | 4 | 5 |
| **7** | 5 | 3 | 4 |
| **8** | 3 | 5 | 5 |
| **9** | 5 | 5 | 5 |
| **10** | 2 | 4 | 4 |
| **11** | 2 | 4 | 5 |
| **12** | 1 | 4 | 4 |
| **13** | 3 | 4 | 5 |
| **14** | 1 | 5 | 5 |
| **15** | 1 | 4 | 4 |
| **16** | 2 | 5 | 4 |
| **17** | 1 | 5 | 3 |
| **18** | 2 | 3 | 5 |
| **19** | 1 | 5 | 4 |
| **20** | 3 | 5 | 4 |
| **21** | 3 | 4 | 4 |
| **22** | 5 | 5 | 4 |
| **23** | 3 | 5 | 4 |
| **24** | 3 | 4 | 5 |
| **25** | 1 | 4 | 5 |
| **26** | 1 | 5 | 3 |
| **27** | 1 | 5 | 5 |
| **Averages** | **2.26** | **4.44** | **4.41** |

| | Accuracy | | |
|---|---|---|---|
| | No Display | Suspenders | Helmet |
| **1** | 1 | 5 | 4 |
| **2** | 1 | 4 | 5 |
| **3** | 2 | 5 | 4 |
| **4** | 2 | 5 | 4 |
| **5** | 1 | 5 | 5 |
| **6** | 3 | 5 | 4 |
| **7** | 5 | 3 | 4 |
| **8** | | 5 | 5 |
| **9** | 5 | 5 | 5 |
| **10** | 1 | 5 | 4 |
| **11** | 3 | 5 | 5 |
| **12** | 1 | 4 | 4 |
| **13** | 5 | 5 | 5 |
| **14** | 1 | 5 | 5 |
| **15** | 1 | 4 | 4 |
| **16** | 3 | 4 | 4 |
| **17** | 1 | 5 | 5 |
| **18** | 2 | 4 | 5 |
| **19** | 1 | 5 | 4 |
| **20** | 2 | 5 | 5 |
| **21** | 2 | 4 | 5 |
| **22** | 5 | 4 | 5 |
| **23** | 2 | 4 | 3 |
| **24** | 3 | 4 | 5 |
| **25** | 1 | 4 | 5 |
| **26** | 1 | 5 | 5 |
| **27** | 1 | 5 | 5 |
| **Averages** | **2.15** | **4.56** | **4.56** |

| | Comfortableness | | |
|---|---|---|---|
| | No Display | Suspenders | Helmet |
| **1** | 5 | 5 | 3 |
| **2** | 5 | 4 | 3 |
| **3** | 5 | 5 | 2 |
| **4** | | 4 | 4 |
| **5** | 2 | 4 | 4 |
| **6** | 5 | 5 | 5 |
| **7** | 5 | 4 | 4 |
| **8** | 5 | 5 | 3 |
| **9** | 5 | 5 | 1 |
| **10** | 5 | 4 | 3 |
| **11** | 4 | 2 | 2 |
| **12** | 5 | 4 | 3 |
| **13** | 4 | 1 | 2 |
| **14** | 1 | 5 | 4 |
| **15** | 5 | 4 | 2 |
| **16** | 3 | 5 | 4 |
| **17** | 5 | 5 | 3 |
| **18** | 5 | 3 | 1 |
| **19** | 5 | 3 | 1 |
| **20** | 4 | 5 | 3 |
| **21** | 3 | 4 | 3 |
| **22** | 5 | 4 | 2 |
| **23** | 5 | 2 | 5 |
| **24** | 3 | 2 | 1 |
| **25** | 5 | 1 | 2 |
| **26** | 5 | 4 | 1 |
| **27** | 5 | 4 | 2 |
| **Averages** | **4.38** | **3.81** | **2.70** |

| | Mental Effort | | |
|---|---|---|---|
| | No Display | Suspenders | Helmet |
| **1** | 5 | 1 | 1 |
| **2** | 5 | 3 | 1 |
| **3** | 5 | 1 | 2 |
| **4** | 5 | 1 | 2 |
| **5** | 5 | 1 | 1 |
| **6** | 5 | 3 | 3 |
| **7** | 2 | 3 | 2 |
| **8** | 5 | 1 | 1 |
| **9** | 5 | 1 | 2 |
| **10** | 5 | 3 | 2 |
| **11** | 4 | 3 | 3 |
| **12** | 5 | 3 | 3 |
| **13** | 3 | 3 | 3 |
| **14** | 5 | 1 | 1 |
| **15** | 4 | 2 | 2 |
| **16** | 4 | 5 | 4 |
| **17** | 5 | 1 | 1 |
| **18** | 5 | 2 | 1 |
| **19** | 5 | 2 | 3 |
| **20** | 2 | 4 | 4 |
| **21** | 4 | 3 | 2 |
| **22** | 3 | 2 | 2 |
| **23** | 5 | 2 | 3 |
| **24** | 3 | 2 | 1 |
| **25** | 5 | 3 | 3 |
| **26** | 3 | 1 | 2 |
| **27** | 5 | 1 | 1 |
| **Averages** | **4.33** | **2.15** | **2.07** |

| | No Display | Suspenders | Helmet |
|---|---|---|---|
| **Performance** | **2.56** | **4.30** | **4.22** |
| **Effectiveness** | **2.26** | **4.44** | **4.41** |
| **Accuracy** | **2.15** | **4.56** | **4.56** |
| **Comfortableness** | **4.38** | **3.81** | **2.70** |
| **Mental Effort** | **4.33** | **2.15** | **2.07** |




***Performance Ratings***

**Mixed ordinal regression**

**..................**

**The**
**GLIMMIX**
**Procedure**

| Model | |
|---|---|
| **Data Set** | WORK.ONE |
| **Response Variable** | Rating |
| **Response Distribution** | Multinomial (ordered) |
| **Link Function** | Cumulative Logit |
| **Variance Function** | Default |
| **Variance Matrix Blocked** | Student |
| **Estimation Technique** | Maximum Likelihood |
| **Likelihood** | Gauss-Hermite |
| **Degrees of Freedom** | Containment |

| | |
|---|---|
| **Number of Observations** | 81 |
| **Number of Observations** | 81 |

| R | | |
|---|---|---|
| **Ordered Value** | **Rating** | **Total Frequency** |
| **1** | 1 | 8 |
| **2** | 2 | 8 |
| **3** | 3 | 12 |
| **4** | 4 | 26 |
| **5** | 5 | 27 |

**The GLIMMIX procedure is modeling the probabilities of levels of rating having lower Ordered**

| Dimensions | |
|---|---|
| **G-side Cov.** | 1 |
| **Columns in X** | 7 |
| **Columns in Z per** | 1 |
| **Subjects (Blocks in** | 27 |
| **Max Obs per Subject** | 3 |

| Optimization Information | |
|---|---|
| **Optimization** | Dual Quasi- |
| **Parameters in** | 7 |
| **Lower Boundaries** | 1 |
| **Upper Boundaries** | 0 |
| **Fixed Effects** | Not Profiled |
| **Starting From** | GLM estimates |
| **Quadrature Points** | 41 |

| Iteration | | | | | |
|---|---|---|---|---|---|
| **Iteratio** | **Restart** | **Evaluatio** | **Objective** | **Chang** | **Max Gradient** |
| **0** | **0** | 4 | 210.61351 | . | 4.52 |
| **1** | **0** | 3 | 209.60920 | 1.004309 | 3.95 |
| **2** | **0** | 3 | 208.419982 | 1.189226 | 3.15 |

| Iteration | | | | | |
|---|---|---|---|---|---|
| **Iterati** | **Restart** | **Evaluation** | **Objective** | **Change** | **Max Gradien** |
| **3** | **0** | 5 | 207.973632 | 0.4463505 | 2.0 |
| **4** | **0** | 5 | 207.651985 | 0.3216462 | 3. |
| **5** | **0** | 3 | 207.556580 | 0.0954050 | 2.2 |
| **6** | **0** | 2 | 207.369727 | 0.1868530 | 1.6 |
| **7** | **0** | 3 | 207.323370 | 0.0463573 | 1.0 |
| **8** | **0** | 2 | 207.263009 | 0.0603611 | 0.1 |
| **9** | **0** | 3 | 207.261287 | 0.0017223 | 0.0 |
| **10** | **0** | 3 | 207.261137 | 0.0001493 | 0.0 |
| **11** | **0** | 3 | 207.261137 | 0.0000001 | 0.0 |

Convergence criterion (GCONV=1E-8) satisfied.

| Fit Statistics | |
|---|---|
| **-2 Log Likelihood** | 207.2 |
| **AIC (smaller is** | 221.2 |
| **AICC (smaller is** | 222.8 |
| **BIC (smaller is** | 230.3 |
| **CAIC (smaller is** | 237.3 |
| **HQIC (smaller is** | 223.9 |

**Fit Statistics for Conditional Distribution**

| | |
|---|---|
| **-2 log L(rating \| r. effects)** | 200.60 |

| Covariance Parameter | | | |
|---|---|---|---|
| **Cov** | **Subjec** | **Estimat** | **Standard** |
| **Intercep** | student | 0.154 | 0.493 |

| Solutions for Fixed Effects | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Effect** | **rating** | **meth** | **Estimate** | **Standard** | **DF** | **t Value** | **Pr** |
| **Intercept** | 1 | | -1.0680 | 0.454 | 26 | -2.35 | 0. |
| **Intercept** | 2 | | 0.05695 | 0.409 | 26 | 0.14 | 0. |
| **Intercept** | 3 | | 1.2581 | 0.470 | 26 | 2.68 | 0. |
| **Intercept** | 4 | | 3.0191 | 0.581 | 26 | 5.19 | <. |
| **method** | | 1 | -2.7422 | 0.636 | 49 | -4.31 | <. |
| **method** | | 2 | -2.9281 | 0.633 | 49 | -4.62 | <. |
| **method** | | 3 | 0 | . | . | . | . |

| Type III Tests of Fixed Effects | | | | |
|---|---|---|---|---|
| **Effect** | **Num** | **Den** | **F** | **Pr >** |
| **metho** | 2 | 49 | 11.9 | <.000 |

***Effectiveness Ratings***

**Mixed ordinal regression**

**.................**

**The**

**GLIMMIX**

**Procedure**

| Model | |
|---|---|
| **Data Set** | WORK.ONE |
| **Response Variable** | Rating |
| **Response Distribution** | Multinomial (ordered) |
| **Link Function** | Cumulative Logit |
| **Variance Function** | Default |
| **Variance Matrix Blocked** | Student |
| **Estimation Technique** | Maximum Likelihood |
| **Likelihood** | Gauss-Hermite |
| **Degrees of Freedom** | Containment |

| | |
|---|---|
| **Number of Observations** | 81 |
| **Number of Observations** | 81 |

| R | | |
|---|---|---|
| **Ordered Value** | **Rating** | **Total Frequency** |
| **1** | 1 | 11 |
| **2** | 2 | 5 |
| **3** | 3 | 11 |

| | | |
|---|---|---|
| **4** | 4 | 24 |
| **5** | 5 | 30 |

**The GLIMMIX procedure is modeling the probabilities of levels of rating having lower Ordered**

| Dimensions | |
|---|---|
| **G-side Cov.** | 1 |
| **Columns in X** | 7 |
| **Columns in Z per** | 1 |
| **Subjects (Blocks in** | 27 |
| **Max Obs per Subject** | 3 |

| Optimization Information | |
|---|---|
| **Optimization** | Dual Quasi- |
| **Parameters in** | 7 |
| **Lower Boundaries** | 1 |
| **Upper Boundaries** | 0 |
| **Fixed Effects** | Not Profiled |
| **Starting From** | GLM estimates |
| **Quadrature Points** | 41 |

| Iteration | | | | | |
|---|---|---|---|---|---|
| **Iterati** | **Restar** | **Evaluatio** | **Objective** | **Chan** | **Max Gradient** |
| **0** | **0** | 4 | 188.93727 | . | 5.909 |
| **1** | **0** | 4 | 186.25115 | 2.686118 | 5.5397 |
| **2** | **0** | 3 | 184.00447 | 2.246682 | 3.9847 |

| Iteration | | | | | |
|---|---|---|---|---|---|
| **Iterati** | **Restar** | **Evaluatio** | **Objective** | **Chang** | **Max Gradient** |
| **3** | **0** | 3 | 183.93943 | 0.065035 | 3.982 |
| **4** | **0** | 4 | 183.64589 | 0.293541 | 3.720 |
| **5** | **0** | 2 | 183.42356 | 0.222327 | 1.677 |
| **6** | **0** | 3 | 183.39511 | 0.028455 | 1.185 |
| **7** | **0** | 2 | 183.37078 | 0.024325 | 1.013 |
| **8** | **0** | 2 | 183.33013 | 0.040647 | 0.346 |
| **9** | **0** | 3 | 183.32293 | 0.007204 | 0.012 |
| **10** | **0** | 3 | 183.32292 | 0.000006 | 0.000 |
| **11** | **0** | 3 | 183.32292 | 0.000000 | 0.000 |

Convergence criterion (GCONV=1E-8) satisfied.

**Estimated G matrix is not positive definite.**

| Fit Statistics | |
|---|---|
| **-2 Log Likelihood** | 183.3 |
| **AIC (smaller is** | 195.3 |
| **AICC (smaller is** | 196.4 |

| | |
|---|---|
| **BIC (smaller is** | 203.1 |
| **CAIC (smaller is** | 209.1 |
| **HQIC (smaller is** | 197.6 |

**Fit Statistics for Conditional Distribution**

| | |
|---|---|
| **-2 log L(rating \| r. effects)** | 183.32 |

| **Covariance Parameter** | | | |
|---|---|---|---|
| **Cov** | **Subjec** | **Estimat** | **Standard** |
| **Intercep** | student | 1.03E- | . |

| **Solutions for Fixed Effects** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Effect** | **rating** | **metho** | **Estimat** | **Standard** | **DF** | **t** | **Pr >** |
| **Intercep** | 1 | | - | 0.3935 | 26 | -1.11 | 0.277 |
| **Intercep** | 2 | | 0.285 | 0.3950 | 26 | 0.72 | 0.476 |
| **Intercep** | 3 | | 1.889 | 0.5615 | 26 | 3.37 | 0.002 |
| **Intercep** | 4 | | 3.877 | 0.6719 | 26 | 5.77 | <.000 |
| **method** | | 1 | - | 0.7271 | 49 | -5.38 | <.000 |
| **method** | | 2 | - | 0.7339 | 49 | -5.48 | <.000 |
| **method** | | 3 | 0 | . | . | . | . |

| **Type III Tests of Fixed Effects** | | | | |
|---|---|---|---|---|
| **Effect** | **Num** | **Den** | **F** | **Pr >** |
| **metho** | 2 | 49 | 16.8 | <.000 |

***Accuracy Ratings***

**Mixed ordinal regression**

**.................**

**The**
**GLIMMIX**
**Procedure**

| **Model** | |
|---|---|
| **Data Set** | WORK.ONE |
| **Response Variable** | Rating |
| **Response Distribution** | Multinomial (ordered) |
| **Link Function** | Cumulative Logit |
| **Variance Function** | Default |
| **Variance Matrix Blocked** | Student |
| **Estimation Technique** | Maximum Likelihood |
| **Likelihood** | Gauss-Hermite |
| **Degrees of Freedom** | Containment |

| | |
|---|---|
| **Number of Observations** | 80 |
| **Number of Observations** | 80 |

| R | | |
|---|---|---|
| **Ordered Value** | **rating** | **Total Frequency** |
| **1** | 1 | 12 |
| **2** | 2 | 6 |
| **3** | 3 | 6 |
| **4** | 4 | 20 |
| **5** | 5 | 35 |
| **6** | 8 | 1 |

**The GLIMMIX procedure is modeling the probabilities of levels of rating having lower Ordered**

| Dimensions | |
|---|---|
| **G-side Cov.** | 1 |
| **Columns in X** | 8 |
| **Columns in Z per** | 1 |
| **Subjects (Blocks in** | 27 |
| **Max Obs per Subject** | 3 |

| Optimization Information | |
|---|---|
| **Optimization** | Dual Quasi- |
| **Parameters in** | 8 |
| **Lower Boundaries** | 1 |
| **Upper Boundaries** | 0 |
| **Fixed Effects** | Not Profiled |
| **Starting From** | GLM estimates |
| **Quadrature Points** | 41 |

| Iteration | | | | | |
|---|---|---|---|---|---|
| **Iterati** | **Restar** | **Evaluatio** | **Objective** | **Chan** | **Max Gradient** |
| **0** | **0** | 4 | 192.61351 | . | 4.4945 |
| **1** | **0** | 2 | 191.27598 | 1.337525 | 8.5688 |

| Iteration | | | | | |
|---|---|---|---|---|---|
| **Iter** | **Restarts** | **Evaluatio** | **Objective** | **Chang** | **Max Gradient** |
| **2** | **0** | 5 | 190.1093 | 1.166628 | 5.08867 |
| **3** | **0** | 2 | 189.7249 | 0.384434 | 6.00422 |
| **4** | **0** | 2 | 189.3965 | 0.328322 | 3.96869 |
| **5** | **0** | 2 | 189.0861 | 0.310440 | 3.48391 |
| **6** | **0** | 4 | 188.3427 | 0.743423 | 2.37461 |
| **7** | **0** | 3 | 188.1987 | 0.144012 | 1.17520 |
| **8** | **0** | 2 | 188.1139 | 0.084734 | 1.40417 |
| **9** | **0** | 3 | 188.0599 | 0.054013 | 0.80240 |
| **10** | **0** | 2 | 187.9926 | 0.067368 | 0.54555 |
| **11** | **0** | 3 | 187.9857 | 0.006840 | 0.07995 |
| **12** | **0** | 3 | 187.9852 | 0.000497 | 0.00810 |
| **13** | **0** | 3 | 187.9852 | 0.000003 | 0.00394 |

| | | | | | |
|---|---|---|---|---|---|
| **14** | **0** | 3 | 187.9852 | 0.000000 | 0.00013 |

Convergence criterion (GCONV=1E-8) satisfied.

**Estimated G matrix is not positive definite.**

| **Fit Statistics** | |
|---|---|
| **-2 Log Likelihood** | 187.9 |
| **AIC (smaller is** | 201.9 |
| **AICC (smaller is** | 203.5 |
| **BIC (smaller is** | 211.0 |
| **CAIC (smaller is** | 218.0 |
| **HQIC (smaller is** | 204.6 |

**Fit Statistics for Conditional Distribution**

**-2 log L(rating | r. effects)** 187.99

| **Covariance Parameter** | | | |
|---|---|---|---|
| **Cov** | **Subjec** | **Estimat** | **Standard** |
| **Intercep** | student | 1.42E- | . |

| **Solutions for Fixed Effects** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Effect** | **ratin** | **metho** | **Estimat** | **Standard** | **DF** | **t** | **Pr >** |
| **Intercep** | 1 | | - | 0.390 | 26 | - | 0.426 |
| **Intercep** | 2 | | 0.543 | 0.415 | 26 | 1.3 | 0.202 |
| **Intercep** | 3 | | 1.460 | 0.522 | 26 | 2.8 | 0.009 |
| **Intercep** | 4 | | 3.170 | 0.627 | 26 | 5.0 | <.000 |
| **Intercep** | 5 | | 7.580 | 1.182 | 26 | 6.4 | <.000 |
| **method** | | 1 | - | 0.701 | 47 | - | <.000 |
| **method** | | 2 | - | 0.702 | 47 | - | <.000 |
| **method** | | 3 | 0 | . | . | . | . |

| **Type III Tests of Fixed Effects** | | | | |
|---|---|---|---|---|
| **Effect** | **Num** | **Den** | **F** | **Pr >** |
| **metho** | 2 | 47 | 15.1 | <.000 |

***Comfortableness Ratings***

**Mixed ordinal regression**

**.................**

**The GLIMMIX Procedure**

| Model | |
|---|---|
| **Data Set** | WORK.ONE |
| **Response Variable** | rating |
| **Response Distribution** | Multinomial (ordered) |
| **Link Function** | Cumulative Logit |
| **Variance Function** | Default |
| **Variance Matrix Blocked** | student |
| **Estimation Technique** | Maximum Likelihood |
| **Likelihood** | Gauss-Hermite |
| **Degrees of Freedom** | Containment |

| | |
|---|---|
| **Number of Observations** | 80 |
| **Number of Observations** | 80 |

| R | | |
|---|---|---|
| **Ordered Value** | **rating** | **Total Frequency** |
| **1** | 1 | 8 |
| **2** | 2 | 11 |
| **3** | 3 | 13 |
| **4** | 4 | 19 |
| **5** | 5 | 29 |

**The GLIMMIX procedure is modeling the probabilities of levels of rating having lower Ordered**

| Dimensions | |
|---|---|
| **G-side Cov.** | 1 |
| **Columns in X** | 7 |
| **Columns in Z per** | 1 |
| **Subjects (Blocks in** | 27 |
| **Max Obs per Subject** | 3 |

| Optimization Information | |
|---|---|
| **Optimization** | Dual Quasi- |
| **Parameters in** | 7 |
| **Lower Boundaries** | 1 |
| **Upper Boundaries** | 0 |
| **Fixed Effects** | Not Profiled |
| **Starting From** | GLM estimates |

| Quadrature Points | 41 |
|---|---|

| Iteration | | | | | |
|---|---|---|---|---|---|
| Iteratio | Restart | Evaluatio | Objectiv e | Chang | Max Gradient |
| 0 | 0 | 4 | 219.460066 | . | 4.80801 |
| 1 | 0 | 2 | 218.292167 | 1.167899 | 9.49421 |
| 2 | 0 | 3 | 217.270926 | 1.021240 | 6.99983 |

| Iteration | | | | | |
|---|---|---|---|---|---|
| Iterati | Restarts | Evaluatio | Objecti ve | Chang | Max Gradient |
| 3 | 0 | 5 | 216.794054 | 0.4768714 | 7.09635 |
| 4 | 0 | 3 | 216.482051 | 0.3120034 | 6.86240 |
| 5 | 0 | 2 | 215.955853 | 0.5261975 | 5.74547 |
| 6 | 0 | 2 | 215.369073 | 0.5867806 | 0.88958 |
| 7 | 0 | 3 | 215.353893 | 0.0151798 | 1.03404 |
| 8 | 0 | 4 | 215.183642 | 0.1702514 | 0.58146 |
| 9 | 0 | 3 | 215.174452 | 0.0091894 | 0.18873 |
| 10 | 0 | 3 | 215.173785 | 0.0006667 | 0.02331 |
| 11 | 0 | 3 | 215.173760 | 0.0000255 | 0.00331 |
| 12 | 0 | 3 | 215.173759 | 0.0000004 | 0.00021 |

Convergence criterion (GCONV=1E-8) satisfied.

| Fit Statistics | |
|---|---|
| -2 Log Likelihood | 215.1 |
| AIC (smaller is | 229.1 |
| AICC (smaller is | 230.7 |
| BIC (smaller is | 238.2 |
| CAIC (smaller is | 245.2 |
| HQIC (smaller is | 231.8 |

**Fit Statistics for Conditional Distribution**

**-2 log L(rating | r. effects)** 208.73

| Covariance Parameter | | | |
|---|---|---|---|
| Cov | Subjec | Estimat | Standard |
| Intercep | student | 0.152 | 0.454 |

| Solutions for Fixed Effects | | | | | | | |
|---|---|---|---|---|---|---|---|
| Effect | ratin | metho | Estimat | Standard | DF | t | Pr > |
| Intercep | 1 | | - | 0.707 | 26 | - | <.000 |
| Intercep | 2 | | - | 0.588 | 26 | - | <.000 |
| Intercep | 3 | | - | 0.509 | 26 | - | 0.000 |
| Intercep | 4 | | - | 0.426 | 26 | - | 0.159 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **method** | | 1 | 2.820 | 0.640 | 48 | 4.4 | <.000 |
| **method** | | 2 | 1.200 | 0.567 | 48 | 2.1 | 0.039 |
| **method** | | 3 | 0 | . | . | . | . |

| **Type III Tests of Fixed Effects** | | | | |
|---|---|---|---|---|
| **Effect** | **Num** | **Den** | **F** | **Pr >** |
| **metho** | 2 | 48 | 9.9 | 0.000 |

***Mental Effort Ratings***

**Mixed ordinal regression**

**..................**

**The**
GLIMMIX
**Procedure**

| **Model** | |
|---|---|
| **Data Set** | WORK.ONE |
| **Response Variable** | Rating |
| **Response Distribution** | Multinomial (ordered) |
| **Link Function** | Cumulative Logit |
| **Variance Function** | Default |
| **Variance Matrix Blocked** | Student |
| **Estimation Technique** | Maximum Likelihood |
| **Likelihood** | Gauss-Hermite |
| **Degrees of Freedom** | Containment |

| | |
|---|---|
| **Number of Observations** | 81 |
| **Number of Observations** | 81 |

| **R** | | |
|---|---|---|
| **Ordered Value** | **rating** | **Total Frequency** |
| **1** | 1 | 19 |
| **2** | 2 | 17 |
| **3** | 3 | 20 |
| **4** | 4 | 7 |
| **5** | 5 | 18 |

**The GLIMMIX procedure is modeling the probabilities of levels of rating having lower Ordered**

| Dimensions | |
|---|---|
| **G-side Cov.** | 1 |
| **Columns in X** | 7 |
| **Columns in Z per** | 1 |
| **Subjects (Blocks in** | 27 |
| **Max Obs per Subject** | 3 |

| Optimization Information | |
|---|---|
| **Optimization** | Dual Quasi- |
| **Parameters in** | 7 |
| **Lower Boundaries** | 1 |
| **Upper Boundaries** | 0 |
| **Fixed Effects** | Not Profiled |
| **Starting From** | GLM estimates |
| **Quadrature Points** | 41 |

| Iteration | | | | | |
|---|---|---|---|---|---|
| **Iteratio** | **Restart** | **Evaluatio** | **Objectiv e** | **Change** | **Max Gradient** |
| **0** | **0** | 4 | 206.813067 | . | 5.8516 |
| **1** | **0** | 3 | 205.478299 | 1.3347677 | 4.3426 |
| **2** | **0** | 2 | 203.512058 | 1.9662408 | 4.9596 |

| Iteration | | | | | |
|---|---|---|---|---|---|
| **Iteratio** | **Restart** | **Evaluation** | **Objecti ve** | **Change** | **Max Gradient** |
| **3** | **0** | 2 | 203.332830 | 0.1792283 | 5.187 |
| **4** | **0** | 3 | 202.654031 | 0.6787985 | 3.5794 |
| **5** | **0** | 3 | 202.58568 | 0.0683506 | 3.8465 |
| **6** | **0** | 4 | 202.243290 | 0.3423901 | 1.0489 |
| **7** | **0** | 3 | 202.188180 | 0.0551108 | 0.7117 |
| **8** | **0** | 2 | 202.119795 | 0.0683847 | 0.7925 |
| **9** | **0** | 3 | 202.115197 | 0.0045981 | 0.7523 |
| **10** | **0** | 4 | 202.103872 | 0.0113246 | 0.066 |
| **11** | **0** | 3 | 202.103754 | 0.0001175 | 0.0076 |
| **12** | **0** | 3 | 202.103753 | 0.0000016 | 0.0011 |
| **13** | **0** | 3 | 202.103753 | 0.0000000 | 0.0000 |

Convergence criterion (GCONV=1E-8) satisfied.

| Fit Statistics | |
|---|---|
| **-2 Log Likelihood** | 202.1 |
| **AIC (smaller is** | 216.1 |
| **AICC (smaller is** | 217.6 |
| **BIC (smaller is** | 225.1 |
| **CAIC (smaller is** | 232.1 |
| **HQIC (smaller is** | 218.8 |

**Fit Statistics for Conditional Distribution**

| | |
|---|---|
| **-2 log L(rating \| r. effects)** | 201.57 |

| Covariance Parameter | | | |
|---|---|---|---|
| **Cov** | **Subjec** | **Estimat** | **Standard** |
| **Intercep** | student | 0.0116 | 0.381 |

| Solutions for Fixed Effects | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Effect** | **ratin** | **metho** | **Estimat** | **Standard** | **DF** | **t** | **Pr >** |
| **Intercep** | 1 | | - | 0.708 | 26 | - | <.000 |
| **Intercep** | 2 | | - | 0.617 | 26 | - | <.000 |
| **Intercep** | 3 | | - | 0.466 | 26 | - | 0.007 |
| **Intercep** | 4 | | - | 0.401 | 26 | - | 0.252 |
| **method** | | 1 | 3.777 | 0.709 | 49 | 5.3 | <.000 |
| **method** | | 2 | 3.707 | 0.712 | 49 | 5.2 | <.000 |
| **method** | | 3 | 0 | . | . | . | . |

| Type III Tests of Fixed Effects | | | | |
|---|---|---|---|---|
| **Effect** | **Num** | **Den** | **F** | **Pr >** |
| **metho** | 2 | 49 | 15.7 | <.000 |

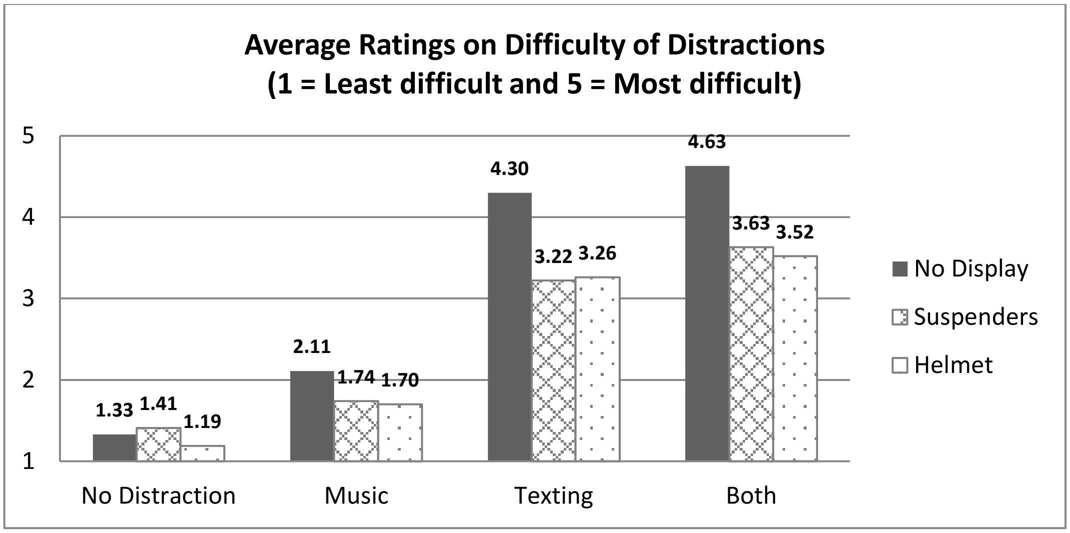
***Ratings on Difficulty of Distractions***

| | Difficulty of distractions with no display | | | |
|---|---|---|---|---|
| | **No Distractions** | **Music** | **Texting** | **Both** |
| **1** | 1 | 2 | 5 | 5 |
| **2** | 1 | 2 | 4 | 5 |
| **3** | 1 | 1 | 2 | 3 |
| **4** | 1 | 2 | 5 | 5 |
| **5** | 1 | 2 | 5 | 5 |
| **6** | 1 | 1 | 4 | 4 |
| **7** | 1 | 1 | 4 | 5 |
| **8** | 1 | 2 | 5 | 5 |
| **9** | 1 | 3 | 4 | 5 |
| **10** | 1 | 2 | 4 | 4 |
| **11** | 1 | 1 | 4 | 4 |
| **12** | 1 | 2 | 4 | 5 |
| **13** | 1 | 1 | 4 | 5 |
| **14** | 2 | 3 | 5 | 5 |
| **15** | 4 | 4 | 5 | 5 |
| **16** | 3 | 2 | 5 | 5 |
| **17** | 1 | 2 | 4 | 5 |
| **18** | 1 | 2 | 4 | 5 |
| **19** | 1 | 3 | 4 | 5 |
| **20** | 1 | 4 | 5 | 3 |
| **21** | 1 | 2 | 5 | 4 |
| **22** | 2 | 3 | 5 | 5 |
| **23** | 1 | 2 | 4 | 5 |
| **24** | 2 | 3 | 4 | 5 |
| **25** | 1 | 2 | 4 | 4 |
| **26** | 2 | 2 | 4 | 5 |
| **27** | 1 | 1 | 4 | 4 |
| **Averages** | **1.33** | **2.11** | **4.30** | **4.63** |

| | Difficulty of distractions with HELMET | | | |
|---|---|---|---|---|
| | No Distractions | Music | Texting | Both |
| **1** | 1 | 1 | 2 | 2 |
| **2** | 1 | 2 | 3 | 4 |
| **3** | 3 | 2 | 2 | 3 |
| **4** | 2 | 1 | 2 | 2 |
| **5** | 2 | 2 | 4 | 5 |
| **6** | 3 | 1 | 4 | 4 |
| **7** | 1 | 1 | 3 | 3 |
| **8** | 1 | 2 | 4 | 5 |
| **9** | 1 | 4 | 4 | 5 |
| **10** | 1 | 1 | 3 | 3 |
| **11** | 1 | 1 | 3 | 3 |
| **12** | 1 | 2 | 4 | 5 |
| **13** | 2 | 4 | 5 | 5 |
| **14** | 1 | 1 | 2 | 2 |
| **15** | 1 | 2 | 3 | 3 |
| **16** | 2 | 1 | 3 | 3 |
| **17** | 1 | 1 | 3 | 4 |
| **18** | 1 | 2 | 4 | 5 |
| **19** | 1 | 2 | 3 | 3 |
| **20** | 1 | 1 | 4 | 3 |
| **21** | 2 | 1 | 3 | 4 |
| **22** | 2 | 2 | 3 | 4 |
| **23** | 1 | 2 | 3 | 4 |
| **24** | 2 | 3 | 4 | 5 |
| **25** | 1 | 3 | 3 | 3 |
| **26** | 1 | 1 | 3 | 3 |
| **27** | 1 | 1 | 3 | 3 |
| **Averages** | **1.41** | **1.74** | **3.22** | **3.63** |

| | Difficulty of distractions with SUSPENDERS | | | |
|---|---|---|---|---|
| | No Distractions | Music | Texting | Both |
| **1** | 1 | 1 | 2 | 2 |
| **2** | 1 | 2 | 3 | 4 |
| **3** | 1 | 1 | 2 | 2 |
| **4** | 2 | 2 | 2 | 3 |
| **5** | 1 | 2 | 4 | 5 |
| **6** | 1 | 1 | 4 | 4 |
| **7** | 1 | 1 | 3 | 3 |
| **8** | 1 | 2 | 4 | 5 |
| **9** | 1 | 5 | 5 | 5 |
| **10** | 1 | 1 | 2 | 2 |
| **11** | 1 | 1 | 3 | 3 |
| **12** | 1 | 3 | 5 | 5 |
| **13** | 2 | 2 | 5 | 5 |
| **14** | 1 | 1 | 2 | 2 |
| **15** | 1 | 2 | 2 | 2 |
| **16** | 2 | 1 | 3 | 3 |
| **17** | 1 | 1 | 3 | 3 |
| **18** | 1 | 2 | 4 | 5 |
| **19** | 1 | 2 | 3 | 4 |
| **20** | 1 | 1 | 3 | 3 |
| **21** | 1 | 1 | 5 | 4 |
| **22** | 2 | 3 | 4 | 5 |
| **23** | 1 | 1 | 2 | 2 |
| **24** | 2 | 3 | 4 | 5 |
| **25** | 1 | 2 | 3 | 3 |
| **26** | 1 | 1 | 3 | 3 |
| **27** | 1 | 1 | 3 | 3 |
| **Averages** | **1.19** | **1.70** | **3.26** | **3.52** |

| Average Ratings on Difficulty of Distractions | | | |
|---|---|---|---|
| | No Display | Suspenders | Helmet |
| No Distraction | 1.33 | 1.41 | 1.19 |
| Music | 2.11 | 1.74 | 1.70 |
| Texting | 4.3 | 3.22 | 3.26 |
| Both | 4.63 | 3.63 | 3.52 |




***Difficulty of Distractions – No Display***

**Mixed ordinal regression**

**The GLIMMIX Procedure**

| Model | |
|---|---|
| **Data Set** | WORK.ONE |
| **Response Variable** | rating |
| **Response Distribution** | Multinomial (ordered) |
| **Link Function** | Cumulative Logit |
| **Variance Function** | Default |
| **Variance Matrix Blocked** | student |
| **Estimation Technique** | Maximum Likelihood |
| **Likelihood** | Gauss-Hermite |
| **Degrees of Freedom** | Containment |

| | |
|---|---|
| **Number of Observations** | 108 |
| **Number of Observations** | 108 |

| R | | |
|---|---|---|
| **Ordered Value** | **rating** | **Total Frequency** |
| **1** | 1 | 27 |
| **2** | 2 | 19 |
| **3** | 3 | 8 |
| **4** | 4 | 25 |
| **5** | 5 | 29 |

**The GLIMMIX procedure is modeling the probabilities of levels of rating having lower Ordered**

| Dimensions | |
|---|---|
| **G-side Cov.** | 1 |
| **Columns in X** | 8 |
| **Columns in Z per** | 1 |
| **Subjects (Blocks in** | 27 |
| **Max Obs per Subject** | 4 |

| Optimization Information | |
|---|---|
| **Optimization** | Dual Quasi- |
| **Parameters in** | 8 |
| **Lower Boundaries** | 1 |
| **Upper Boundaries** | 0 |
| **Fixed Effects** | Not Profiled |
| **Starting From** | GLM estimates |
| **Quadrature Points** | 41 |

| Iteration | | | | | |
|---|---|---|---|---|---|
| **Iterati** | **Restar** | **Evaluatio** | **Objective** | **Chan** | **Max Gradient** |
| **0** | **0** | 4 | 186.64452 | . | 3.2218 |
| **1** | **0** | 3 | 185.70923 | 0.935294 | 2.6210 |
| **2** | **0** | 2 | 184.75283 | 0.956400 | 2.9380 |

| Iteration | | | | | |
|---|---|---|---|---|---|
| **Iterati** | **Restar** | **Evaluatio** | **Objective** | **Chan** | **Max Gradient** |
| **3** | **0** | 2 | 183.8265 | 0.926276 | 1.8077 |
| **4** | **0** | 2 | 182.26003 | 1.566527 | 2.238 |
| **5** | **0** | 2 | 181.1859 | 1.074110 | 4.6083 |
| **6** | **0** | 2 | 180.08514 | 1.100777 | 3.3648 |
| **7** | **0** | 3 | 179.63304 | 0.452099 | 2.6971 |
| **8** | **0** | 2 | 179.15374 | 0.479298 | 0.5817 |
| **9** | **0** | 3 | 179.05240 | 0.101339 | 0.1323 |
| **10** | **0** | 3 | 179.04931 | 0.003088 | 0.0452 |
| **11** | **0** | 3 | 179.04900 | 0.000317 | 0.0104 |
| **12** | **0** | 3 | 179.04897 | 0.000024 | 0.0015 |
| **13** | **0** | 3 | 179.04897 | 0.000000 | 0.0002 |

Convergence criterion (GCONV=1E-8) satisfied.

| Fit Statistics | |
|---|---|
| -2 Log Likelihood | 179.0 |
| AIC (smaller is | 195.0 |
| AICC (smaller is | 196.5 |
| BIC (smaller is | 205.4 |
| CAIC (smaller is | 213.4 |
| HQIC (smaller is | 198.1 |

**Fit Statistics for Conditional Distribution**

**-2 log L(rating | r. effects)** 119.8

| Covariance Parameter | | | |
|---|---|---|---|
| **Cov** | **Subjec** | **Estimat** | **Standard** |
| **Intercep** | student | 4.410 | 2.361 |

| Solutions for Fixed Effects | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Effect** | **ratin** | **metho** | **Estimat** | **Standard** | **DF** | **t** | **Pr >** |
| **Intercep** | 1 | | 1.690 | 0.701 | 26 | 2.4 | 0.023 |
| **Intercep** | 2 | | 4.891 | 1.011 | 26 | 4.8 | <.000 |
| **Intercep** | 3 | | 6.745 | 1.252 | 26 | 5.3 | <.000 |
| **Intercep** | 4 | | 11.082 | 1.809 | 26 | 6.1 | <.000 |
| **method** | | 1 | - | 1.929 | 75 | - | <.000 |
| **method** | | 2 | - | 1.691 | 75 | - | <.000 |
| **method** | | 3 | - | 0.793 | 75 | - | <.000 |
| **method** | | 4 | 0 | . | . | . | . |

| Type III Tests of Fixed Effects | | | | |
|---|---|---|---|---|
| **Effect** | **Num** | **Den** | **F** | **Pr >** |
| **metho** | 3 | 75 | 13.7 | <.000 |

***Difficulty of Distractions - Helmet***

**Mixed ordinal regression**

**..................**

**The**
**GLIMMIX**
**Procedure**

| Model | |
|---|---|
| **Data Set** | WORK.ONE |
| **Response Variable** | Rating |
| **Response Distribution** | Multinomial (ordered) |
| **Link Function** | Cumulative Logit |

| | |
|---|---|
| **Variance Function** | Default |
| **Variance Matrix Blocked** | Student |
| **Estimation Technique** | Maximum Likelihood |
| **Likelihood** | Gauss-Hermite |
| **Degrees of Freedom** | Containment |

| | |
|---|---|
| **Number of Observations** | 108 |
| **Number of Observations** | 108 |

| **R** | | |
|---|---|---|
| **Ordered Value** | **Rating** | **Total Frequency** |
| **1** | 1 | 31 |
| **2** | 2 | 24 |
| **3** | 3 | 29 |
| **4** | 4 | 16 |
| **5** | 5 | 8 |

**The GLIMMIX procedure is modeling the probabilities of levels of rating having lower Ordered**

| **Dimensions** | |
|---|---|
| **G-side Cov.** | 1 |
| **Columns in X** | 8 |
| **Columns in Z per** | 1 |
| **Subjects (Blocks in** | 27 |
| **Max Obs per Subject** | 4 |

| **Optimization Information** | |
|---|---|
| **Optimization** | Dual Quasi- |
| **Parameters in** | 8 |
| **Lower Boundaries** | 1 |
| **Upper Boundaries** | 0 |
| **Fixed Effects** | Not Profiled |
| **Starting From** | GLM estimates |
| **Quadrature Points** | 41 |

| **Iteration** | | | | | |
|---|---|---|---|---|---|
| **Iterati** | **Restar** | **Evaluatio** | **Objective** | **Chan** | **Max Gradient** |
| **0** | **0** | 4 | 232.80398 | . | 7.9570 |
| **1** | **0** | 2 | 229.5571 | 3.246853 | 2.4618 |
| **2** | **0** | 3 | 228.56912 | 0.988007 | 3.7511 |

| **Iteration** | | | | | |
|---|---|---|---|---|---|
| **Iterati** | **Restar** | **Evaluatio** | **Objective** | **Chan** | **Max Gradient** |
| **3** | **0** | 2 | 228.30333 | 0.265789 | 3.993 |
| **4** | **0** | 4 | 226.10804 | 2.195289 | 3.5422 |
| **5** | **0** | 3 | 224.68763 | 1.420411 | 2.6002 |

| | | | | | |
|---|---|---|---|---|---|
| **6** | **0** | 3 | 224.34878 | 0.338845 | 0.8140 |
| **7** | **0** | 3 | 224.14609 | 0.202687 | 0.5722 |
| **8** | **0** | 3 | 224.06903 | 0.077065 | 0.1442 |
| **9** | **0** | 3 | 224.05888 | 0.010144 | 0.0127 |
| **10** | **0** | 3 | 224.05886 | 0.000024 | 0.0023 |
| **11** | **0** | 3 | 224.0588 | 0.000000 | 0.0003 |

Convergence criterion (GCONV=1E-8) satisfied.

| **Fit Statistics** | |
|---|---|
| **-2 Log Likelihood** | 224.0 |
| **AIC (smaller is** | 240.0 |
| **AICC (smaller is** | 241.5 |
| **BIC (smaller is** | 250.4 |
| **CAIC (smaller is** | 258.4 |
| **HQIC (smaller is** | 243.1 |

**Fit Statistics for Conditional Distribution**

**-2 log L(rating | r. effects)** 168.08

| **Covariance Parameter** | | | |
|---|---|---|---|
| **Cov** | **Subjec** | **Estimat** | **Standard** |
| **Intercep** | student | 3.060 | 1.468 |

| **Solutions for Fixed Effects** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Effect** | **ratin** | **metho** | **Estimat** | **Standard** | **DF** | **t** | **Pr >** |
| **Intercep** | 1 | | 1.105 | 0.615 | 26 | 1.8 | 0.084 |
| **Intercep** | 2 | | 3.812 | 0.803 | 26 | 4.7 | <.000 |
| **Intercep** | 3 | | 6.896 | 1.060 | 26 | 6.5 | <.000 |
| **Intercep** | 4 | | 9.239 | 1.273 | 26 | 7.2 | <.000 |
| **method** | | 1 | - | 1.048 | 75 | - | <.000 |
| **method** | | 2 | - | 0.945 | 75 | - | <.000 |
| **method** | | 3 | - | 0.666 | 75 | - | 0.041 |
| **method** | | 4 | 0 | . | . | . | . |

| **Type III Tests of Fixed Effects** | | | | |
|---|---|---|---|---|
| **Effect** | **Num** | **Den** | **F** | **Pr >** |
| **metho** | 3 | 75 | 17.2 | <.000 |

***Difficulty of Distractions - Suspenders***

**Mixed ordinal regression**

**.................**

**The**
**GLIMMIX**
**Procedure**

| Model | |
|---|---|
| **Data Set** | WORK.ONE |
| **Response Variable** | rating |
| **Response Distribution** | Multinomial (ordered) |
| **Link Function** | Cumulative Logit |
| **Variance Function** | Default |
| **Variance Matrix Blocked** | student |
| **Estimation Technique** | Maximum Likelihood |
| **Likelihood** | Gauss-Hermite |
| **Degrees of Freedom** | Containment |

| | |
|---|---|
| **Number of Observations** | 108 |
| **Number of Observations** | 108 |

| R | | |
|---|---|---|
| **Ordered Value** | **rating** | **Total Frequency** |
| **1** | 1 | 36 |
| **2** | 2 | 27 |
| **3** | 3 | 22 |
| **4** | 4 | 10 |
| **5** | 5 | 13 |

**The GLIMMIX procedure is modeling the probabilities of levels of rating having lower Ordered**

| Dimensions | |
|---|---|
| **G-side Cov.** | 1 |
| **Columns in X** | 8 |
| **Columns in Z per** | 1 |
| **Subjects (Blocks in** | 27 |
| **Max Obs per Subject** | 4 |

| Optimization Information | |
|---|---|
| **Optimization** | Dual Quasi- |
| **Parameters in** | 8 |
| **Lower Boundaries** | 1 |
| **Upper Boundaries** | 0 |
| **Fixed Effects** | Not Profiled |
| **Starting From** | GLM estimates |
| **Quadrature Points** | 41 |

| Iteration | | | | | |
|---|---|---|---|---|---|
| **Iterati** | **Restar** | **Evaluati** | **Objective** | **Chan** | **Max Gradient** |
| **0** | **0** | 4 | 218.82128 | . | 11.30 |
| **1** | **0** | 2 | 214.22681 | 4.594462 | 3.8068 |
| **2** | **0** | 3 | 212.36037 | 1.866442 | 3.6959 |

| Iteration | | | | | |
|---|---|---|---|---|---|
| **Iterati** | **Restar** | **Evaluatio** | **Objective** | **Chan** | **Max Gradient** |
| **3** | **0** | 3 | 211.09457 | 1.265804 | 2.4165 |
| **4** | **0** | 2 | 209.23937 | 1.855192 | 4.3959 |
| **5** | **0** | 4 | 203.31753 | 5.921843 | 4.605 |
| **6** | **0** | 3 | 201.30140 | 2.016135 | 2.3191 |
| **7** | **0** | 3 | 200.62022 | 0.681172 | 0.9802 |
| **8** | **0** | 2 | 200.24397 | 0.376250 | 1.0290 |
| **9** | **0** | 3 | 200.01860 | 0.225373 | 0.2433 |
| **10** | **0** | 3 | 199.94822 | 0.070375 | 0.2272 |
| **11** | **0** | 3 | 199.94472 | 0.003506 | 0.0481 |
| **12** | **0** | 3 | 199.94425 | 0.000466 | 0.0097 |
| **13** | **0** | 3 | 199.94424 | 0.000011 | 0.0021 |
| **14** | **0** | 3 | 199.94424 | 0.000000 | 0.00 |

Convergence criterion (GCONV=1E-8) satisfied.

| Fit Statistics | |
|---|---|
| **-2 Log Likelihood** | 199.9 |
| **AIC (smaller is** | 215.9 |
| **AICC (smaller is** | 217.4 |
| **BIC (smaller is** | 226.3 |
| **CAIC (smaller is** | 234.3 |
| **HQIC (smaller is** | 219.0 |

**Fit Statistics for Conditional Distribution**

**-2 log L(rating | r. effects)** 128.50

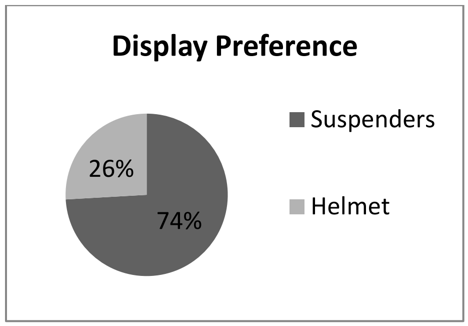
| Covariance Parameter | | | |
|---|---|---|---|
| **Cov** | **Subjec** | **Estimat** | **Standard** |
| **Intercep** | student | 7.116 | 3.205 |

| Solutions for Fixed Effects | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Effect** | **rating** | **metho** | **Estimat** | **Standard** | **DF** | **t** | **Pr > \|t\|** |
| **Intercep** | 1 | | 3.0285 | 0.9357 | 26 | 3.24 | 0.0033 |
| **Intercep** | 2 | | 7.2049 | 1.3650 | 26 | 5.28 | <.0001 |
| **Intercep** | 3 | | 10.376 | 1.6924 | 26 | 6.13 | <.0001 |
| **Intercep** | 4 | | 12.115 | 1.8767 | 26 | 6.46 | <.0001 |
| **method** | | 1 | - | 1.5763 | 75 | -6.38 | <.0001 |
| **method** | | 2 | -9.2188 | 1.4774 | 75 | -6.24 | <.0001 |
| **method** | | 3 | -3.3151 | 0.9399 | 75 | -3.53 | 0.0007 |
| **method** | | 4 | 0 | . | . | . | . |

| Type III Tests of Fixed Effects | | | | |
|---|---|---|---|---|
| **Effect** | **Num** | **Den** | **F** | **Pr >** |
| **metho** | 3 | 75 | 14.8 | <.000 |

***Display Preference & Speed Interference***

| | Display Preference | |
|---|---|---|
| | Suspenders | Helmet |
| Percent | 74.1 | 25.9 |
| Number | 20 | 7 |




| | Speed Interference? | |
|---|---|---|
| | No | Yes |
| Percent | 77.8 | 22.2 |
| Number | 21 | 6 |