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16. Abstract

Older drivers seem to have the greatest difficulty negotiating intersections, as indicated by overrepresentation in intersection crashes. Older drivers are also the fastest growing segment of the general population and the fastest growing sector of the driving population. To address this area of concern, this research is an effort aimed to support technology development that can mitigate older driver intersection crashes.

This project explored a vehicle-based technology countermeasure for crashes associated with failure-to-obey (running a stop sign or stop light) violations developed under the Intelligent Transportation Systems' CICAS-V project. This system warned drivers when it determined it was likely the driver would violate a red light or stop sign. An evaluation was performed in the NADS-1 high-fidelity driving simulator. The experimental design used 36 participants from three age-related groups; 'middle-normal'(25-55), 'older normal'(>65) and 'older at-risk'(>65) drivers. The participants were presented two levels of vehicle system presence (present and not present).

There was an overall benefit associated with the presence of the warning system as there were significantly fewer did-not-stop outcomes when the system was present than when it was not. The benefit associated with the system was also seen in the stopping position data. Participants who experienced the system warning stopped instead of driving through the intersection, resulting in more stops past the stop bar, but before the collision zone. From the survey data, there was also a general perception that the system improved driving safety and that the system aided drivers in driving more carefully. Older-at-risk drivers had the greatest decrease in did-not-stop outcomes when the system was present, although this trend did not reach statistical significance.

This study shows promise for improving the safety of all drivers, including at-risk-older drivers, with intersection warning systems. However, this study did not thoroughly explore possible unintended consequences of intersection warning systems such as overreliance on or inappropriate reactions to warnings under certain situations.

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LIST OF ABBREVIATIONS

CICAS	Cooperative Intersection Collision Avoidance Systems
CICAS-V	Cooperative Intersection Collision Avoidance Systems-Violations
FARS	Fatality Analysis Reporting System
GES	General Estimates System
HFID	Human Factors for IntelliDrive
ICAV	Intersection Crash Avoidance Violation
IIHS	Insurance Institute for Highway Safety
ITS	Intelligent Transportation Systems
LCD	liquid crystal display
MFVP	Motor-Free Visual Perception
MMSE	Mini Mental State Examination
NADS	National Advanced Driving Simulator
NHTSA	National Highway Traffic Safety Administration
TICS	Telephone Interview for Cognitive Status
UFOV	Useful Field of View

EXECUTIVE SUMMARY

People age 65 years and older are the fastest growing segment of the U.S. population and the fastest growing sector of the driving population. When compared to other age groups, older drivers are overrepresented in intersection crashes (Subramanian & Lombardo, 2007; Braitman et al., 2007), and approximately half of the charges in fatal intersection crashes are for failure to obey the traffic control device. This project explored an in-vehicle warning system for failure-to-obey (running a stop sign or stop light) violations. Participants using the system made significantly fewer did-not-stop errors at intersections. Participants who were not using the system made nearly three times as many did-not-stop errors (27%) than participants who were using the system (10%). This effect was most pronounced in older drivers with more risk factors associated with crashes; however, the effect of age group was not statistically significant.

Evidence suggests that driving performance tends to diminish with age and that the decline can be attributed to factors such as declines in vision, hearing, reaction time, cognitive function, and motor abilities. An in-vehicle system that can aid drivers at greater risk of crashes may significantly reduce the number of fatalities as the driving population ages. The 3x2 between-subject factorial experimental design created experimental conditions that presented two between-subject levels of in-vehicle system presence (present and not present) to 36 participants from three age-related groups.

The protocol included a screening for general health and driving criteria and a process to classify potential participants as “normal” or “at risk” based on their scores relating to cognitive impairment and health and mobility factors that are related to crash risk in older drivers. Once enrolled, participants underwent the following evaluations to document the presence of risk factors:

- Mini Mental State Examination (MMSE) (Appendix 8)
- Visual acuity-near and distance, and contrast sensitivity
- Rapid Walk, Foot Tap, Neck Rotation tests (Appendix 10)

Participants completed one 25-minute drive in the NADS-1 on an urban and arterial four-lane road network with a posted speed limit of 35 mph. During the simulator drive, they passed through several controlled intersections: eight traffic lights and six stop signs. The intersection violation warning system was present during the drive for half of the participants.

The warning system is designed to provide alerts when a driver was likely to violate a red light or a stop sign at an intersection. The system uses vehicle location, traffic signal state, and timing to determine the probability of violation and conformed to the specifications provided by the National Highway Traffic Safety Administration (NHTSA), which were generally based on the recommendations for in-vehicle specifications included in the Cooperative Intersection Collision Avoidance Systems-Violations (CICAS-V). The system was active throughout the simulator drives in which it was present, with an assumed communication range of 300 meters prior to each intersection. The system alert included three display components: a visual icon, an auditory alert, and a brake pulse. Following the simulator drives, participants completed short surveys about their experience in the simulator.

Variables collected during the simulator drive for analysis included two types of measures: safety and confirmatory. Safety measures included violations of a stop sign or traffic light and stopping position relative to the stop bar, which was further classified into stopping zones. Confirmation measures served the purpose of documenting experimental conditions associated with the simulator drives and the in-vehicle system, such as the alert timing and distraction task trigger, but do not speak directly to whether or not there was a safety benefit when the system was present.

There was an overall benefit associated with the presence of the warning system. Participants using the system had significantly fewer did-not-stop outcomes than participants not using the system. This was particularly true in situations where the presence of a stop sign or the state of a traffic light was more difficult for drivers to detect. It is possible that the drivers most at risk of crashes may benefit most from the system because the greatest change in did-not-stop outcomes was in the older at-risk group, even though the trend did not reach statistical significance. The benefit associated with the system was also evident in the stopping position data. Participants who experienced the system warning stopped instead of driving through the intersection, resulting in more stops past the stop bar but before the collision zone. Participants reported a general perception that the system improved driving safety and that it aided drivers in driving more carefully. They also reported that the alert timing was good, that they understood how the system functioned, that the system was desirable, and that they would be willing to purchase the system.

The results of this study are relevant to efforts to improve driver safety, including vehicle-to-infrastructure components, such as the IntelliDrive program, specifically the Intersection Movement Assist component. Design recommendations based on this work are limited, but it is evident that a CICAS-V type warning system worked well for both older and younger drivers. It should be noted, however, that the system implemented here differed from the CICAS-V recommendations in some ways and that the data set has some limitations. There are a number of untested conditions (traffic situations, system differences, levels of system experience) that could produce differing levels of safety impact. Additionally, the small sample size coupled with the examined outcomes being events that drivers attempt to avoid resulted in insufficient outcome frequencies for some analyses.

1 INTRODUCTION

Older drivers seem to have the greatest difficulty negotiating intersections as indicated by their high percentage of intersection crashes. This project explored vehicle-based technology countermeasures for crashes associated with failure-to-obey (running a stop sign or stop light) violations. Older drivers were defined as those over 65 years of age. This age group is the fastest growing segment of the general population as well as the fastest growing sector of the driving population. Evidence suggests that driving performance tends to diminish with age. This has been attributed to factors such as declines in vision, hearing, reaction time, cognitive function, and motor abilities. The crash record identifies older drivers as having an increased fatality risk per vehicle mile traveled. The development of in-vehicle technologies has the capability to reduce this risk.

1.1 Project Background

In 2005, 36 million people in the United States, or 12 percent of the population, were aged 65 years and older. Older people (65 and older) are the fastest growing segment of the U.S. population. The Census Bureau estimates that about 13 percent of the population will be over 65 by 2010 and that the percentage will increase to 16.4 percent by 2020 as the "baby boomers" enter this age group (He et al., 2005).

As individuals move into the older population, most continue to drive. When compared to the entire U.S. driving population, older drivers are not dramatically overrepresented in terms of driver fatalities in terms of percentage of drivers. Older drivers accounted for 14% of driver fatalities in 2007 and 15% of the licensed drivers in 2006 (NHTSA, 2007). However, older drivers travel approximately half the number of miles of those under age 65 (Lyman et al., 2002). As a result, the crash rate per mile driven is about twice as great for older drivers. Some of these fatalities can be attributed to the increased fragility of older drivers. In other words, older drivers are more likely to be killed than younger drivers involved in similar crashes. Fragility does not explain the entire picture of older driver risk, however. With age, many drivers experience declines in vision, hearing, reaction times, and cognitive and motor abilities (Staplin et al., 1998). Even conscientious drivers must accommodate for these physical and mental challenges. Due to increases in the number of older drivers, and the increased risks for this group, any technologies that successfully improve the safety of older drivers would be expected to make a large impact.

The American Automobile Manufacturers Association estimates that drivers age 60 and older are the principal purchasers of 23 percent of new passenger cars in the United States. Since many older drivers purchase new vehicles, there is an opportunity for the older drivers' vehicles to incorporate technologies that may help them compensate for some of their diminished driving capabilities. A variety of technologies have been developed to aid drivers in avoiding crashes. These include systems such as electronic stability control, brake assist, forward collision warning systems, adaptive cruise control, and night vision. The development and testing of these systems tends to be focused on the driving population as a whole rather than the specific needs of older drivers. Conducting research that evaluates the impact of technology on older drivers as well as developing older driver focused safety is critical to addressing the future needs of traffic safety in the U.S. This need was also noted in NHTSA's most recent Older Road User Research Plan (Raymond et al., 2001). This project addresses how older drivers could benefit from in-vehicle crash avoidance technologies.

When compared to other age groups, older drivers are overrepresented in intersection crashes (Subramanian & Lombardo, 2007; Braitman et al., 2007). An analysis of automobile fatalities has shown that 31 percent of fatal intersection crashes involve older drivers, yet only 13 percent of non-intersection fatal crashes involve older drivers (Subramanian & Lombardo, 2007). This overrepresentation of intersection crashes has also been shown to increase as older drivers age (IIHS, 2005). In response to this data, the first technologies that will be examined in the current older driver effort are those aimed at reducing intersection crashes for older drivers.

Intersection crashes can be broken down into two basic categories: those in which the driver fails to stop for the intersection signal or stop sign (failure to obey), and those in which the driver has stopped appropriately at the intersection, but misjudges when it is safe to proceed through the intersection (failure to yield). Fatality Analysis Reporting System (FARS) data on intersection crashes indicates that about half of the fatal two-vehicle intersection crashes with an older driver that involve a violation can be attributed to failure-to-obey for traffic-signal-controlled intersections. For stop-sign-controlled intersections, one third of the fatalities involved a failure-to-obey violation, as shown in Table 1. To address these safety problems, this project explores an in-vehicle driver assistance systems that can help older drivers know when to stop at stop signs and red lights.

Table 1 Major Violations Charged in Fatal Two-Vehicle Crashes that Occurred at Intersections for Older Drivers (FARS 1997-2004)

Traffic Control	Failure-to-obey	Failure-to-yield
Traffic Signal	47%	53%
Stop Sign	33%	66%

1.2 Evaluation of Intersection Violation Warning Systems for Older Drivers

Approximately half of the charges in fatal intersection crashes are for failure to obey the traffic control device. Since many of these crashes may be caused by inattention, one countermeasure approach is to present a warning to drivers when they are at risk of violating an approaching intersection. While not specifically focused on older drivers, the Intelligent Transportation Systems' (ITS) Cooperative Intersection Collision Avoidance Systems (CICAS) initiative includes a research program to create this type of countermeasure. At the time this protocol was developed, the CICAS-V program was working to develop a failure-to-obey warning system. Because the CICAS project was still in the early stages, work was still underway to determine the safety and effectiveness of the CICAS concept for violations. To enhance the current development activities, it is beneficial to determine how older drivers respond to these types of systems and determine which operational and driver/vehicle interface factors contribute to the safety and effectiveness of the technology for this group of high-risk drivers.

While some intersection violations stem from willful disregard for the sign or signal, the majority of intersection violations appear to happen because a driver is not looking at the forward roadway or is otherwise distracted. According to General Estimates System (GES) data, driver distraction was coded as the primary contributing factor for 37 percent of crossing path crashes (Lee et al., 2004). In these situations, older drivers could potentially react differently to these warnings and not have enough time to stop prior to an intersection. Given that older divers account for a major portion of intersection crashes and experience declines in vision, hearing, reaction times, and cognitive and motor abilities, any technology introduced to assist in avoiding intersection crashes must account for the characteristics of this driver group. To maximize effectiveness and driver acceptance, research is needed to determine how intersection violation warning systems can accommodate the capabilities of older drivers. To this end, this effort had the following objectives:

- Determine the range of driver responses to intersection violation warnings
- Determine the effect of driver group (middle normal, older normal, older at risk) on intersection violation warning response

The primary question posed in this study was whether or not there was a benefit to an in-vehicle system that warns drivers of possible intersection traffic signal violations. A review of the literature concerning older drivers and intersection crashes was conducted. Section 2 draws on that work to describe risk factors for older drivers and inform the experimental conditions for Task 1 of this project, which was the evaluation of a failure-to-obey warning system that was consistent with the previous work within the CICAS-V project. The primary questions targeted in the review were which characteristics make some older drivers at greater risk for motor vehicle crashes than others and which situations pose greater risk to older drivers. A summary of other research investigating older drivers and intersection crashes is also included to provide a context for the current effort.

2 LITERATURE REVIEW

Over half of all fatal two-vehicle crashes involving older drivers occur at intersections (Stutts et al., 2009). In their review of FARS and GES data, Stutts et al. also found older drivers to be over-represented in crashes during the daytime in good weather conditions in specific situations, including:

- Left turns
- Rural roadways, although older drivers were also over-represented in crashes in urban areas
- Stop lights and intersections controlled by stop signs and yield signs

It is counter-intuitive that older drivers would be at higher risk of crashes during the day in good weather conditions than at night or in adverse weather. However, older drivers are also under-represented in crashes involving other risk factors such as alcohol and speeding, and once in a critical situation, older drivers seem to be less likely to initiate avoidance maneuvers such as braking or steering (Stutts et al., 2009). From this wider view, it can be speculated this is because older drivers choose not to drive in situations that they perceive as riskier and may attempt to compensate when they perceive a loss in ability (Hakamies-Blomqvist, 1994).

Additionally, older drivers are more likely to be driving the vehicle that is struck in a crash than the striking vehicle and are more likely to be struck on the left or right side of the vehicle than on the front or rear (Stutts et al., 2009). Scenarios that could result in this kind of crash are drivers failing to obey a stop light or stop sign (failure to obey) and proceeding into intersections when it is not safe to do so (failure to yield). At traffic signals, 20% of vehicles involved in fatal crashes failed to obey a signal, and at stop signs, 21% failed to obey the signal (Campbell et al., 2004). Older drivers are more likely to be cited with failure to obey and failure to yield when they are involved in crashes than are younger drivers (Stutts et al., 2009).

The increase in crash risk will be of greater concern as the U.S. population ages. As older drivers remain licensed, there may be an increase in the number of crashes involving older drivers. Since older drivers are found to be at fault in greater proportions than other age groups, the aging of the driving population will affect not just the older drivers, but all drivers on the road. However, older drivers’ higher fatality rate in crashes alone is reason enough to implement measures to decrease older driver crashes.

2.1 Factors Contributing to Older Driver Risk

Driving research is increasingly including older drivers as an age group, and failure-to-obey and failure-to-yield situations are often considered under the single topic of negotiating intersections. However, there is a clear division in the successful negotiation of intersections: a safe and appropriate stop (failure to obey), then proceeding through the intersection (failure to yield). It is clear from the crash statistics cited earlier in this section that both these categories contribute significantly to older driver crashes.

2.1.1 Situational factors of older driver risk

While older drivers have difficulty in several driving situations, a variety of factors may contribute to intersection crashes resulting from failure to obey. An understanding of the factors that contribute to higher crash risk for older drivers can inform the design of interventions to mitigate risk. Older drivers may fail to obey traffic signals and stop signs for a number of reasons as shown in the range of research concerned with older drivers. Attention problems are highly relevant when considering risk for intersection crashes in older drivers and may contribute to failure to obey. In an analysis of accidents occurring in Finland, inattention was the most common primary causal factor identified in fatal accidents involving an at-fault driver over the age of 60, and was responsible for more than 30% of such accidents (Summala & Mikkola, 1994). Older drivers had greater problems than younger drivers with negotiating an intersection safely in a simulator after simulated breaks of attention (Caird et al., 2005). In a simulator, drivers with impaired attention indicated willingness to make a left turn in front of oncoming traffic with less safety cushion than drivers with unimpaired attention (Pietras et al., 2006).

Older drivers may be more likely to fail to obey in situations where other traffic behaves in a manner older drivers may mimic. In a road test, drivers with Alzheimer's disease respond to cues from other drivers; for example, they might stop at stop signs and stop lights if they see other drivers doing so, or they might follow other drivers who have made left turns without checking traffic (Hunt et al., 1997). Additionally, older drivers who run yellow lights are less likely to clear the intersection before the red phase than younger drivers (Caird et al., 2007). Yellow light dilemmas are situations in which older drivers may benefit from a system that warns drivers of possible traffic signal violations. While the literature review did not reveal discussion of situations in which a traffic signal or stop sign is obscured, practical experience would suggest this is a situation in which all drivers could benefit from a system that not only warns of a possible violation, but indicates the presence of the signal upon approach.

2.1.2 Driving situations included in the current effort

Situations in which older drivers have been found to be at higher risk for crashes were included in the simulator drives. Participants drove through an environment with multiple intersections, which allowed the creation of both lower- and higher-risk driving situations. Control devices at the intersections included both traffic signals and stop signs. Four types of events were presented: traffic cues where surrounding traffic behaved in a manner inappropriate for the participant to mimic, obstructed view of a control device, yellow light dilemmas, and general events such as red and green traffic signals. Inattention was introduced by asking participants to change the track of a CD in the stereo system of the vehicle. The driving environment and individual events are described in Sections 3.5.1 and 3.5.3 of this document.

2.2 Prevention of Crashes

Several research programs into the causes of crashes and how to prevent crashes are ongoing. Various driver-oriented approaches to reducing crash risk for older drivers have been suggested. These include driver restrictions (Grabowski & Morrisey, 2001; Stav, 2008), driver education and re-training (Kua et al., 2007), and cataract surgery or eye drops for drivers with cataract (Wood & Carberry, 2006; Babizhayev, 2004). Researchers are also studying how to design systems to assist drivers in safely negotiating intersections.

2.2.1 In-vehicle systems

Various in-vehicle systems that are designed to prevent crashes, often with automated components, are under development. Some systems include both components in the vehicle and information transmitted from the infrastructure. There are systems specifically designed to prevent intersection crashes, such as the Intersection Crash Avoidance Violation (ICAV) warning system. This system warns drivers if they are in danger of running a red light or stop sign, and involves visual, auditory, and haptic warning systems, as well as an in-vehicle system to detect speed and uphill or downhill approach (Lee et al., 2004). Preliminary driving range tests determined that older drivers had a response similar to that of younger drivers (Lee et al., 2007). A similar system, which notified drivers of an approaching signal or stop sign with only a visual warning on a head-up display, was recently tested in a driving simulator and was found to be effective at reducing the occurrence of yellow light runs in both older and younger drivers (Caird et al., 2008).

A device to warn of insufficient gap while turning is under development as part of the European Commission's DRIVE II Project "Elderly and Disabled Drivers Information Telematics" and was tested in a driving simulator (Alexander et al., 2002). This device would be useful in intersections as well as other turning occasions. Some products that involve front or rear cameras are currently available. The Lexus Wide-view Front and Side Monitor system places cameras on the front grille of the car and the right mirror (Lexus, 2008), and the Magna Donnelly CornerVue system includes cameras in the front bumper (Murphy, 2007). Both systems display views on a screen and may improve vision around corners. No further information is available, as the manufacturers declined to comment on these systems or any current research into efficacy for older drivers.

The Interaction Decision support system is being developed by the Intelligent Transport Systems Institute at the University of Minnesota in conjunction with the Minnesota Department of Transportation. This system involves radar sensors placed near intersections that warn drivers via an in-vehicle device of a small turning gap (Intersection Decision Support Fact Sheet, 2008). The CICAS is under development and aims to reduce crashes at intersections by preventing violations of stop signs and traffic lights. It involves sensors at the intersection that gather information about local traffic signal conditions and send information to a computer in the approaching vehicle in order to trigger warnings as the vehicle approaches the intersection (Chan & Bougler, 2005). Recent work endeavored to determine the most useful combination of warning modalities. It was determined that the best warning system includes a voice auditory warning that says "stop light," a flashing visual display of an icon, and a haptic pulse (Maile et al., 2008). The haptic pulse was found to be the most important warning component in this system. Subjects were balanced between gender and three age ranges, with the oldest subjects in the 60-70 age group. Sample size was not adequate to test for differences in reaction to the warnings by age group or gender.

2.2.2 System evaluated as part of current effort

The effort described here, Task 1 of Enhancing the Effectiveness of Safety Warning Systems for Older Drivers, is concerned with the evaluation of a failure-to-obey warning system that combines an in-vehicle interface with information transmitted via infrastructure components and is consistent with the previous work within the CICAS-V project. The system implemented for this research study is described in Section 3.2.2 of this document. The in-vehicle component of the system allows the system to travel with drivers where the consistency of a single interface can facilitate driver understanding of the system. The information transmitted by the surrounding infrastructure provides location- and situation-specific information that would not be available to a system solely contained within a vehicle.

Previous work involving this warning system was aimed at determining an appropriate combination of alert modalities. The current effort took the next step by evaluating the warning system in situations where drivers, particularly older drivers, may benefit from warnings alerting them to impending failure to obey a traffic signal or stop sign. This evaluation also aimed to understand whether there was a difference in system benefits for older drivers and younger adult drivers, and whether some older drivers benefited more than others. This distinction between the two groups of older drivers was made by identifying factors that have placed older drivers at a higher risk for crashes. This two-pronged approach in understanding the possible benefits of a warning system is unique. Many evaluations of warning systems include older drivers as an age group; however, older drivers with risk factors that differentiate them from other adult drivers are often excluded from those studies. Such exclusions allow the comparison of performance across age groups without the confounding factors often associated with advancing age. Inclusion of older drivers with risk factors in this evaluation will allow another level of understanding of the benefit of the system.

2.3 Identifying Older Drivers at Greater Risk of Crashes

Age alone does not explain the higher incidence of accidents among older drivers, so factors that co-exist with greater age are considered. Health conditions in general may or may not increase older drivers' risk of motor vehicle crashes. The presence of some health conditions, such as cardiovascular disease or stroke and diabetes, has not been consistently shown to increase motor vehicle crash risk (McGwin et al., 2000; Sims et al., 2000; Koepsell et al., 1994; Delaney et al., 2006; Koepsell, et al., 1994; Kennedy et al., 2002). However, persons with cognitive or physical impairment from specific conditions, such as Alzheimer's disease or Parkinson's disease, may be at increased risk of motor vehicle crashes (Gorrie et al., 2007; Johansson et al., 1997; Dobbs et al., 1998; Rizzo et al., 1997; Wood et al., 2005; Zesiewicz et al., 2002; Uc et al., 2006; Uc et al., 2007).

Cognitive impairment is an important risk factor for crash risk in older drivers, but it is not the only health condition that may increase crash risk. Physical impairment may influence crash risk as well. Motor functions and physiological factors such as loss of mobility in the head and neck may challenge drivers when entering an intersection (Isler et al., 1997). Vision problems are a relevant specific risk for crashes. Older drivers with low vision reported more problems with both near and distance acuity and with physical obstructions than did older drivers with normal vision (McGregor & Chaparro, 2005), and decreased visual acuity and contrast sensitivity were associated with self-reported difficulty in high-risk driving situations (McGwin et al., 2000). For example, loss of contrast sensitivity due to cataract in one or both eyes may predict crash involvement (Owsley et al., 2001). Other physical indicators, such as at least one fall in the past year or foot reaction time, may be risk factors for crashes in older women (Margolis et al., 2002). Additionally, history of involvement in motor vehicle crashes may predict future accidents (Daigneault et al., 2002).

2.3.1 Detecting risk factors in older drivers

This project does not focus on any one particular risk factor or a specific category of risk factors for older drivers. This study compares the performance of drivers who can be classified as normal to that of drivers who can be classified as at risk. For this reason, several risk factors will be used as inclusion criteria for the at-risk group. It will be necessary both to classify potential participants during the screening process prior to enrollment in the study and to document the risk factors of participants after enrollment. Based on personal characteristics revealed by the literature to increase crash risk, evaluations have been identified that should be useful for identifying persons who are at higher risk for crashes and who are suitable research participants. These evaluations will include both cognitive risk factors and physical factors.

2.3.1.1 Cognitive evaluations

Cognitive tests have successfully predicted crash risk for older drivers. Trail-making A and Trail-making B are tests of executive function, and both Trails A (De Raedt & Ponjaert-Kristoffersen, 2001; Szlyk et al., 2002) and Trails B (Ball et al., 2006; Szlyk et al., 2002; Rizzo et al., 1997; Richardson & Marottoli, 2003) frequently predict driving ability or crash risk. Clock drawing tests may predict crash risk and driver ability (De Raedt & Ponjaert-Kristoffersen, 2001; Freund et al., 2005). The MMSE is widely used to assess cognitive function and is sometimes found to be an independent predictor of crash risk (Johansson et al., 1996; Marottoli et al., 1994; Molnar et al., 2007; Stav et al., 2008). One group found that MMSE score was particularly predictive of score in a driving test for subjects with mild Alzheimer’s disease or vascular dementia, while the predictive ability of the test was weaker or unclear among control subjects (Fitten et al., 1995). The Telephone Interview for Cognitive Status (TICS) may be an acceptable substitute for the MMSE if subjects must be evaluated by telephone instead of in person (Ferrucci et al., 1998).

2.3.1.2 Physical evaluations

Visual tests that may be useful for predicting crash risk or driving performance include visual acuity, contrast sensitivity, and Useful Field of View (UFOV). Visual acuity tests (De Raedt & Ponjaert-Kristoffersen, 2001; Marottoli et al., 1998), the Humphrey Field Analyzer visual field test (Wood et al., 2008), the FACT Contrast sensitivity slide-B (Stav et al., 2008), the Pelli Robinson contrast sensitivity test (Janke & Eberhard, 1997) or brightness acuity test (Rubin et al., 2007), and the Motor-Free Visual Perception

(MFVP) test may be useful (Ball et al., 2006) predictors of driving performance or crash risk. However, a composite measure of vision may more successfully assess crash risk. A study of Pennsylvania drivers found that neither visual acuity nor horizontal visual field tests independently predicted crash risk in the 3.67-year period prior to vision screening, but a pass/fail score that included the domains of visual acuity, horizontal visual fields, and broad contrast sensitivity was associated with increased crash involvement (Decina & Staplin, 1993). UFOV is an extremely strong predictor of driving ability (Clay et al., 2005), with high sensitivity and specificity (Ball et al., 1993). It is widely used in research and generally successful at predicting crash involvement or driving ability (Ball et al., 2006; Stav et al., 2008; Rizzo et al., 1997; De Raedt & Ponjaert-Kristoffersen, 2001). Physical and motor tests have been less successful at predicting crash risk or driving performance; however, a neck rotation test (Marottoli et al., 1998) or a postural sway test (Wood et al., 2008) may be useful. A rapid walk test may be useful (Stav et al., 2008), as may a foot tap test (Molnar et al., 2007). Several methods for screening for and documenting risk factors will be employed. Screening of potential participants will employ telephone interview questions focusing on identified risk factors. Documentation of participants' risk factors will take place during the study visit through the use of cognitive and physical tests.

2.3.2 Participant screening and risk factor documentation

Screening participants for cognitive and physical risk factors is necessary in order to assign them to the age and risk categories outlined in the statement of work. The most efficient method would be to employ telephone screening tools prior to enrollment to minimize the number and length of visits necessary for study participation. Screening procedures are described in Section 3.3 of this document. Documentation of risk factors once participants are enrolled during their study visit will allow specific tools for evaluating risk to be compared to performance in the experimental drives. Evaluations for documentation of risk factors are described in Section 3.4 of this document.

3 METHODOLOGY

This section begins with a discussion of the experimental design and the independent and dependent measures. This is followed by a description of the participant groups and the experimental protocol for the study visit to the National Advanced Driving Simulator (NADS). The methodology described here was utilized in the main data collection. Following the pilot test, two intersection events that produced the highest percentages of violations in the baseline condition during the pilot test of scenario drives were chosen to be the focus of main data collection: tree-obstructed stop sign (25%) and moving-truck-obstructed stop light (50%). Other events included in the pilot drive were removed or changed for the main study data collection. Section 3.5 discusses the driving scenario events, distraction task placement, and system detection of specific intersections.

3.1 Experimental Design

Three participant groups were evaluated with and without the in-vehicle warning system, resulting in a 3x2 between-subject factorial experimental design. This section discusses these independent variables, how they were combined to create the experimental conditions, and the dependent variables.

3.1.1 Independent variables

3.1.1.1 Age and risk

Age was a between-subject variable at three levels: “normal” middle drivers (25-55 years old), “normal” older drivers (>65 years old), and “at risk” older drivers (>65 years old). Potential participants were assigned to the “normal” and “at risk” groups using telephone screening questionnaires. Descriptions of these questionnaires are included in Section 3.4.1.

3.1.1.2 In-vehicle system presence

The presence of the in-vehicle system was also a between-subject variable presented at two levels (present and not present). Half the participants in each age group completed the experimental drive with the in-vehicle system and the other half completed the drive without the in-vehicle system.

Table 2 Experimental conditions

# of participants	Age Group	In-vehicle System
6	Middle Normal	present
6	Middle Normal	not present
6	Older Normal	present
6	Older Normal	not present
6	Older At Risk	present
6	Older At Risk	not present

3.1.2 Dependent measures

Dependent variables for analysis included two categories of measures: safety and confirmatory. The safety measures address questions relating to the benefit of the system. Confirmatory measures were used to confirm experimental conditions associated with the simulator drives and in-vehicle system, such as distraction tasks and system warnings. Descriptions of the dependent measures are included in Table 3.

3.1.2.1 Safety measures

The primary benefit measure, violations, documented when participants violated the stop signs or traffic lights. Analyses explored group differences in violations to evaluate the influence of the in-vehicle system, as well as participant group.

Number of violations cannot tell the whole story. A driver may stop past the stop bar, which is a violation, but not encroach on the pathway of cross traffic where there is a possibility of a collision. While a driver stopped in this position may not be in immediate danger of a collision, it is less safe than stopping behind the stop bar. Similarly, a driver who stops significantly behind the stop bar is not in danger of a collision with oncoming traffic, but the view of oncoming traffic may be impaired by the position. The stopping zone variable captured differences in stopping with and without the system relative to the stop bar. The zones in this variable were defined in a manner similar to that used in the CISAS-V project work. The six zones were:

- Premature Stop – driver stopped with front of vehicle more than 1½ car lengths before the stop bar
- No Violation – driver stopped with front of vehicle less than 1½ car lengths before stop bar
- Violation Zone – driver stopped with front of vehicle past the stop bar, but the rear of vehicle remains before the stop bar
- Intrusion Zone – driver stopped with entire vehicle past the stop bar, but front of the vehicle does not protrude into the path of cross traffic
- Collision Zone – driver stopped with some part of vehicle in the path of cross traffic
- Did Not Stop – driver did not stop at intersection

An illustration of the violation, intrusion, and collision zones is included in Figure 1. The zones were defined for each of the intersection geometries within the simulator drive.

3.1.2.2 Confirmation measures

The confirmation measures documented experimental conditions associated with the simulator drives and the in-vehicle system, such as the alert timing and distraction task trigger, but do not speak directly to whether or not there was a safety benefit when the system was present. Confirmation variables provided assurances that the events happened as expected or explanations for how the event differed from expected. These variables were particularly useful in pilot testing as a final high-level check of system and scenario function. They then formed the basis for analysis of main study data, much like checking distributions of continuous variables to confirm that the assumptions of the planned statistical analysis were met.

Table 3 Dependent Measures

	Safety Measures	
Variable	Definition	Units
Violation	Did the participant stop before stop bar	Categorical
Stopping zone	Six categories based on participant's stopping distance from the stop bar, exact distances specific to each intersection geometry	Categorical
Stopping position	Distance from front bumper to participant's vehicle to stop bar	Feet
	Confirmation Measures	
Alert trigger	Confirms alerts happened when expected	Binary
Time to stop bar at alert	Confirms alerts happened when expected	Seconds
Distraction task trigger	Confirms distraction task was triggered when expected	Binary
Distraction task engagement	Number of times button on CD player was pressed	Count

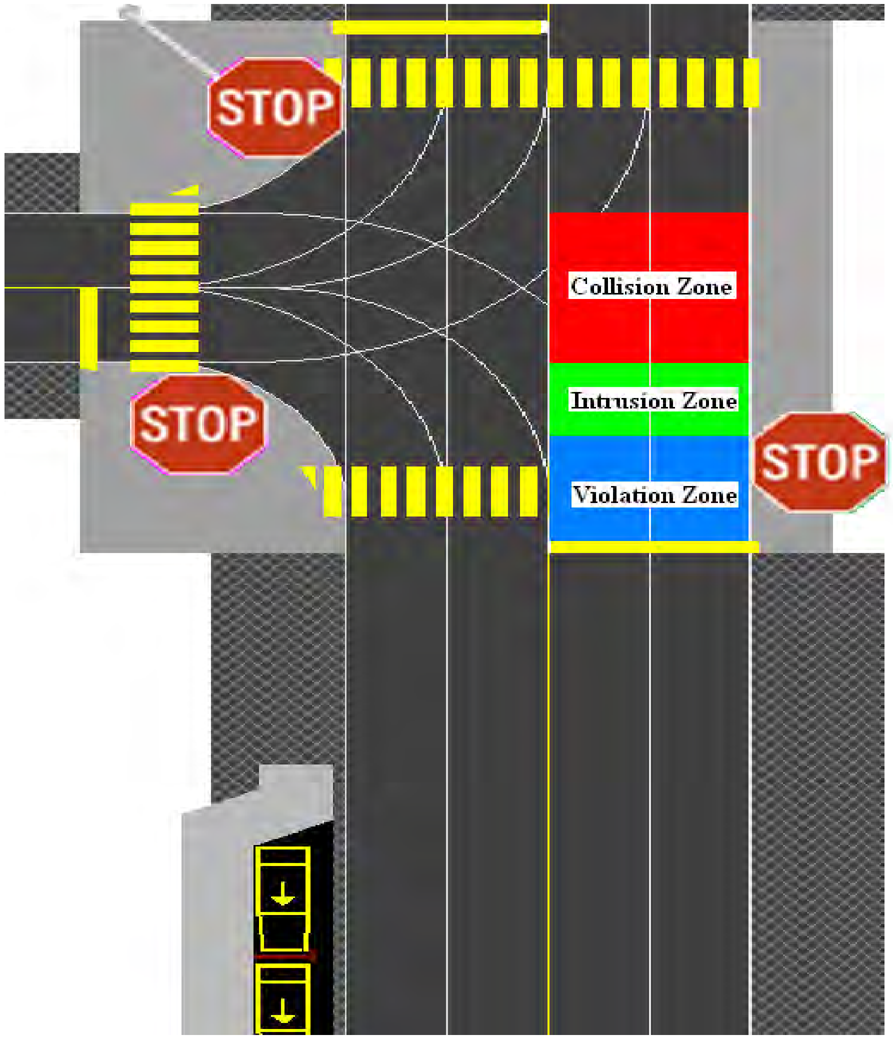

Figure 1 Illustration of violation, intrusion, and collision zones

3.2 Test Devices

The test devices include the driving simulator, NADS-1, in which the experimental drives were run, the in-vehicle warning system being studied in this work, and the distraction task that was employed during the experimental drives.

3.2.1 NADS-1

The NADS-1 driving simulator, owned by NHTSA and located at The University of Iowa, comprises a 13-degree-of-freedom motion base with a 24-foot-diameter dome in which a Chevrolet Malibu cab was mounted for this study. Inside the dome, the cab was mounted to the floor through four hydraulic actuators. The dome can rotate about its vertical axis by 330 degrees in each direction and was mounted on top of a traditional hydraulic hexapod, which in turn was mounted on two belt-driven beams that could move independently along the X and Y axes in a 64-foot-by-64-foot bay. The visual system consisted of eight liquid crystal display (LCD) projectors that project a 360-degree photo-realistic virtual environment. The front three projectors had a resolution of 1600 x 1200.

The right and left projectors had a resolution of 1280 x 1024. The three projectors in the back had a resolution of 1024 x 768. All scenery was updated and displayed 60 times per second. A complete statement of capabilities can be found in the *NADS Statement of Capabilities* (National Advanced Driving Simulator, 2007).

3.2.2 In-vehicle intersection violation warning system

The in-vehicle system was designed to provide alerts when a driver was likely to violate a red light or stop sign at an intersection. The system used vehicle location, traffic signal state, and timing to determine probability of violation. The system conformed to the specifications provided by NHTSA, which were based on the recommendations for in-vehicle specifications included in the CICAS-V. However, there were some variations in the implementation of the warning system for this study. One variation was the absence of brake pedal depression resulting from the activation of the vehicle braking system. It was decided through collaboration with NHTSA that this component of the system alert would not be implemented due to budget constraints.

The system was active throughout the simulator drives in which it was present, with an assumed communication range of 300 meters prior to each intersection. A violation was predicted by a time to arrival to the stop bar of an intersection of less than t_{crit} given the following equation derived from the CICAS-V critical stop distance equation (Maile et al., 2008):

$$t_{crit} = t_{react} + \frac{V_i}{2(a_{lim})}$$

where t_{react} (reaction time) was 1.5 s, and $a_{lim}(v_i)$ (assumed rate of deceleration for a given velocity) was specified as a contestant 0.35 g (D. Band, personal communication, December 15, 2008). In other implementations, a_{lim} may be a function, $a_{lim}(v_{i,})$ to match a given velocity with a driver specific deceleration. Also, no violation warning was given if the participant’s time to arrival to the stop bar was less than the time to red (Maile et al., 2008). In other words, if the participant could make it through the yellow light before the light turned red, no violation warning was given. In addition, no violation warning was given if the participant’s speed was below 5 mph (D. Band, personal communication, May 26, 2009). The visual alert was reset after a warning 5 seconds after the participant had come to a stop (speed < 0.4 mph), or when the participant had crossed the midpoint in the intersection.

The system alert included three display components: a visual icon, an auditory alert, and a brake pulse. Specifications for the visual icon were as follows, and the icon display is shown in Figure 2:

- Size: 0.68° X 0.68° visual angle

- Independently addressable high-intensity blue and red LEDs
- A display is mounted on the center of the dashboard
- The same icon is used for stop signs and stop lights
- At a pre-established time to arrival at an intersection, the icon becomes blue and steady
- On warning activation, the icon becomes red and flashes at 4 Hz with a 50% duty cycle (125 ms on, 125 ms off) until 5 seconds after the participant has crossed the stop line

Figure 2 Visual alert icon

The visual alert hardware was installed in the NADS-1 Malibu cab in a manner consistent with the above specifications. The auditory alert was presented simultaneously with the visual icon and was a voice alert. Two sound files were utilized: "stop light" or "stop sign" for system-predicted violations at traffic-signal-controlled intersections and stop-sign-controlled intersections, respectively. The alerts were recorded using a female voice and were presented at approximately 75 db measured from the driver's head. The brake pulse followed the same profile as the examples provided in the CICAS-V work (Maile et al., 2008); however, adjustments were made to accommodate the motion washout in NADS-1. Specifications for the brake pulse are below, with braking profiles in Figure 3:

- The brake pulse was triggered immediately before the onset of the visual and auditory warnings, such that deceleration would reach .10 g at the same time as the visual and auditory warnings
- The total pulse duration was approximately 0.6 seconds
- The peak pulse was reached between 0.25 and 0.35 seconds after the onset of the visual/auditory warning
- The brake pulse was shut off after a predefined brake pressure defined by the driver

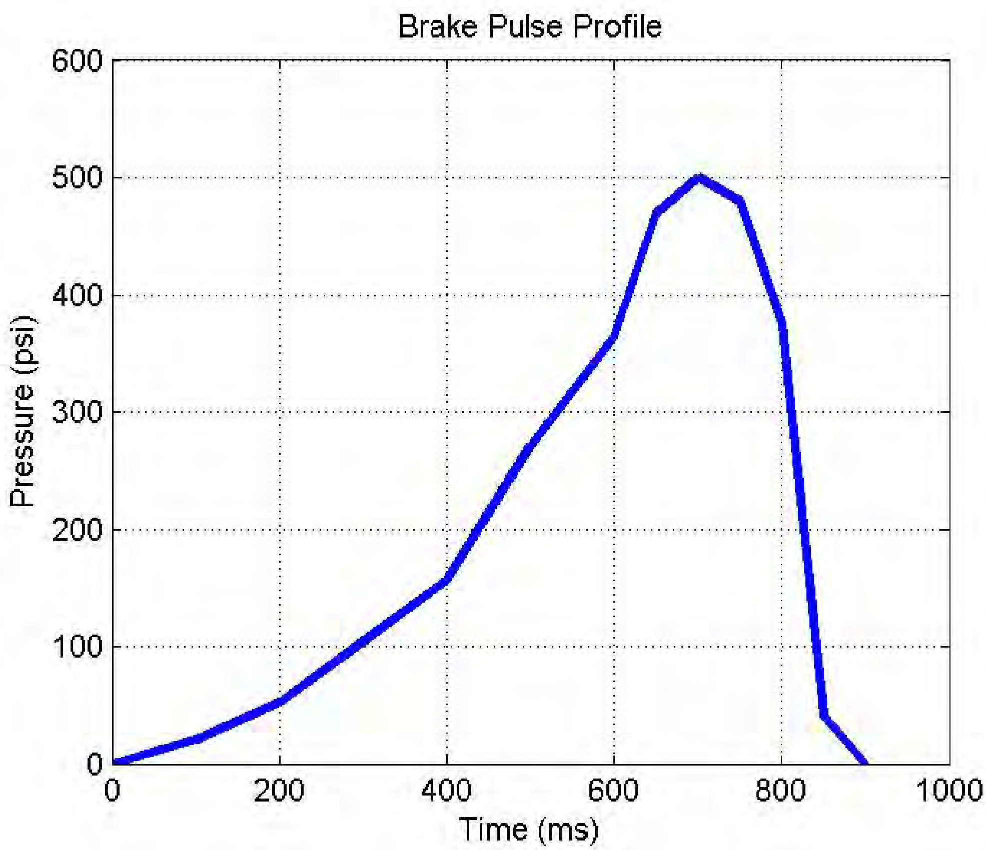

Figure 3 Brake pulse profile in NADS-1

3.2.3 Distraction task

Researchers used a distraction task to create situations in which drivers may receive an alert from the in-vehicle system. Drivers who are distracted are more likely to not see traffic signals or to notice them later than undistracted drivers; in such situations there may be a greater benefit to the system than with undistracted drivers. The number of opportunities for participants to receive a system alert was limited during a 20-minute drive. Including a distraction task provided more opportunities for the participants to experience a system warning. Activation of system warnings was necessary for determining whether there was a benefit associated with the system.

The distraction task employed for this study asked the participant to change the track on the CD player that exists in the console of the vehicle cab. This is a common in-vehicle task that has been successfully implemented in other research studies, such as the NHTSA-funded study Advanced Vehicle-based Counter Measures for Alcohol Related Crashes, and was one of the distraction tasks used by the CICAS-V project to determine the alert configuration specified in this study. Additionally, this task allowed collection of confirmation variables regarding participant engagement in the task by recording the number of times the participant pushed the button to change the CD track. Researchers chose a single task for this protocol to minimize the required training for participants in hopes of retaining “at-risk” older drivers.

During the briefing, researchers instructed participants on the use of the CD player and presented an example of the auditory prompt to begin the task and a diagram of which buttons they would use to complete the task. The auditory prompt--"Please adjust the CD player. Select track ___ now."--asked the participant to change to a specific track. The CD in the player contained several tracks of silence so that noise from a CD was not an additional distraction during the drive. Engagement in the task could be confirmed by the number of button presses needed to advance the CD track as requested. The task was included in the practice portion of the simulator drive to allow participants to experience the audio prompt and become familiar with the CD player in the cab.

Researchers employed an incentive ruse to encourage participants to change the CD track. During training, they told participants that a portion of their pay would be based on their ability to change the CD track correctly and in a timely manner. The perceived financial incentive to complete the requested task was intended to encourage participants who may have chosen to ignore the task in some situations to engage in the task. Researchers revealed the ruse after the participants completed their simulator drives, and all participants who completed the study received the full $30 in compensation. In a debriefing statement, researchers asked participants not to reveal the ruse to other potential participants in order to maintain the effectiveness of the ruse throughout data collection.

3.3 Participants

Participants fit into one of three groups: "normal" middle drivers (25-55 years old), "normal" older drivers (>65 years old), and "at risk" older drivers (>65 years old). "At risk" was defined as participants whose scores on the Health and Mobility Classification questionnaire (Appendix 1) or the TICS (Appendix 2) showed they had physical and/or cognitive risk factors for involvement in a driving accident. "Normal" was defined as participants whose scores did not reach the thresholds on the Health and Mobility questionnaire and the TICS that would put them in the "at risk" category. Eight "at-risk" older drivers participated in the pilot study: four with and four without the warning system. Thirty-six, twelve from each age group, participated in the main study, as noted in Table 2.

3.3.1 Recruitment method

Researchers used two volunteer databases to identify potential participants for this study:

- The NADS database of potential participants
- The STAR Registry at the University of Iowa Center on Aging

3.3.2 Inclusion/exclusion criteria

Potential participants had to fall into one of the age groups in this study and meet general driving and health criteria to enroll. Potential participants were classified as at risk if they scored 30 or less on the TICS or 10 or more on the Health and Mobility questionnaire during the pre-study screening procedure discussed in Section 3.4.1.

3.4 Experimental Procedures

This section discusses the details of participant participation in this study, beginning with recruitment and continuing through the end of the visit to the NADS facility.

3.4.1 Recruitment

The first step of the experiment was recruitment. All potential participants underwent a pre-study screening procedure that began with the Driving and General Health Screening Procedure (Appendix 3). The general criteria included being either 25 to 55 or over 65 years old, holding a valid driver's license, and minimum driving frequency of once per week. The health criteria helped ensure the safety and comfort of participants in the simulator by excluding persons with conditions such as epilepsy, proneness to dizziness or motion sickness, claustrophobia, and people currently undergoing chemo or radiation therapy for cancer. Potential participants were also screened for risk factors associated with older drivers' higher incidence of driving accidents using the Health and Mobility Classification questionnaire (Appendix 1) and the TICS (Appendix 2). The Health and Mobility Classification questionnaire includes questions about physical and behavioral factors that indicate a higher risk for crashes. It was created for this study based on the risk factors revealed by the literature review as described in Section 2. The TICS identifies cognitive impairment, which is a risk factor for crashes in older drivers. These questionnaires each provided a score and a threshold for the classification of "normal" or "at risk" based on the individual's score. Drivers in the age range of 25-55 years old had to be considered "normal" based on scores from the Health and Mobility questionnaire and the TICS to be appointed to the study. Participants over 65 years of age were appointed to either the "normal" or "at risk" group as indicated by their scores on the Health and Mobility questionnaire and the TICS. If the participant met the screening criteria, they were asked to report to the NADS facility for a study visit. Information provided by potential participants during the telephone screening was not kept because it was obtained prior to informed consent. Risk factor data was collected during participants' study visit and is described below in Section 3.4.2. Participants received the NADS Demographic and Driving Survey (Appendix 4) by mail so they could complete it and bring it to their study visit.

3.4.2 Simulator drive visit

Participants completed the informed consent document (Appendix 5), a payment voucher, which required a social security number for University payment (Appendix 6), and a video release document or video release with altered ID document (Appendix 7).

Participants filled out the NADS Driving and Demographic survey, as well as several evaluations for risk factors associated with traffic accidents in older drivers. These evaluations were included during the study visit because the information gathered during the screening process could not be kept because it was gathered prior to the participant giving informed consent. Researchers documented the level of risk using the following evaluations:

- Mini Mental State Examination (MMSE) (Appendix 8)
- Visual acuity-near and distance, and contrast sensitivity

- Rapid Walk, Foot Tap, Neck Rotation tests (Appendix 10)

The MMSE examined general cognition (Johansson et al., 1996; Marottoli et al., 1994; Molnar et al., 2007; Stav et al., 2008), and the vision exams documented visual impairment that may affect driving ability (Wood et al., 2008; De Raedt & Ponjaert-Kristoffersen, 2001; Marottoli et al., 1998; Stav et al., 2008; Janke & Eberhard, 1997). Finally, the rapid walk (Stav et al., 2008), foot tap (Molnar et al., 2007), and neck rotation tests (Marottoli, et al., 1998) documented mobility issues.

Four evaluations in the pilot data collection protocol were not included in the main data collection. They were:

- PTSD Checklist (Appendix 11)
- Trail Making B (Appendix 12)
- Clock-drawing (Appendix 13)
- Vision tests for visual fields

These evaluations did not prove to be useful in documenting the risk factors in the self-selected group of volunteers interested in participating in driving studies.

After the paperwork and evaluations were completed, the participant went through a self-paced PowerPoint presentation (Appendix 14) that included a description of the distraction task and the in-vehicle system and what they could expect in the simulator. The presentation also stated that a portion of their pay would be based on their ability to accurately complete the distraction task in a timely manner. This information was a ruse designed to encourage engagement in the task. The ruse was revealed after the participants' drive, and all participants were paid the full amount. The research assistant answered any questions the participant had about the information in the presentation. The last survey that participants completed prior to their drive was the Pre-Drive Survey (Appendix 15), which asked about their confidence driving in several situations and their recent alcohol and drug use.

After the participant completed the survey, a set of stickers was applied to the participant's face to facilitate eye tracking during the simulator drives. A research assistant escorted the participant to the simulator and rode in the simulator with the participant in case a medical emergency were to occur.

Once they were in the simulator, the participant heard a set of instructions and completed the simulator drive, which was approximately 15 minutes. During the first part of the drive, participants became acquainted with the simulator cab and practiced stopping in the simulator. Since there was only one simulator drive combining both a practice or familiarization portion and a data collection portion, an opportunity to check for simulator sickness was necessary. Halfway through the drive, when the participant came to a stop at the red light, an audio prompt played, asking the participant to report how they were feeling at that time with the answer options of:

- I am feeling OK.
- I am not feeling OK.
- I want to stop.

If the participant responded that they were feeling OK, the drive continued when the traffic light turned green. If the participant responded they were not feeling OK, the drive was paused and the research assistant in the vehicle administered the Wellness Survey (Appendix 16) and determined whether the drive continued. A restart point created at the same point in the drive allowed participants to continue with the drive after completing the Wellness Survey. If the participant responded to the prompt that they wanted to stop driving, the drive ended and the participant was brought back to the dock to exit the simulator.

The participant filled out a Wellness Survey (Appendix 16) at the end of the simulator drive. This survey, combined with the wellness report in the middle of the drive, was used to evaluate whether the participant was experiencing any signs of simulator sickness. After the drives, a research assistant escorted the participant back to the study room and asked the participant to fill out the following questionnaires:

- A realism survey used by NADS to enhance the realistic features of the simulator cab and drives (Appendix 17)
- Post-Drive Questionnaire (Appendices 18 and 19)

Following the short Realism Survey, information about the in-vehicle system that was presented during the briefing was reviewed with the participant again if they requested it. The participant was then asked to complete the Post-Drive Questionnaire. There were two versions of the Post-Drive Questionnaire, one for participants who experienced the in-vehicle system (Appendix 18) and one for those who did not (Appendix 19). Finally, the debriefing statement (Appendix 20) was given to the participant, revealing the incentive ruse and asking that they refrain from discussing the details of the simulator drive with other potential participants until a date when we expected data collection to be complete. The research assistant reviewed the participant’s payment voucher with the full amount of compensation and answered any questions. When all of the necessary information was filled out, the participant was free to leave.

3.5 Experimental Drives

This section describes the virtual environment in which the simulator drive took place, the experimental events, and the order in which the distraction task was presented. Each participant completed a simulator drive of 14-20 minutes. During the simulator drive, they passed through several controlled intersections: eight traffic lights and six stop signs. The intersections for which the system was active in the system-present experimental condition are described in Section 3.5.2 below. Distraction tasks were presented throughout the drive during events and at non-critical times between intersections to reduce the association of the distraction task with an intersection and are illustrated in the discussion of the experimental drives.

3.5.1 Scenario and virtual environment

The road network consisted of a main four-lane road. Speed limit signs were placed throughout and established the speed limit as 35 mph. The environment for the simulator drive included two urban sections, each with six intersections labeled A-F in Figure 4. The two urban sections were separated by an arterial section of shallow curves.

3.5.2 Simulator drive

The simulator drive began at the top of the environment in Figure 4. Experimental events occurred at several intersections in the urban sections, as well at a stop signs with crosswalks placed in the arterial section. The asterisks (*) in Table 4 indicate how the distraction tasks were distributed throughout the drive as well as which intersections were detected by the warning system in the system-present experimental condition. The intersection labels listed in the first column of Table 4 indicate the location of each intersection in the database in Figure 4 in the order the participant encountered them. The distraction tasks noted with a yellow tag in Figure 4 correspond to distraction tasks between intersections as noted in Table 4.

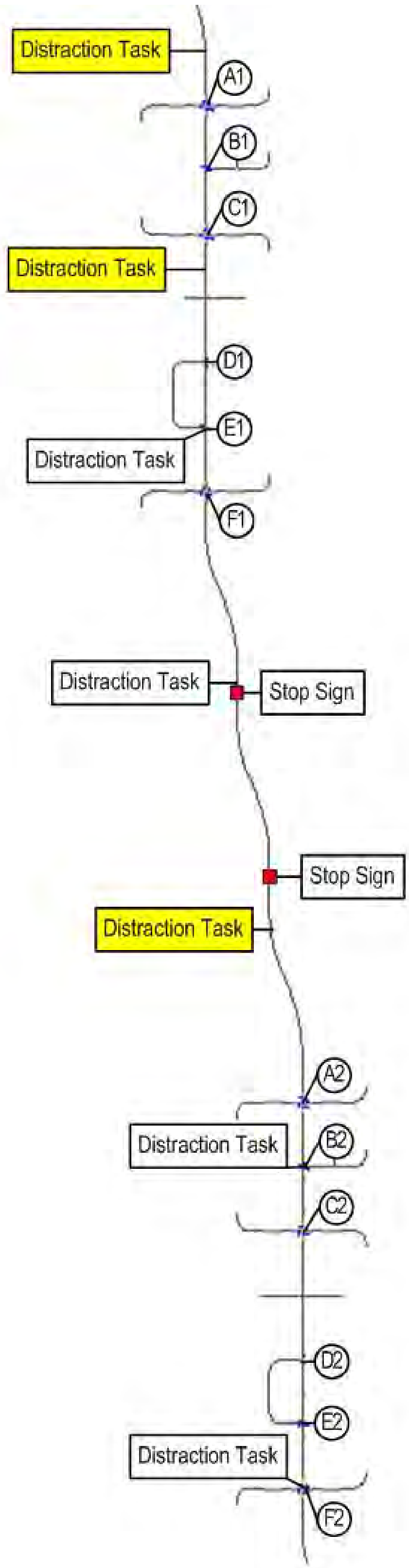

Figure 4 Simulator drive intersections and distraction tasks

Table 4 Scenario Events and Distraction Task Orders

Intersection	Event Type	Description	Distraction Task	System Detects Intersection
		Distraction task between intersections	*	
A1		Green Light		*
B1	General	Unobstructed Stop Sign		
C1		Green Light		*
		Distraction task between intersections	*	
D1	General	Unobstructed Stop Sign		
E1		Green Light	*	*
F1	General	Red Light		
		Audio prompt for wellness report		
Arterial 1	Obstructed	Tree-obstructed Stop Sign	*	*
Arterial 2	General	Unobstructed Stop Sign		*
		Distraction task between intersections	*	
A2	General	Red Light		*
B2	General	Unobstructed Stop Sign	*	*
C2		Green Light		
D2	General	Unobstructed Stop Sign		*
E2		Green Light		
F2	Dilemma with Traffic Cue	Moving-truck-obstructed Light	*	*

3.5.3 Scenario events

Some intersections did not include experimental events. Participants encountered green lights at intersections A1, C1, E1, C2, and E2. The traffic light was green upon the participants' approach and remained green until the participant had passed through the intersection. Analysis of the data collected for the green light events was not expected within the scope of this study. The events in the simulator drives were designed to present participants with two types of situations in which drivers may be aided by the in-vehicle system, obscured traffic signals and dilemmas

3.5.3.1 Obscured traffic signals

Researchers presented obscured traffic signals in hopes of understanding the potential benefit of the system in situations where drivers have limited warning of the presence and state of a traffic signal in the absence of the in-vehicle system. There was one obstructed stop sign event. The first of the two stop signs in the arterial section was obscured by tree (Figure 5), which was placed at a point in the drive that corresponds to a driveway leading from parking lot. Crosswalks and pedestrians in the area were included to provide context for the stop signs in the arterial section.

Figure 5 Tree-obstructed stop sign in arterial segment

3.5.3.2 Dilemma

The final event of the drive at intersection F2 was a dilemma with a traffic cue (Figure 6). As the participant approached the intersection, a truck was ahead of the driver in the right lane and a car was ahead of the driver in the left lane. The truck obstructed the view of the traffic light above the right lane. The light changed from green to yellow as the vehicles ahead entered the intersection, allowing the vehicles to pass through the intersection without violation. The light changed from yellow to red while the truck obscured the participant's view of the traffic light; however, the yellow light above the left lane was visible. A vehicle was behind the participant to encourage maintenance of a headway to the trucks that allowed the obstruction of the traffic light.

Figure 6 Truck-obstructed stop light at intersection F2

3.5.3.3 General events

There were also general events that did not include environmental factors that may signal the driver to behave in a specific way, such as encouraging either compliance or violation of the traffic signal. These events were the red lights and unobstructed stop signs. Unobstructed stop signs were presented in the arterial segment (Figure 7) at intersections B1, D1, B2, and D2 (Figure 8). Red light events were presented at intersections F1 and A2 (Figure 9).

Figure 7 Unobstructed stop sign in arterial segment

Figure 8 Unobstructed stop sign at intersection D2

Figure 9 Red light at intersection A2

4 EXPERIMENTAL RESULTS

The objectives of this study were:

1) Determine the range of driver response to intersection violation warnings
2) Determine the effect of driver group (middle normal, older normal, older-at risk)

The data analysis for this effort made comparisons between the age groups for range of driver response. The primary question was whether or not there was a safety benefit to the presence of the intersection violation warning system. The safety variables discussed in Section 3.1.2.1 addressed this question.

4.1 Confirmation of Experimental Conditions and Statistical Assumptions

4.1.1 Participants

Thirty-six participants in three age-risk groups completed the study protocol with 12 participants (6 men and 6 women) in each age-risk group. The mean age for each age-risk group was: middle-normal mean 35.6 years (std.dev. 9.9), older-normal mean 74.4 years (std. dev. 6.1), and older-at-risk mean 78.7 years (std. dev. 5.2). Prior to analysis of the dependent variables, confirmation of the experimental conditions was necessary.

4.1.2 Age and risk group assignment

Confirmation began with a comparison of the "at risk" group assignment from the screening procedures with risk factors indicated by the evaluations conducted during the study visit. The presence of a risk factor was based on the scores for the evaluations as described in Table 5.

Table 5 Evaluation scores indicating risk

Evaluation	Indication of Risk Factor	Type
MMSE	Score of 23 or less	Cognitive
Visual Acuity - far	Less than 20/40	Visual
Visual Acuity - near	Less than 20/40	Visual
Contrast Sensitivity	Score below normal for any of the frequencies tested	Visual
Rapid Walk	Greater than 7 seconds	Physical
Foot Tap	Greater than 8 seconds	Physical
Neck Rotation	Fail; unable to read time	Physical

The cumulative risk factors documented in each age-risk group of participants are shown in Figure 10. More risk factors were documented in the middle-normal and older-normal age-risk groups than expected. However, there was a clear trend for the older groups to have more risk factors, with the older-at-risk group having the highest number of documented risk factors. The extent to which each risk factor was documented in each group can be seen in each of the data series noted in the legend of Figure 10.

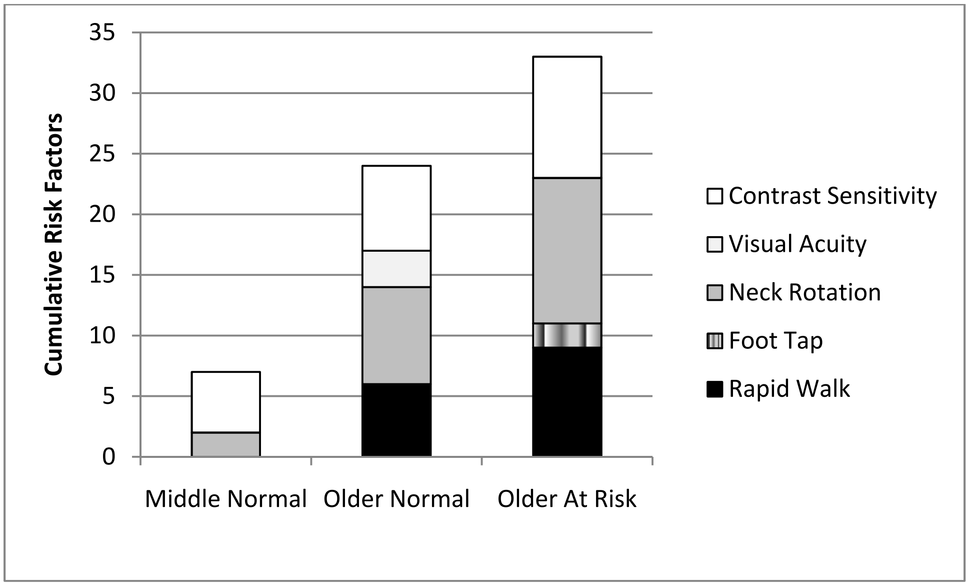

Figure 10 Cumulative risk factors by age-risk group

No participants were below the cut-off score for the MMSE exam. The Rapid Walk, Foot Tap, and Neck Rotation tests followed the trend seen across the age-risk groups in general, with the Neck Rotation test being the only one of the three documented in the middle-normal group, and to a lesser degree in the older-normal group than in the older-at-risk group. Participants with visual acuity less than 20/40 in both eyes were seen only in the older-normal group. Visual acuity of at least 20/40 in one eye is a licensure requirement in the state of Iowa. It can be speculated that the occurrence of this risk factor only in the older-normal group was due to visual acuity becoming a factor for that age group without their knowledge. Members of the older-at-risk group, on the other hand, were more aware of risk factors because they were noticing a cumulative presence of risk factors and were more careful to mitigate as many as possible. Contrast sensitivity was documented as less than normal for some participants in all three age-risk groups, but again for the fewest number of participants in the middle-normal group, for more participants in the older-normal group, and for the highest number of participants in the older-at-risk group.

4.1.3 Event, alert and distraction conditions

Researchers thoroughly tested scenario events, warning system alerts, and distraction task conditions during integration of the driving scenarios into the NADS-1 simulator.

Confirmation that scenario events, system alerts, and distraction tasks continued to function as expected was carried out during participant drives through visual observation by staff in the cab and in the control room. No notations of events, alerts, or distraction tasks functioning differently than expected were made during the study drives. Additionally, a review of the frame number within the data stream at which the components of the alerts were triggered revealed that alerts were triggered as expected.

The data verification continued with an examination of the reduced simulator data for any inconsistencies between the calculated outcome variables (stop zone and stopping position) and the alert conditions. Five instances of a violation were found where no violation was or would have been issued. In all five instances, the participants slowed normally, slowing below the 5 mph cutoff for system warnings before crossing the stop bar and coming to a stop within seven feet past the stop bar. No change to the outcome variables were made because the system functioned as specified.

4.1.4 Normality and outliers

Researchers completed a univariate analysis to verify normality and identify outliers in the continuous dependent variable stopping position, measured in units of feet. No transformation of the data was necessary; however, three data points were identified as outliers. The outliers were large positive values that were separated from the closest data points by 20 to 50 feet. The positive value of these outliers indicates they were extremely premature stops by participants and all three instances occurred in the older-at-risk group. These three data points were removed from the data set for the analysis of the stopping position variable.

4.2 Safety measures

The primary question asked in this study, whether or not there was a safety benefit to the presence of the system, focused the analysis on the outcomes at intersections: violations and stopping zones. Two additional analyses, the effect of driver group and the range of driver response, considered whether there was a greater benefit for one age-risk group and whether the age-risk groups responded differently to the presence of the system.

The first step in analysis was to create a data set appropriate for the experimental question. Intersections at which the driver was not expected to stop, for example, green lights, are not of interest and were removed. Similarly, intersections that the system did not detect and therefore could not have issued a warning for were also removed from the data set. This produced a data set that included six intersections (Table 6) that the warning system detected and at which the participants were expected to stop (stop signs and red lights).

Table 6 Stop-expected system-detected intersections

Intersection	**Event Type**	**Description**	**Distraction Task**	**System Detects Intersection**
Arterial 1	Obstructed	Tree Obstructed Stop Sign	*	*
Arterial 2	General	Unobstructed Stop Sign		*
A2	General	Red Light		*
B2	General	Unobstructed Stop Sign	*	*
D2	General	Unobstructed Stop Sign		*
F2	Dilemma with Traffic Cue	Moving Truck Obstructed Light	*	*

Two outcome variables were analyzed: violation and stopping zone. Violation had three levels: stopped with no violation (before the stop bar), stopped with violation (after the stop bar), and did not stop. Stopping zone had six levels: premature stop, stopped with no violation, violation zone, intrusion zone, collision zone, and did not stop. Table 7 shows the frequency of outcome for each level of the stopping zone and violation variables. The higher frequency of participants stopping in the violation zone with the system than without should be considered in conjunction with the frequency for did-not-stop. It was probable that some of the participants with the system who received warnings of possible violations attempted to stop at the intersection, but were unable to do so before the stop, resulting in a stop with violation rather than no stop at all.

Table 7 Frequency table of system presence by stopping zone

	Stopped, No Violation		Stopped, With Violation				
System Presence	Premature Stop	Normal Stop	Violation Zone	Intrusion Zone	Collision Zone	Did Not Stop	Totals
No System	6	65	4	4	0	29	108
With System	2	74	18	3	0	11	108
Totals	8	139	22	7	0	40	216

The alignment of levels of violation and stopping zone is shown in Table 8. No participants stopped in the collision zone of the stopping zone variable at any intersections. While coming to a stop in the violation or intrusion zone is technically a violation, it is also a stop before there is the potential of a collision with cross traffic at the intersection. This allowed the outcome at each intersection to be condensed into stopped and did not stop.

Table 8 Violation and stopping zone variable levels

<table>
<tr><th>Variable</th><th colspan="6">Variable Levels</th></tr>
<tr><td>Violation</td><td colspan="2">Stopped No Violation</td><td colspan="3">Stopped With Violation</td><td>Did Not Stop</td></tr>
<tr><td>Stopping Zone</td><td>Premature Stop</td><td>Stopped No Violation</td><td>Violation</td><td>Intrusion</td><td>Collision</td><td>Did Not Stop</td></tr>
<tr><td>Outcome</td><td colspan="4">Stopped</td><td></td><td>Did Not Stop</td></tr>
</table>

4.2.1 Effect of system presence

A statistically significant effect of the presence of the warning system χ^2 (1, N=216) = 9.94, p=0.0016) is evident in Table 9 and Figure 11 where there were 29 (27%) instances of not stopping at an intersection when the system was not present compared to only 11 (10%) when it was.

Table 9 Frequency table of system presence by outcome, stopped – did not stop

	Outcome		
System Presence	Stopped	Did Not Stop	Totals
No System	79	29	108
With System	97	11	108
Totals	176	40	216

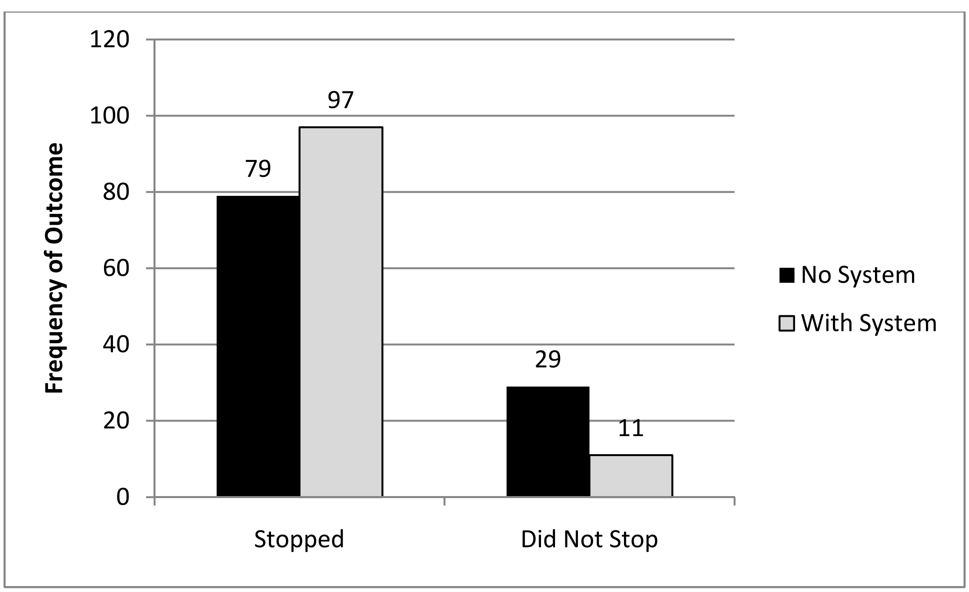

Figure 11 Frequency of outcome by system presence

4.2.1.1 Outcomes by individual event

As noted from the literature review, stop signs pose a greater problem for older drivers than traffic lights. Both traffic lights and stop signs are included in the six stop-expected system-detected events, so considering individual events during the study drive may prove interesting. The frequencies for individual events did not have cell counts high enough for a chi-square analysis, but the outcomes for the individual events reveal an expected pattern for older drivers: did-not-stop outcomes occurred primarily, but not exclusively, at stop signs. The pattern of more did-not-stop outcomes without the system than with the system is shown in Figure 12. Two events were designed to promote violations: Arterial 1 – Tree-obstructed Stop Sign and F2 – Moving-truck-obstructed Stop Light. These events were successful at promoting violations as seen from the "no system" condition. The absence of did-not-stop outcomes at the moving-truck-obstructed light illustrates the benefit of the system in situations involving traffic signals in addition to stop signs. There were no did-not-stop outcomes at two intersections, A2 - Red Light and D2 - Unobstructed Stop Sign, which are not included in Figure 12.

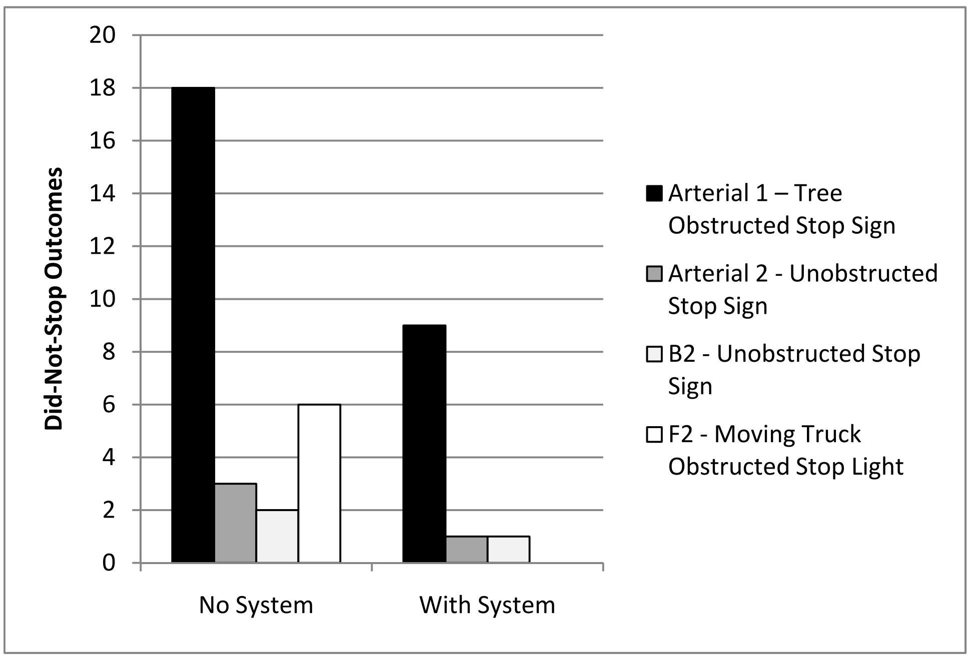

Figure 12 Did-not-stop outcomes for individual events

4.2.2 Effect of age group

Frequency of the variable outcome by age group is shown in Figure 13. The effect of age group on outcome did not reach statistical significance. However, a trend can be seen in Figure 13 with 18 instances of not stopping for an intersection in the older at-risk group and fewer instances for the older normal (12) and middle normal (10) groups.

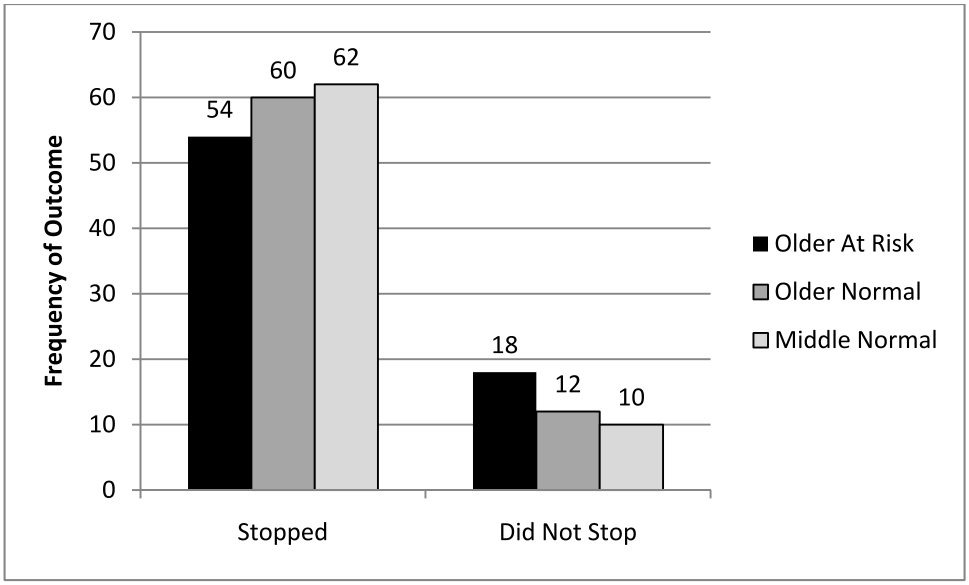

Figure 13 Frequency of outcome by age-risk group

When the outcome for each age group was further broken down by system presence, the pattern for each of the age groups was quite similar. For the older at-risk group, there was a statistically significant effect of system presence χ^2 (1, N = 72) = 4.74, p<0.0295), shown in Figure 14 and Table 10. While the effect of system presence was not significant for the older normal and middle normal groups, the pattern of outcome was the same: fewer did-not-stop outcomes with the system than without.

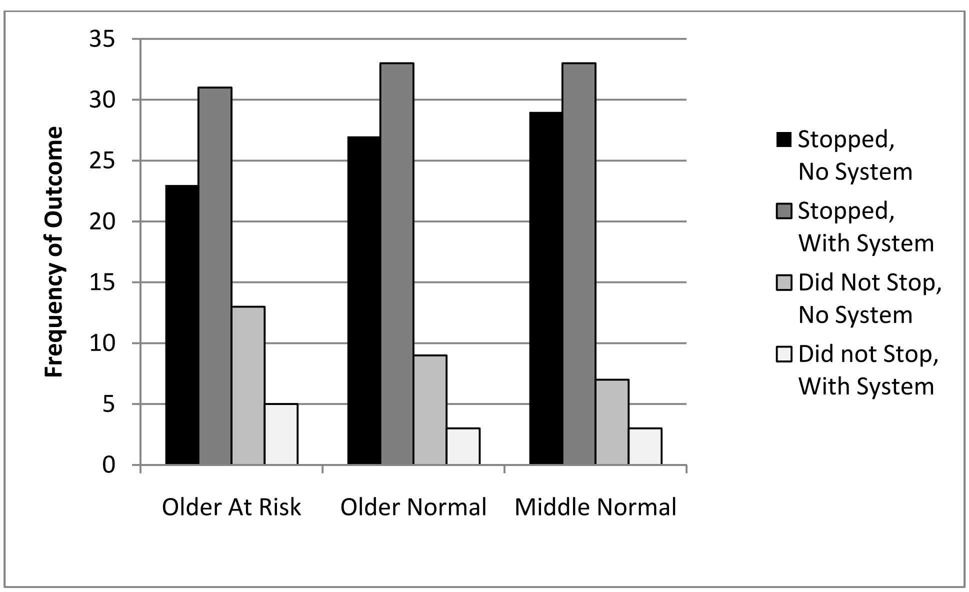

Figure 14 Frequency of outcome within each age group

Table 10 Frequency of outcome by system presence for older at-risk group

	Outcome		
	Older At-risk		
System Presence	Stopped	Did Not Stop	Totals
No System	23	13	36
With System	31	5	36
Totals	54	18	72

The significant effect for older at-risk drivers associated with the presence of the system presented the question of whether the older at-risk participants may have benefited more from the system than other age-risk groups. Understanding whether there was a difference in the benefit across the age groups required a different approach to the data analysis. A continuous variable was created by calculating the proportion of did-not-stop violations for each participant. There was a statistically significant effect for both age-risk group ($F(2,30)=3.33$, $p=0.0493$) and system presence of the system ($F(1,30) = 20.77$, $p< 0.0001$); however, the interaction between age-risk group and system presence did not reach statistical significance ($F(2,30)=0.77$, $p<0.4723$). These results are illustrated in Figure 15. The benefit to the presence of the system was again clear with the proportion of did-not-stop outcomes decreasing across all age groups. However, the absence of a significant interaction between age-risk group and system presence left the question of a greater benefit to older at-risk drivers unanswered. It is possible this interaction would have reached statistical significance with a larger sample size.

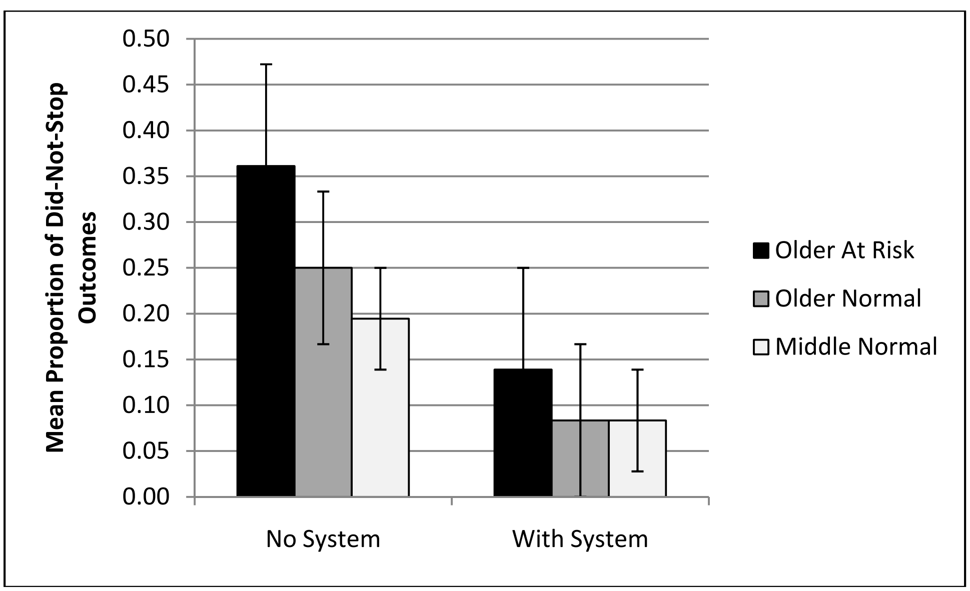

Figure 15 Proportion of did-not-stop outcome by age-risk group

4.2.3 Range of driver response

The range of driver response was investigated by an analysis of stopping position, a continuous variable. The data set for this analysis included only instances where the participant stopped at the six system-detected intersections; did-not-stop outcomes were excluded. For this variable, a positive value indicated a stop before the stop bar as the participant approached the intersection and a negative value indicated a stop past the stop bar (a stop with violation). A mixed linear model was employed to evaluate differences in stopping position between the age-risk groups and the system presence groups. Neither age-risk group nor system presence reached statistical significance. Interestingly, the mean distance before the stop bar was slightly higher for the participants who did not have the system than for those who did across all age groups.

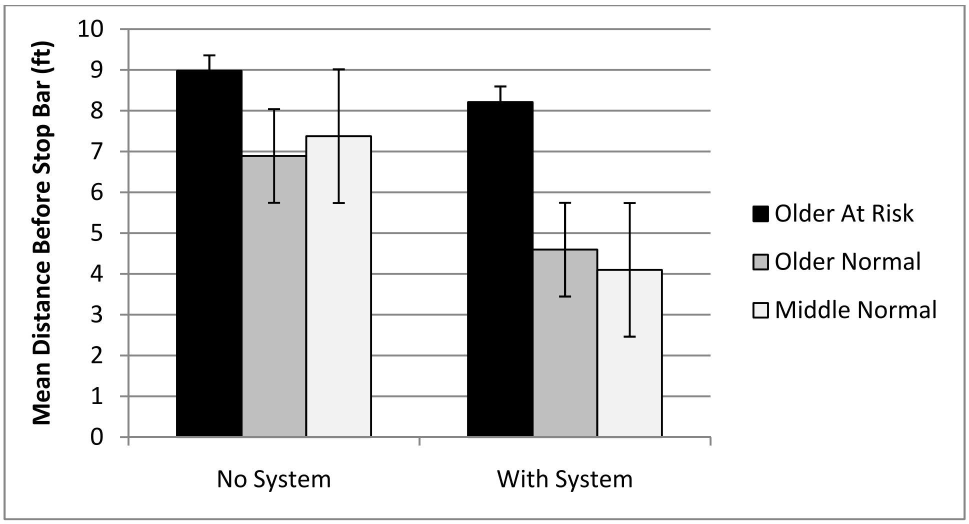

Figure 16 Stop position by age-risk group and system presence

This may seem counter-intuitive until the effect of receiving a warning from the system is considered: drivers who would not have stopped at the intersection received an alert and therefore attempted to stop. The more aggressive braking would have produced shorter stopping distances before the stop bar (lower positive values) and stopping distances past the stop bar (negative values), which would create lower mean distance from the stop bar with the system.

Two additional variables were analyzed to look at stopping behavior in greater detail: maximum brake reaction time to event and maximum brake value. No significant effect was found for maximum brake value. There was a significant effect on maximum brake reaction time for age-risk group ($F(2,167)=5.3$, $p=0.0059$), as shown in Figure 17, and a nearly significant effect for system presence. The interaction did not reach significance. The higher reaction times with the system than without the system indicate that participants began braking earlier when the system was present. When combined with the generally lower maximum brake values, the results support the benefit associated the presence of the system discussed above.

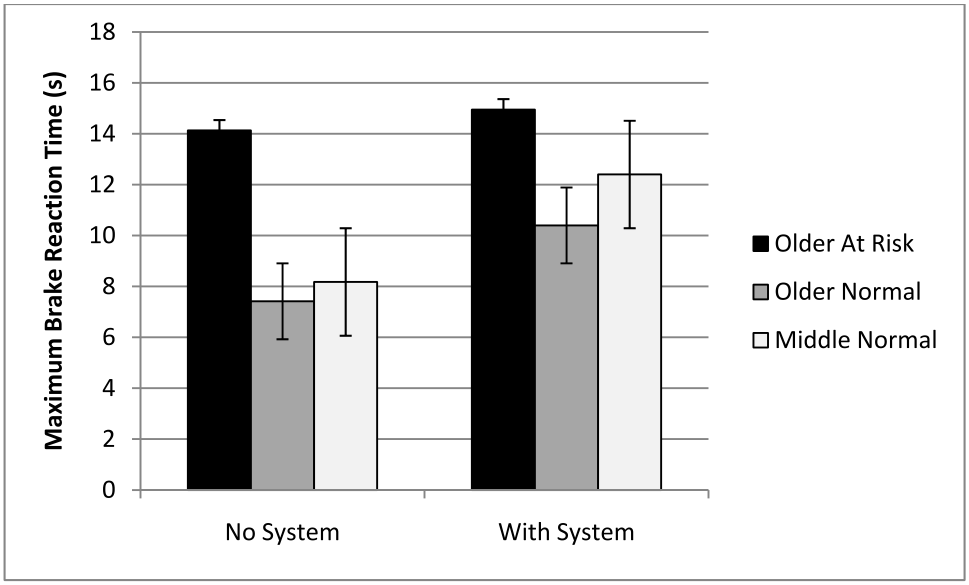

Figure 17 Maximum brake reaction time by age-risk group

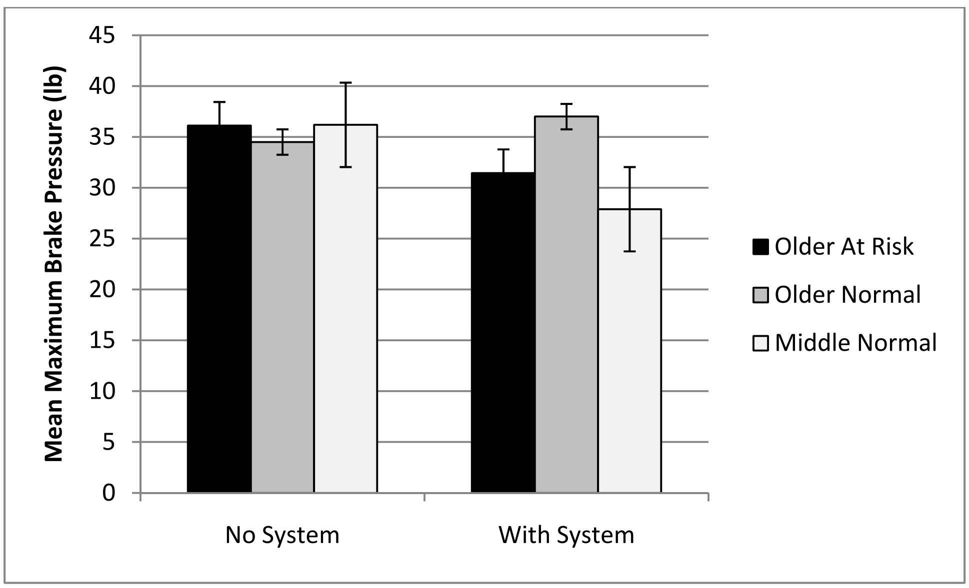

Figure 18 Maximum brake pressure by age-risk group

4.3 Survey and Questionnaire Data

This section provides an overview of some of the questionnaire data concerning participant's views of the warning system. Participants were asked about their perceptions of the warning system in the Post-Drive Questionnaire (Appendices 18 and 19). There were two versions of this questionnaire, one for participants who experienced the warning system and one for those who did not. A summary table of responses for all items on both versions of the questionnaire as well as an explanation of the rating scales used for each item can be found in Appendix 21. The mean ratings will be presented in parentheses in the discussion below.

4.3.1 Participants who experienced the warning system

4.3.1.1 Perceived benefit and desirability

While participants were confident in their ability to drive safely without the warning system (1.56[1]), they agreed that the system made driving safer for themselves and others (1.94[1]) and would help them drive more carefully (2.28[1]), but were fairly neutral about whether it would help them avoid a potential crash (2.94[1]). Participants also found the system to be useful (-0.94[2]) and satisfying, (–0.40[2]). Participants felt they were familiar with the operation of the system (2.39[1]) and trusted the system (2.22[1]). They also felt the system was reliable (2.11[1]) and knew when it was active (1.78[1]).

Participants indicated they would be willing to pay for this system if its cost was $300 (3.28[3]), and when asked how much they would pay for the system the mean response was $470, with a range of $0 to $2000. The system was the seventh most frequently chosen option in a list of fourteen vehicle options with other safety systems, such as side impact airbags, ESC, and tire pressure monitoring gauge, chosen more frequently and entertainment systems chosen less frequently. Participants did not view the system as annoying (3.33[1]) or intrusive (3.67[1]).

4.3.1.2 Functionality of the system

Participants disagreed that the timing of the alert was too late (3.28[1]). In open-ended questions, participants found the timing of the alert to be good, with 12 (67%) responding it was good or about right. While four responded that the alert came too late, only one thought it came too early. Seven participants considered the blue light icon that indicated the system was active and detected an intersection part of the alert and indicated it as the first part of the alert they noticed. Of the three alert components--red light icon, audio warning, and brake pulse--the audio warning was noticed first by most participants (6), the red light by a few (3), and the brake pulse by none.

4.3.2 Participants who did not experience the warning system

Participants who did not experience the system were slightly less confident in their ability to drive safely without the system (2.00[1]) than those who experienced the system. They also tended to disagree that the system would make driving safer for themselves and others (3.67[1]) and that it would help them drive more carefully than they normally would (3.11[1]); those who experienced the system agreed with those statements. Not

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[1] Likert-type five point scale: 1=strongly agree, 2= mildly agree, 3=agree and disagree equally, 4= mildly disagree, 5=strongly disagree

[2] numerical scale from -2 to +2 anchored by pairs of adjectives with the positive adjective, such as useful, anchoring the -2 end of the scale and the negative adjective, such as useless, anchoring the +2 end of the scale

[3] Likert-type scale: 1=definitely would not consider, 2, 3=might or might not consider, 4, 5=definitely would consider

surprisingly, participants who did not experience the warning system also felt they were less familiar with how it operates (2.83[1]) than those who did experience the system.

4.4 Discussion

There was a significant overall benefit associated with the presence of the warning system. There were nearly three times more did-not-stop outcomes without the system (27%) than when the system was present (10%). This was particularly true in situations where the presence of a stop sign or the state of a traffic light would be more difficult for drivers to detect. Additionally, it is possible that the drivers most at risk of crashes may benefit most from the presence of the system as implied by the greatest change in did-not-stop outcomes in the older at-risk group even though the trend did not reach statistical significance. The benefit associated with the system was also seen in the stopping position data. Participants who experienced the system warning stopped instead of driving through the intersection, resulting in more stops past the stop bar, but before the collision zone.

There was also a general perception among those who experienced the system that it improved driving safety and that the system helped drivers drive more safely. The disagreement with these statements by those who did not experience the system may indicate that experiencing the system reveals its benefit to users. The positive perception of the system coupled with the benefit seen in did-not-stop outcomes indicates that an intersection violation warning system would be welcomed and used by drivers.

The results of this study will be used to develop better crash warning interfaces for the broad range of drivers, including those who are older, who will be using the technology. One program with that focus is the Human Factors for IntelliDrive (HFID) program. HFID is focused on developing effective interfaces for the various IntelliDrive applications that do not increase driver distraction. The HFID program will be able to leverage the results of the current study in assessing driver needs.

Design recommendations based on this work are limited; however, the safety benefit seen here shows that a CICAS-V type warning system worked well for both older and younger drivers. However, it should be noted that the system implemented here differed from the CICAS-V recommendations in some ways. Specifically, brake pedal depression resulting from the activation of the vehicle braking system was absent, and the minimum speed for alert was lowered to 5 mph from 15 mph.

It should also be noted that this experimental design and protocol included simple situations at intersections and did not examine potential unintended consequences of the presence of the system. The data from this study are from a first-time single use of the system. How drivers would respond to the system over time is unknown, and over reliance is a possibility. It is also not clear from this work how drivers would respond to the warning system in more complex situations such as intersections with cross traffic present, the presence of tailgating vehicles, and the presence of pedestrians crossing the road at intersections. Additionally, only one system specification was used, and systems using different alert timings and combinations may not show the same benefits. This study showed a system benefit; however there are a number of untested conditions (traffic situations, systems differences, levels of system experience) that could produce differing levels of safety impact.

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APPENDIX 1: HEALTH AND MOBILITY CLASSIFICATION QUESTIONNAIRE

	Score	
Has a doctor ever told you that you should no longer drive?		yes = 10; no =0
Has a doctor ever told you that you have cataracts?		yes = 5; no = 0
Has a doctor ever told you that you have Macular degeneration?		yes = 5; no = 0
Has a doctor confirmed for you that you have experienced symptoms of Post Traumatic Stress Disorder (PTSD) in the last six months?		yes = 7, no = 0
Do you avoid driving in some situations? Some examples: - at night - in certain weather conditions -on certain types of roads - certain types of intersections -alone Other situations, please describe…		3 points for each situation
Do you have trouble looking over your shoulder?		yes = 5; no = 0
Do you have trouble walking for one block or climbing one flight of stairs?		yes = 5; no = 0
Have you fallen to the floor or ground in the past year?		yes = 5; no = 0
Total Score		

Scores of 9 or less are considered "normal"

Scores of 10 or more are considered "at risk"

If the participant is:

- "**Normal**" (score 9 or LESS)
  - **Any Age** then
    - Administer **TICS Questionnaire**

- "**At Risk**" (score 10 or GREATER)
  - **Age 25-55** then
    - Proceed to Closing for DOES NOT MEET CRITERIA on **Driving and General Health Screening**
    - Do not schedule study appointment
  - **Age > 65** then
    - Proceed to Closing for MEETS ALL CRITERIA on **Driving and General Health Screening**
    - Schedule appointment for study participation and assign participant number in the > 65 AT RISK group

ADMINISTER **TICS Questionnaire** if potential participant considered “normal”

APPENDIX 2: TELEPHONE INTERVIEW FOR COGNITIVE STATUS (TICS)

For this I need your distractions to be minimal. So please turn off your television and radio. Please make sure that newspapers, calendars, and pens and pencils are out of reach.

Question	Score	Max Score
1. Please tell me your full name? (1 point each first, last)		2
2. What is today's date? (year) (season) (date) (day) and (month)?		5
3. Where are you right now? (house number) (street) (city) (state) and (zip)		5
4. Count backwards from 20 to 1. 2 pts if completely correct on the first trial,; 1 point if completely correctly on second try.; 0 points for anything else		2
5. I'm going to read you a list of ten words. Please listen carefully and try to remember them. When I am done, tell me as many words as you can, in any order. Ready? The words are: (cabin) (pipe) (elephant) (chest) (silk) (theatre), (watch), (whip), (pillow), (giant). Now tell me all the words that you can remember.		10
6. One hundred minus 7 equals what? And 7 from that? And 7 from that? And 7 from that? And 7 from that? Stop at 5 serial subtractions. (1 point for each correct subtraction. Do not inform the subject of incorrect responses, but allow subtractions to be made from last response (e.g. "93-85-78-71-65" would get 3 points))		5
7. What do people usually use to cut paper? (scissors) or shears)		1
8. How many things are in a dozen? (12)		1
9. What do you call the prickly green plant that lives in the desert? (cactus)		1
10. What animal does wool come from? (sheep or lamb)		1
11. Say this: "No ifs, ands or buts."		1
12. Say this:: "Methodist Episcopal		1
13. Who is the President of the United States right now (first and last name)		1
14. Who is the Vice-President of the United States (first and last name)		1
15. With your finger tap 5 times on the part of the phone that you talk into. 2 points for 5 taps, 1 point for more or less than 5 taps.		2
16. I'm going to give you a word and I want you to give me the opposite. For example, the opposite of "hot" is "cold." What is the opposite of "west" (East)		1
17. What is the opposite of "generous?"		1

(selfish, greedy, stingy, tight, cheap, mean, meager, skimpy, other good antonym)		
TOTAL		41

Scores of 31 or greater are considered "normal"

Scores of 30 or less are considered "at risk"

If the participant is:

- "**Normal**" (score 31 or GREATER)
  - **Age 25-55** then
    - Proceed to Closing for MEETS ALL CRITERIA on **Driving and General Health Screening**
    - Schedule appointment for participation and assign participant number in the 25-55 NORMAL group
  - **Age > 65** then
    - Proceed to Closing for MEETS ALL CRITERIA on **Driving and General Health Screening**
    - Schedule appointment for study participation and assign participant number in the 65 and Older NORMAL group

- "**At Risk**" (score 30 or LESS)
  - **Age 25-55** then
    - Proceed to Closing for DOES NOT MEET CRITERIA on **Driving and General Health Screening**
    - Do not schedule study appointment
  - **Age** > **65** then
    - Proceed to Closing for MEETS ALL CRITERIA on **Driving and General Health Screening**
    - Schedule appointment for study participation and assign participant number in the 65 and Older AT RISK group

APPENDIX 3: DRIVING AND GENERAL HEALTH SCREENING PROCEDURE

NADS Phone Screening Procedures

For a participant to be eligible for a study they must meet **ALL** of the following criteria:

- Be able to participate when the study is scheduled
- Meet all inclusion criteria
- Pass the health screening

Overview

The purpose of this research study is to understand the helpfulness of a safety warning system for older drivers.

Study Information, Time Commitment and Compensation

Being a part of this study involves one study visit that will last about 2 hours. You would have to come to the Oakdale Campus to participate.

You would also have to sign a consent form, fill out surveys before and after your study drive, eye exams, and training of the safety warning system you will be using while driving in the simulator.

If you agree to participate in this study, you will be paid up to $30 for your time and effort. A portion of your payment depends on your ability to change the track on the CD player in the car during your study drive. Specifically, $10 of your pay will be based on whether you change the CD track the correct number of tracks in a timely manner. This task is not difficult and it is expected that you will receive the entire $30.

Willing to participate?

Are you still interested in being in this study?

- If YES, continue with Inclusion Criteria
- IF NO, ask if he/she would like us to keep him/her in our recruitment database for consideration of future participation.
    - IF NOT interested in future studies and wish to be removed from database
        - Make note regarding deletion
        - Reason if given

Inclusion Criteria ~ General Driving Questions

Overview

Before this list of questions is administered, please communicate the following:
I will need to ask you several questions to determine whether you are eligible to be in this study.

- If a participant fails to meet one of the following criteria,
    - STOP as soon as exclusion criterion is evident and proceed to Closing (Do not complete the Health Screening)

1) Do you have a valid U.S. Driver's License? ➢ If YES - Are there any restrictions on your driver's license? Vision - Acceptable if vision is corrected to 20/20 with lenses Hearing Loss – Acceptable if corrected to within normal range with hearing device
Inclusion criteria: • Valid U.S. driver's license • Doesn't use Mechanical aid • Doesn't have Prosthetic aid

2) What is your age?
Inclusion criteria: • 25 - 55 years old • 65 years or older

3) How often do you drive?
Inclusion criteria: • Drives at least once per week

4) Do you use any special equipment to help you drive such as a pedal extension, hand brake or throttle, spinner wheel knob, seat cushion or booster seat?
Inclusion criteria: • Doesn't uses pedals extensions, hand brake or throttle, spinner wheel knobs, or other non-standard equipment that would limit interpretation of accelerator pedal, brake pedal, or steering inputs. • Doesn't use seat cushion or booster seat AND is custom fit to their car, if not custom fitted request they bring seat with them for driving

5) Do you currently have any mobility problems that we should be concerned about which would require extra staff to assist you? (Cane, walker, or crutches)
Inclusion criteria:

• To be determined by PI and participant circumstances at present time

6) Have you ever participated in a driving simulator study before?
Inclusion criteria: • Has not participated in any driving simulator study during the last year.

7) Have you participated in a research study about in-vehicle safety systems in the past year?
Inclusion criteria: • Has not participation in a research study about in-vehicle safety systems in the past year

- If all Inclusion Criteria are met,
- Proceed to General Health Exclusion Criteria

General Health Exclusion Criteria

Overview

Before administering this list of questions, please communicate the following:

- Because of pre-existing health conditions, some people are not eligible for participation in this study.
- I need to ask you several health-related questions before you can be scheduled for a study session.
- Your responses are voluntary and all answers are confidential.
- You can refuse to answer any questions and only a record of your motion sickness susceptibility will be kept as part of this study.
- No other responses will be kept.

- If a participant fails to meet one of the following criteria, proceed to the Closing (If unsure about exclusion criteria, consult Principal Investigator)

1) If the subject is female and under 65 years old:

- **Are you, or is there any possibility that you are pregnant?**

Exclusion criteria:

- If there is ANY possibility of pregnancy

2) Have you been diagnosed with Cancer, Crohn's Disease or Hodgkin's Disease?

- If YES, is the condition still active?
- Are there any lingering effects?
  - If YES, do you care to describe?

Exclusion criteria:

- Cancer (receiving any radiation and/or chemotherapy treatment currently or within last 6 months)
- Crohn's disease active in the last year
- Hodgkin's disease

3) Do you have Diabetes?

- If yes, do you take insulin or any other medication for blood sugar?

NOTE: Type II Diabetes accepted if controlled (medicated and under the supervision of physician)

Exclusion criteria:

- Type I Diabetes - insulin dependent
- Type II – **Uncontrolled** (see above)

4) Do you suffer from a heart condition such as disturbance of the heart rhythm or have you had a heart attack or a pacemaker implanted within the last 6 months?

- If YES, please describe?

Exclusion criteria:

- History of ventricular flutter or fibrillation
- Systole requiring cardio version (atrial fibrillation may be acceptable if heart rhythm is stable following medical treatment or pacemaker implants)

5) Have you ever suffered brain damage from a stroke, tumor, head injury, or infection? If YES, what was the reason?

Exclusion criteria:

- A stroke within the past 6 months
- An active tumor
- Any visual loss, blurring or double vision

6) Have you ever been diagnosed with seizures or epilepsy?

- If YES, how frequently and what type?

Exclusion criteria:

- A seizure within the past 12 months

7) Do you have Ménière's Disease or any inner ear, dizziness, vertigo, or hearing?

- Wear hearing aides - full correction with hearing aides acceptable
- If YES, please describe.
- **Ménière's Disease** is a problem in the inner ear that affects hearing and balance. Symptoms can be low- pitched roaring in the ear (tinnitus), hearing loss, which may be permanent or temporary, and vertigo.
- **Vertigo** is a feeling that you or your surroundings are moving when there is no actual movement, described as a feeling of spinning or whirling and can be sensations of falling or tilting. It may be difficult to walk or stand and you may lose your balance and fall.

Exclusion criteria:

- Any recent history of inner ear, dizziness or vertigo

8) Do you currently have a sleep disorder such as sleep apnea, narcolepsy or Chronic Fatigue Syndrome?

- If YES, please describe.
- Sleep apnea: how long under treatment and was treatment successful

Exclusion criteria:

- Untreated sleep apnea
- Narcolepsy
- Chronic Fatigue Syndrome

9) Do you have any respiratory disorder?

- ➢ If YES, please describe.
- ➢ Accept if condition is controlled

Exclusion criteria:

- Oxygen therapy

10) Do you have migraine or tension headaches?

- ➢ If YES, what is the nature of this pain? (How severe? Where pain is located?)
- ➢ How frequent and when was the last headache?
- ➢ Are you currently taking medication for these headaches?
- ➢ (Women only) Are your headaches associated with your menstrual cycle?

Exclusion criteria:

- Medication taken daily for chronic headaches
- Any narcotic medications
- Headaches that occur more than 2 times a month
- Headache within the past 48 hours

11) Do you currently have untreated anxiety disorder or claustrophia?

- ➢ If YES, please describe.

Exclusion criteria:

- Agoraphobia, hyperventilation, or anxiety attacks

12) Are you currently taking any prescription or over the counter medications?

- ➢ If YES, what is the medication?
- ➢ **Are there any warning labels on your medications, such as potential for drowsiness?**

Exclusion criteria:

- Sedating medications or drowsiness label on medication UNLESS potential participant indicates they have been on the medication consistency for the last 6 months AND states they have NO drowsiness effects from this medication

13) Do you experience any kind of motion sickness? ➢ If YES, what were the conditions you experienced: when occurred (age), what mode of transportation, (boat, plane, train, car), and what was the intensity of your motion sickness? ➢ On a scale of 0 to 10**, how often** do you experience motion sickness with **0 = Never and 10 = Always** ➢ On a scale of 0 to 10, **how severe** are the symptoms when you experience motion sickness with **0 = Minimal and 10 = Incapacitated**
Exclusion criteria: • One single mode of transportation where intensity is high and present • More than 2 to 3 episodes for mode of transportation where intensity is moderate or above • Severity and susceptibility scores rank high

Because we need to know whether you have any risk factors for some types of driving accidents I will be asking you a few more questions.

Your answers will determine if you continue to meet the study criteria.

ADMINISTER **Health and Mobility Classification Questionnaire**

ADMINISTER **Telephone Interview for Cognitive Status (TICS)**

Closing

MEETS ALL CRITERIA

Instructions for Subjects:

- Determine how subject wants to receive directions to appointment at the National Advanced Driving Simulator (mail or email) and obtain contact information.
- Confirm mailing address to send **NADS Demographic and Driving Survey**
  - Survey will be sent for participant to complete and bring to study appointment

Instructions for Subjects for Driving Visits:

- Refrain from drinking alcohol and taking any new prescription or over the counter drugs for the 24 hours preceding your driving session. Ibuprofen, Tylenol, aspirin, and vitamins are acceptable to take prior to driving session.

- Bring Driver's License with you to appointment.

- We ask that cell phones and pagers be turned off or left home as they are not allowed while participating in the driving study.

- Request following of all subjects:
  - Wear flat shoes to drive in
  - No hats worn or gum chewing allowed while driving
  - Refrain from wearing artificial scents (perfume or cologne) as some staff allergic to scents

- You will be required to wear a seat belt while driving.

- If appointment is before 8:00 am or after 5:00 pm explain how to use Call Box on front entrance of building.

- Give directions, explain where to park and ask them to check in at the front desk inside the main entrance.

DOES NOT MEET CRITERIA:

- Explain that this study requires meeting all of the above conditions (If necessary, explain condition not met)

- Thank the person for their time and remind them that they may qualify for a future study and ask if they wish their name to be placed in our database to be called for future studies.

APPENDIX 4: NADS DEMOGRAPHIC AND DRIVING SURVEY

Study: ___ODSS___
Date:__________
Participant: ODSS2009_P1001AS

NADS Demographic and Driving Survey

The following questions ask about you and your health, your personal vehicle, and your driving patterns. Please read each question carefully. If something is unclear, leave the question blank and ask the research assistant for help at your study appointment. You do not have to answer any questions you do not wish to.

Background Information

1) What is your birth date? ________ / ________ / ________
Month Day Year

2) What is your gender?

- Male
- Female

3) What is your marital status? (Check only one)

- Single
- Married
- Domestic Partnership
- Separated or Divorced
- Widowed

4) What is your present employment status? (Check only one)

- Unemployed
- Retired
- Work part-time
- Work full-time
- None of the above

5) What type of work do you do (e.g., teacher, law enforcement official, homemaker)?

____

Continue to next page

6) Of which ethnic origin(s) do you consider yourself? (Check all that apply)

- ☐ American Indian/Alaska Native
- ☐ Asian
- ☐ Black/African American
- ☐ Hispanic/Latino
- ☐ Native Hawaiian/Other Pacific Islander
- ☐ White/Caucasian
- ☐ Other

7) What is the highest level of education that you have completed? (Check only one)

- ☐ Primary School
- ☐ High School Diploma or equivalent
- ☐ Technical School or equivalent
- ☐ Some College or University
- ☐ Associate's Degree
- ☐ Bachelor's Degree
- ☐ Some Graduate or Professional School
- ☐ Graduate or Professional Degree

Continue to next page

Driving Experience

8) How old were you when you started to drive? _________ years of age

9) How old were you when you got your FIRST driver's license? ________ years of age

10) Approximately how many miles do you drive per year in each vehicle type? (Check only one)

- ❒ Under 2,000
- ❒ 2,000 - 7,999
- ❒ 8,000 - 12,999
- ❒ 13,000 - 19,999
- ❒ 20,000 or more

11) How often do you drive? (Check the most appropriate category)

- ❒ Less than once weekly
- ❒ At least once weekly
- ❒ At least once daily

12) How frequently do you drive in the following environments? (Check only one for each environment)

	Never	Yearly	Monthly	Weekly	Daily
Residential	❒	❒	❒	❒	❒
Business District	❒	❒	❒	❒	❒
Rural Highway (e.g., Route 6)	❒	❒	❒	❒	❒
Interstate (e.g., Interstate 80)	❒	❒	❒	❒	❒
Gravel Roads	❒	❒	❒	❒	❒

13) Do you avoid driving in any of the following situations?

- ❒ at night
- ❒ in certain weather conditions
- ❒ on certain types of roads
- ❒ certain types of intersections

14) What speed do you typically drive on the highway when the speed limit is 55 miles per hour? __________mph

15) What speed do you typically drive on the highway when the speed limit is 65 miles per hour? __________mph

16) Have you ever participated in any special driving schools (e.g., Driver's education, AARP or insurance courses, racing school, or as part of law enforcement training)?

- ❒ No
- ❒ Yes (Please describe) ____

Continue to next page

Personal Vehicle

17) What type of automobile do you drive most often?

Year	Make (e.g., Ford, Toyota)	Model (e.g., Escort, Celica)
__ __ __ __	____________________	____________________

a. Which of the following features does this automobile have? (Check all that apply)

____ None of these
____ Air Bag
____ Anti-Lock Brakes
____ Automatic Transmission
____ CB Radio
____ CD/Cassette Player
____ Cruise Control
____ Power Brakes
____ Power Steering
____ Radar Detector
____ Sun/Moon Roof
____ Other technologies (e.g., trip computer, vehicle information center)

Please list other technologies: ______________________________

b. After having driven the vehicle, please rank your features from most to least important to you today. Leave blank features that your vehicle does not have. (1 = **most** important)

____ None of these
____ Air Bag
____ Anti-Lock Brakes
____ Automatic Transmission
____ CB Radio
____ CD/Cassette Player
____ Cruise Control
____ Power Brakes
____ Power Steering
____ Radar Detector
____ Sun/Moon Roof
____ Other technologies (e.g., trip computer, vehicle information center)

Please list other technologies: ______________________________

Continue to next page

Violations

18) Within the past five years, how many moving violations have you received?

- □ 0
- □ 1 – 2
- □ 3 – 4
- □ 5 or more
- □ Not sure

19) Within the past five years, have you received a ticket for any of the following? (Please check a response for each ticket)

	0	1	2	3+
Speeding	❒	❒	❒	❒
Going too slowly	❒	❒	❒	❒
Failure to yield right of way	❒	❒	❒	❒
Disobeying traffic lights	❒	❒	❒	❒
Disobeying traffic signs	❒	❒	❒	❒
Improper passing	❒	❒	❒	❒
Improper turning	❒	❒	❒	❒
Reckless driving	❒	❒	❒	❒
Following another car too closely	❒	❒	❒	❒
Driving while intoxicated	❒	❒	❒	❒
Other (please specify **type** and **frequency** of violation) ______				

Continue to next page

Accidents

20) In the past five years, how many times have you been the driver of a car involved in an accident?

- ☐ 0 (Go to question # 21)
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4 or more

Please provide the following information for each accident.

Accident 1

	No	Yes
Was another vehicle involved?	☐	☐
Was a pedestrian involved?	☐	☐
Were you largely responsible for this accident?	☐	☐
Did you go to driver's rehabilitation?	☐	☐

Weather Condition: ______________________
Month/Year: ______________________
Brief Description: ______________________

Accident 2

	No	Yes
Was another vehicle involved?	☐	☐
Was a pedestrian involved?	☐	☐
Were you largely responsible for this accident?	☐	☐
Did you go to driver's rehabilitation?	☐	☐

Weather Condition: ______________________
Month/Year: ______________________
Brief Description: ______________________

Accident 3

	No	Yes
Was another vehicle involved?	☐	☐
Was a pedestrian involved?	☐	☐
Were you largely responsible for this accident?	☐	☐
Did you go to driver's rehabilitation?	☐	☐

Weather Condition: ______________________
Month/Year: ______________________
Brief Description: ______________________

Brief Description: ______________________

Continue to next page

Health Status

21) What type of prescription glasses or contact lenses are you wearing as you drive in today's study? (Check only one)

- ❒ None (Go to question # 22)
- ❒ Single Lens Glasses
- ❒ Bifocals
- ❒ Trifocals
- ❒ Contact Lenses

b) How many years ago did you obtain your current pair of glasses/contact lenses? (Check only one)

- ❒ 0 - 3
- ❒ More than 3

c) What type of visual problem do you have? (Check only one)

- ❒ Distance - can only see items that are near without glasses
- ❒ Near - can only see items that are far away without glasses
- ❒ Distance and Near - cannot see items that are near or far without glasses
- ❒ Other

22) Do you currently have symptoms of Post Traumatic Stress Disorder (PTSD)?

- ❒ No
- ❒ Yes

23) Do you currently use a hearing aid? (Check only one)

- ❒ No
- ❒ Yes

24) Has a doctor ever told you that you have cataracts?

- ❒ No
- ❒ Yes

25) Has a doctor ever told you that you have Macular degeneration?

- ❒ No
- ❒ Yes

26) Has a doctor ever told you that you should no longer drive?

- ❒ No
- ❒ Yes

27) Have you fallen to the floor or ground in the past year?

- ❒ No
- ❒ Yes

Continue to next page

28) Have you ever suffered brain damage from any of the following: (Check all that apply)

- ❒ Stroke
- ❒ Tumor
- ❒ Head injury
- ❒ Infection

b. Do you still experience any of the of the following symptoms: (Check all that apply)

- ❒ Weakness, numbness, or funny feelings in the arms, legs or face
- ❒ Any trouble swallowing or slurred speech
- ❒ Any uncoordination or loss of control
- ❒ Any trouble walking, thinking, remembering, talking, or understanding?

29) How often do you experience motion sickness? (Circle only one)

0	1	2	3	4	5	6	7	8	9	10

Never Always

30) How severe are your symptoms when you experience motion sickness (Circle only one)

0	1	2	3	4	5	6	7	8	9	10

None Severe

Continue to next page

Other Studies

31) Have you participated in other driving studies?

- ☐ No (End of questionnaire)
- ☐ Yes (please provide details for each study you have participated in below)

Study 1
What vehicle was used for this study? (Check only one)

- ☐ Actual car - only
- ☐ Another simulator not at the National Advanced Driving Simulator - only
- ☐ The National Advanced Driving Simulator (motion simulator) - only
- ☐ The National Advanced Driving Simulator (static simulator) - only
- ☐ Both - actual car and another simulator
- ☐ Both - actual car and the National Advanced Driving Simulator (motion)

Brief Description: ______________________________

____

Study 2
What vehicle was used for this study? (Check only one)

- ☐ Actual car - only
- ☐ Another simulator not at the National Advanced Driving Simulator - only
- ☐ The National Advanced Driving Simulator (motion simulator) - only
- ☐ The National Advanced Driving Simulator (static simulator) - only
- ☐ Both - actual car and another simulator
- ☐ Both - actual car and the National Advanced Driving Simulator (motion)

Brief Description: ______________________________

____

Study 3
What vehicle was used for this study? (Check only one)

- ☐ Actual car - only
- ☐ Another simulator not at the National Advanced Driving Simulator - only
- ☐ The National Advanced Driving Simulator (motion simulator) - only
- ☐ The National Advanced Driving Simulator (static simulator) - only
- ☐ Both - actual car and another simulator
- ☐ Both - actual car and the National Advanced Driving Simulator (motion)

Brief Description: ______________________________

____

The End

APPENDIX 5: INFORMED CONSENT DOCUMENT

FOR IRB USE ONLY
APPROVED BY: IRB-02
IRB ID #: 200801753
APPROVAL DATE: 12/31/09
EXPIRATION DATE: 12/31/10

INFORMED CONSENT DOCUMENT

Project Title: Enhancing the Effectiveness of Safety Warning Systems for Older Drivers

Principal Investigator: Dawn Marshall, MS

Research Team Contact: Dawn Marshall, MS, 319-335-4774

This consent form describes the research study to help you decide if you want to participate. This form provides important information about what you will be asked to do during the study, about the risks and benefits of the study, and about your rights as a research subject.

- If you have any questions about or do not understand something in this form, you should ask the research team for more information.
- You should discuss your participation with anyone you choose such as family or friends.
- Do not agree to participate in this study unless the research team has answered your questions and you decide that you want to be part of this study.

WHAT IS THE PURPOSE OF THIS STUDY?

This is a research study. We are inviting you to participate in this research study because you are between the ages of 25-55 or 65 years and older, have a valid U.S. driver's license, and drive at least once a week.

The purpose of this research study is to understand the helpfulness of a safety warning system for older drivers.

HOW MANY PEOPLE WILL PARTICIPATE?

Approximately 120 people will take part in this study at the University of Iowa.

HOW LONG WILL I BE IN THIS STUDY?

If you agree to take part in this study, your involvement will be one study visit that will last approximately 2 hours.

WHAT WILL HAPPEN DURING THIS STUDY?

You will be sent a survey form before your scheduled visit to the National Advanced Driving Simulator, located at the Oakdale Research Park. You will be asked to bring your driver's license and the completed survey to your scheduled appointment. You will be asked to show your driver's license to confirm you have a valid driver's license and fill out a payment form which asks for your social security number. Then staff will review the demographic and driving survey that was mailed to you that asked you questions about your driving history including the type of vehicles you drive, your license history, driving violations and accidents, and driving habits. We will also ask for your birth date, gender, ethnicity, marital status, highest level of education completed, employment information, and participation in other driving studies. This survey also asks you about your health status including

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vision correction, hearing aid use, medication use, and history of motion sickness.

Next you will be asked to complete several tasks and surveys about your cognitive, motor, and visual skills, and use of alcohol and drugs. Some of these tasks and surveys will be given by staff and some you will do yourself. First, staff will give you the Mini Mental State Examination which is a list of questions about everyday topics such as date, day, season, etc.

Next staff will give you several vision tests using a vision tester: a visual acuity test (ability to see small details) and a contrast sensitivity test (vision in low light or in particular lighting conditions). You will be asked to sit in a chair with the vision test machine on the table in front of you, then press your forehead against a bar on the machine and respond to questions about what you can see.

Then staff will ask you to do three physical tasks: a rapid walk test in which you to walk a straight line for a specific distance, turn and walk the distance again as fast as you can comfortably; a neck rotation task where you will sit in a chair and staff will ask you to turn your head without turning your torso; and a foot tap task in which you will be asked to alternately tap your foot in two specific locations on the floor directly in front of you. Next you will complete a questionnaire about how often you drive and your confidence in various driving situations and about your recent alcohol and drug use.

You will then be shown a presentation on the computer that will provide you a brief description of the intersection warning system that maybe present during your drive, an introduction to the simulator cab and an explanation of your study drive. During your drive you will be asked to complete several tasks that involve changing the tracks of a CD player in the car.

Prior to entering the simulator, temporary stickers will be applied to your face so that we may track your eye and head movements while you drive. If you are allergic to latex, please inform study staff and we will use temporary tattoos in place of stickers containing latex. If tattoos are used, a damp cloth will be pressed upon the tattoo that is applied to your face for about 30 seconds after which the damp cloth and tattoo backing will be removed leaving the tattoo. If tattoos are used instead of stickers, you will be asked to remove the tattoos before leaving, using your choice of several available over the counter cleansers. The stickers will be removed at the end of the study drives.

The study staff will then escort you into the simulator. You will be ask to complete the study drive, about 15 minutes in length, and involves in town driving. During the drive you will be asked to respond to an audio prompt about how you are feeling. If you are not feeling well you will be asked to complete a survey about how you feel. You may also say you would like to stop driving at this time and the study drive will end. After the drive, you will be asked to complete a survey about how you feel at the end of the drive.

You will be escorted out of the simulator into a waiting room and asked to fill out two surveys: one about your experience in the simulator and another about the intersection warning system and driving. Upon completion of the surveys, staff will finalize your payment form and you will be free to leave.

You may skip any questions that you do not wish to answer on the surveys.

<u>All driving trials will be recorded on video.</u>

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The simulator contains sensors that measure vehicle operation, vehicle motion, and your driving actions. The system also contains video cameras that capture images of you while driving (e.g., driver's hand position on the steering wheel, forward road scene). These sensors and video cameras are located in such a manner that they will not affect you or obstruct your view while driving. The information collected using these sensors and video cameras are recorded for analysis by research staff and may be used as described in the Confidentiality section below.

SOCIAL SECURITY NUMBER (SSN) USAGE

You will be asked to provide your social security number on **a payment voucher.** The information collected on this form is entered into the University of Iowa accounts payable system and the University of Iowa will send you a check for the amount of your compensation. The payment voucher is destroyed after your information is entered into the University of Iowa accounts payable system. The collection of your social security number is solely for the purpose of payment. Your social security number will not be used for any purpose other than payment.

____ I allow you to collect and use my social security number for the purposes outlined above.

____ I do NOT allow you to collect or use my social security number for the purposes outlined above.
(Initial your choice above)

We will keep your name and information about you including birth date, contact phone numbers and the annual mileage you drive each year on file. In the future, we may contact you to see if you would be willing to complete questionnaires, interviews, or drives relating the data from this study to future studies. Agreeing to participate in this study does not obligate you to participate in future studies. You will be asked to give a separate consent for any future studies.

WHAT ARE THE RISKS OF THIS STUDY?

You may experience one or more of the risks indicated below from being in this study. In addition to these, there may be other unknown risks, or risks that we did not anticipate, associated with being in this study.

The risk involving driving the simulator is possible discomfort associated with simulator disorientation. Some participants in driving simulator studies reported feeling uncomfortable during or after the simulator drive. These feelings were usually mild to moderate and consisted of slight uneasiness, warmth, or eyestrain. These effects typically last for only a short time, usually 10-15 minutes, after leaving the simulator. You may quit driving at any time if you experience any discomfort.

If you ask to quit driving as a result of discomfort, you will be allowed to quit at once. If you ask to quit driving due to discomfort, you will be escorted to a room, asked to sit and rest, and offered a beverage and snack. A trained staff member will determine if and when you will be allowed to leave. If you show few or no signs of discomfort, you will be able to go home or transportation will be arranged if you feel you are unable to drive home. If you experience anything other than slight effects, a follow-up call will be made to you 24 hours later to ensure you're not feeling ill effects.

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In the rare event that normal exiting of the simulator is not available, you will need to exit the simulator through an alternative path. You will be assisted down a small ladder and escorted to a participant waiting room. This could pose a minimal risk if you have difficulty negotiating the ladder or walkway in the simulator bay.

An experimenter will be in the back seat of the simulator cab to ensure your safety while you drive.

Risks associated with latex stickers can be dryness, itching, burning, scaling, and lesions of the skin. Risks associated with temporary tattoos can be mild skin irritation during removal.

The questionnaires collect information about alcohol and drug usage. Some of this information may disclose illegal activities. Data collected from questionnaires will remain confidential and can only be identified by a study assigned number.

WHAT ARE THE BENEFITS OF THIS STUDY?

You will not benefit from being in this study. However, we hope that, in the future, other people might benefit from this study of the intersection warning system which could help prevent drivers from running stop lights and stop signs and result in reducing fatalities and serious injuries on our roadways.

WILL IT COST ME ANYTHING TO BE IN THIS STUDY?

You will not have any costs for being in this research study.

WILL I BE PAID FOR PARTICIPATING?

You will be paid for being in this research study. You will need to provide your social security number (SSN) in order for us to pay you. You may choose to participate without being paid if you do not wish to provide your social security number (SSN) for this purpose. You may also need to provide your address if a check will be mailed to you. If your social security number is obtained it is for payment purposes only, it will not be kept for research purposes.

If you agree to participate in this study, you will be paid up to $30 for your time and effort. A portion of your payment depends on your ability to change the track on the CD player in the car during your study drive. Specifically, $10 of your pay will be based on whether you change the CD track the correct number of tracks in a timely manner. This task is not difficult and it is expected that you will receive the entire $30.

You will be paid with a check sent to the address you provide on the payment voucher.

WHO IS FUNDING THIS STUDY?

The National Highway Traffic Safety Administration (NHTSA) is the study sponsor and funding this research. This means that the University of Iowa is receiving payments from NHTSA to support the activities that are required to conduct the study. No one on the research team will receive a direct payment or increase in salary from NHTSA for conducting this study.

WHAT ABOUT CONFIDENTIALITY?

We will keep your participation in this research study confidential to the extent permitted by law. However, it is possible that other people such as those indicated below may become aware of your participation in this study and may inspect and copy records pertaining to this research. Some of these records could contain information that personally identifies you.

The following groups may have access to the information collected:

- federal government regulatory agencies,
- auditing departments of the University of Iowa, and
- the University of Iowa Institutional Review Board (a committee that reviews and approves research studies)

You will be assigned a study number which will be used instead of your name to identify all data collected for the study. The list linking your study number and name will be stored in a secure location and will be accessible only to the researchers at the University of Iowa. All records and data containing confidential information will be maintained in locked offices or on a secure password protected computer systems that are accessible to the researchers, the study sponsor, and its agents. It is possible that persons viewing the video data may be able to identify you. Study documents will be kept in a locked cabinet within a secure building that can only be entered by research personnel. After completion of analysis, all hard copies except the Informed Consent Documents will be scanned, placed on a CD and placed into the NADS archival room that has limited access by designated archival personnel. The original Informed Consent Documents will be stored in the NADS archival room that has limited access by designated archival personnel.

The **engineering data** collected and recorded in this study (including any performance scores based on these data) will be analyzed along with data gathered from other participants. These data may be publicly released in final reports or other publications or media for scientific (e.g., professional society meetings), regulatory (e.g., to assist in regulating devices), educational (e.g., educational campaigns for members of the general public), outreach (e.g., nationally televised programs highlighting traffic safety issues), legislative (e.g., data provided to the U.S. Congress to assist with law-making activities), or research purposes (e.g., comparison analyses with data from other studies). Engineering data may also be released individually or in summary with that of other participants, but will not be presented publicly in a way that permits personal identification, except when presented in conjunction with video data.

The **video data** (video image data recorded during your drive) recorded in this study includes your video-recorded likeness and all in-vehicle audio including your voice (and may include, in some views, superimposed performance information). Video and in-vehicle sounds will be used to examine your driving performance and other task performance while driving. Video image data (in continuous video or still formats) and associated audio data may be publicly released, either separately or in association with the appropriate engineering data for scientific, regulatory, educational, outreach, legislative, or research purposes (as noted above).

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The **simulator data** is captured and stored on hard drives located within a limited access area of the NADS facility. Access to simulator data is controlled through permissions established on a per-study basis.

If we write a report or article about this study, or share the study data set with others, we typically describe the study results in a summarized manner so that you cannot be identified by name.

IS BEING IN THIS STUDY VOLUNTARY?

Taking part in this research study is completely voluntary. You may choose not to take part at all. If you decide to be in this study, you may stop participating at any time. If you decide not to be in this study, or if you stop participating at any time, you won't be penalized or lose any benefits for which you otherwise qualify.

Can Someone Else End my Participation in this Study?

Under certain circumstances, the researchers might decide to end your participation in this research study earlier than planned. This might happen if you fail to operate the research vehicle in accordance with the instructions provided, or if there are technical difficulties with the driving simulator.

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WHAT IF I HAVE QUESTIONS?

We encourage you to ask questions. If you have any questions about the research study itself, please contact: Dawn Marshall, (319) 335-4774. If you experience a research-related injury, please contact Dawn Marshall (319) 335-4774.

If you have questions, concerns, or complaints about your rights as a research subject or about research related injury, please contact the Human Subjects Office, 340 College of Medicine Administration Building, The University of Iowa, Iowa City, Iowa, 52242, (319) 335-6564, or e-mail irb@uiowa.edu. General information about being a research subject can be found by clicking "Info for Public" on the Human Subjects Office web site, http://research.uiowa.edu/hso. To offer input about your experiences as a research subject or to speak to someone other than the research staff, call the Human Subjects Office at the number above.

This Informed Consent Document is not a contract. It is a written explanation of what will happen during the study if you decide to participate. You are not waiving any legal rights by signing this Informed Consent Document. Your signature indicates that this research study has been explained to you, that your questions have been answered, and that you agree to take part in this study. You will receive a copy of this form.

Subject's Name (printed): ______________________________

Do not sign this form if today's date is on or after EXPIRATION DATE: 12/31/10

______________________________ ______________________________
(Signature of Subject) (Date)

Statement of Person Who Obtained Consent

I have discussed the above points with the subject or, where appropriate, with the subject's legally authorized representative. It is my opinion that the subject understands the risks, benefits, and procedures involved with participation in this research study.

______________________________ ______________________________
(Signature of Person who Obtained Consent) (Date)

APPENDIX 6: PAYMENT VOUCHER

NADS PARTICIPANT COMPENSATION VOUCHER

Department Name: NADS & Simulation Center
Contact Person: Sue Ellen Salisbury
Campus Address: 127 NADS
Campus Phone: 54666

TO RECEIVE COMPENSATION, PLEASE PROVIDE THE FOLLOWING INFORMATION:

Name: ____
LAST FIRST MIDDLE INITIAL

Social Security Number: ☐☐☐ – ☐☐ – ☐☐☐☐

Address: ____
MAILING ADDRESS

____

______________________ ________ ☐☐☐☐☐
CITY STATE ZIP

(_______)________________________
PHONE

Are you a U.S. citizen or resident of the U.S. or U.S. territories? ☐ YES ☐ NO

If NO, complete the following information:

VISA Type: ______________________ Date of Birth: ☐☐ / ☐☐ / ☐☐☐☐

Tax Residency Country: ____

Permanent Foreign Address: ____

____

FOR NADS STAFF ONLY:

Start Date: ☐☐ / ☐☐ / ☐☐☐☐ Stop Date: ☐☐ / ☐☐ / ☐☐☐☐

Description: Research participant in __________ODSS__ study.

Base Compensation $ __________________

Incentive Payment, if applicable $ __________________

Other $ __________________

Total Compensation $ __________________

APPENDIX 7: VIDEO RELEASE

CONSENT FOR RELEASE OF VIDEO IMAGE AND AUDIO DATA

I, the undersigned, have agreed to participate in a research project to be conducted at the University of Iowa entitled "Older Driver Safety Systems" The purpose of the study is to examine the effectiveness of a safety warning system. As part of the informed consent form I have signed for that study, I have agreed to allow the University, the study sponsor, and those acting pursuant to its authority, to record and use for research purposes video image data (including my video-recorded likeness) and audio data (including my voice), as well as, in some views, superimposed performance information (referred to below as "the Recording"). This Consent for Release of Video Image and Audio Data pertains to the following non-research purposes the University, the study sponsor, and those acting pursuant to its authority propose for my video image data (in continuous video or still formats) and associated audio data, either separately or in association with the appropriate engineering data:

1) Public release for regulatory purposes (e.g., to assist in regulating devices);
2) Public release for educational purposes (e.g., to assist with educational campaigns for members of the general public);
3) Public release for outreach purposes (e.g., to nationally-televised programs highlighting traffic safety issues);
4) Public release for legislative purposes (e.g., to assist the U.S. Congress with law-making/rule-making activities).

Engineering or simulator data may also be released individually or in summary with that of others participating in the study, but will not be presented publicly in a way that permits personal identification, except when presented in conjunction with video image data.

I hereby authorize the University of Iowa, the study sponsor, and those acting pursuant to its authority, to use my recorded video image and audio data, with or without related engineering or simulator data, for the non-research purposes specified above.

I transfer and assign to the University of Iowa and the study sponsor any right, title, and interest I may have in and to the Recording, including the copyright, and in and to all works based upon, derived from, or incorporating the recorded data.

I irrevocably waive any right to inspect, edit, or approve said Recording in any of its forms.

I irrevocably release the University of Iowa and the study sponsor, and any of their employees, agents, and assigns, from any and all claims that I may have at any time arising out of, or related to, the Recording or use of the Recording, including, but not limited to, any claims based on the right of privacy, libel, or defamation.

____

Name of Participant

____

Signature of Participant

____

Date

APPENDIX 8: MINI MENTAL STATE EXAMINATION (MMSE)

Mini Mental State Examination

Question	Score	Max Score
18. What is the (year) (season) (date) (day) and (month)?		5
19. Where are we (state) (county) (town) (building) (floor)?		5
20. I will name 3 objects and I want you to repeat them to me after I have said all 3. (ball, crayon, clock) You should also remember these objects because I will ask you to repeat them in a few moments.		3
21. Please count backwards by sevens starting with 100 (stop after 5 answers –93, 86, 79, 72, 65). Alternative- Spell the word “world” backwards (d-l-r-o-w).		5
22. Please recall the 3 objects I told you earlier.		3
23. Show the subject a pencil and a watch and have him tell you what they are.		2
24. Please repeat the following phrase: “No ifs, ands or buts.”		1
25. Take this piece of paper in your right hand, fold it in half, and put it on the floor”		3
26. Read and obey the following: CLOSE YOUR EYES		1
27. Write a complete sentence on this sheet of paper.		1
28. Copy this design. (a piece of paper with 2 intersecting pentagons)		1
TOTAL		30

APPENDIX 9: VISUAL SCREENING

«Participant_ID»

VISION SCREENING RECORD FORM

Subject Number	Subject Initials	Date	Study
	☐☐☐	☐☐/☐☐/☐☐	**ODSS**

This screening is used to test how well you see at a distance. The exam will be administered for both eyes simultaneously.

Control Panel Setup:

☐ RIGHT Eye
☐ LEFT Eye
☐ FAR
☐ SLIDE #3

Participant Instructions:

1. **Please look at the numbers on the screen by pressing the bar with your forehead. Do you see three columns of numbers?**
   ☐ YES *(Move onto question 2)*
   ☐ NO *(Ensure control panel is set up and forehead is pressed against black bar – green ready light appears on control panel. If set up properly and you can see lines, turn off left then right on control panel to make certain subject can see in both eyes.)*

2. **Please read the numbers on line 7 from left to right.** — **2 9 8 6 5   3 5 2 6 9   6 5 3 8 2**
   ☐ ≤ 2 missed/any group record a vision of 20/20 below.
   ☐ > 2 missed in any group go to question 3.

3. **Please read the numbers on line 6 from left to right.** — **3 2 5 9 6   6 8 3 5 2   8 2 6 3 5**
   ☐ ≤ 2 missed/any group record a vision of 20/30 below.
   ☐ > 2 missed in any group go to question 4.

4. **Please read the numbers on line 5 from left to right.** — **5 8 6 9   2 6 8 3   9 5 3 2**
   ☐ ≤ 2 missed/any group record a vision of 20/40 below.
   ☐ > 2 missed in any group go to question 5.

5. **Please read the numbers on line 4 from left to right.** — **9 2 8 6   5 9 6 3   2 8 5 9**
   ☐ ≤ 2 missed/any group record a vision of 20/50 below.
   ☐ > 2 missed in any group go to question 6.

6. **Please read the numbers on line 3 from left to right.** — **5 3 6 2   9 8 5 6   2 3 6 5**
   ☐ ≤ 1 missed/any group record a vision of 20/70 below.
   ☐ > 1missed in any group go to question 7.

7. **Please read the numbers on line 2 from left to right.** — **8 5 2   3 9 5   6 2 8**
   ☐ ≤ 1 missed/any group record a vision of 20/100 below.
   ☐ > 1 missed in any group

Far Visual Acuity Reading: ☐☐/☐☐

«Participant_ID»

VISION SCREENING RECORD FORM

Subject Number	Subject Initials	Date	Study
	☐☐☐	☐☐/☐☐/☐☐	ODSS

This screening is used to test how well you see up close. The exam will be administered for both eyes simultaneously.

Control Panel Setup:

☐ RIGHT Eye
☐ LEFT Eye
☐ NEAR
☐ SLIDE #4

Participant Instructions:

1. **Please look at the numbers on the screen by pressing the bar with your forehead. For this test you will need to look down into the lower view finders. Do you see three columns of letters?**

☐ YES *(Move onto question 2)*
☐ NO *(Ensure control panel is set up and forehead is pressed against black bar – green ready light appears on control panel. If set up properly and you can see lines, turn off left then right on control panel to make certain subject can see in both eyes.)*

2. **Please read the numbers on line 6 from left to right.**
☐ ≤ 2 missed/any group record a vision of 20/20 below.
☐ > 2 missed in any group go to question 3.

Z O N V R H C S K D V K C D S

3. **Please read the numbers on line 5 from left to right.**
☐ ≤ 2 missed/any group record a vision of 20/30 below.
☐ > 2 missed in any group go to question 4.

H S K R C N Z D O V Z S H N K

4. **Please read the numbers on line 4 from left to right.**
☐ ≤ 2 missed/any group record a vision of 20/40 below.
☐ > 2 missed in any group go to question 5.

V H R N O D S K N Z C S

5. **Please read the numbers on line 3 from left to right.**
☐ ≤ 2 missed/any group record a vision of 20/50 below.
☐ > 2 missed in any group go to question 6.

C K V D S N Z R D O H C

6. **Please read the numbers on line 3 from left to right.**
☐ ≤ 1 missed/any group record a vision of 20/70 below.
☐ > 1missed in any group go to question 7.

R N Z H D O K V C S Z N

7. **Please read the numbers on line 1 from left to right.**
☐ ≤ 1 missed/any group record a vision of 20/100 below.
☐ > 1 missed in any group

S V C N R K H Z O

Near Visual Acuity Reading: ☐☐/☐☐

«Participant_ID»

VISION SCREENING RECORD FORM

Subject Number	Subject Initials	Date	Study
	☐☐☐	☐☐/☐☐/☐☐	ODSS

This screening is used to test for contrast sensitivity. The exam will be administered for each eye separately, beginning with your right eye.

This is an example of what you will see (Show example). Each of the circles contain lines, tell me if the top of the lines point to the LEFT, RIGHT, **or** STRAIGHT UP.

Control Panel Setup:
- ☐ RIGHT Eye
- ☐ FAR
- ☐ SLIDE #10 Line C, #11 Line D, and #12 Line E

Instructions:
Please press the bar with your forehead. Starting with Box 1on the left, tell me if the lines are going ***LEFT, RIGHT, or STRAIGHT UP.*** *Continue until you can't see anymore.*

SCORING: CIRCLE if correct, X if incorrect

Slide	Line	Plate 1	Plate 2	Plate 3	Plate 4	Plate 5	Plate 6	Plate 7	Plate 8	Plate 9	Line Score
8	C	U	R	L	U	R	U	R	L	R	
9	D	L	R	U	R	U	L	U	R	L	
10	E	U	L	R	U	L	R	U	R	U	

«Participant_ID»

VISION SCREENING RECORD FORM

Subject Number	Subject Initials	Date	Study
	☐☐☐	☐☐/☐☐/☐☐	ODSS

✓ **Switch to Left eye and repeat procedure**

Control Panel Setup:

- ☐ LEFT Eye
- ☐ FAR
- ☐ SLIDE #10 Line C, #11 Line D, #12 Line E

SCORING: CIRCLE if correct, X if incorrect

Slide	Line	Plate 1	Plate 2	Plate 3	Plate 4	Plate 5	Plate 6	Plate 7	Plate 8	Plate 9	Line Score
8	C	U	R	L	U	R	U	R	L	R	
9	D	L	R	U	R	U	L	U	R	L	
10	E	U	L	R	U	L	R	U	R	U	

APPENDIX 10: RAPID WALK, FOOT TAP, NECK ROTATION TESTS

Study/Participant: «Participant_ID»

Date: _____________

Physical Task Instructions

Rapid Walk Task

Test description: The participant will walk along a 3 meter path marked with tape on the floor then returned along the same path to starting point, as quickly as possible.

Instructions: *I want you to walk along the side of this tape line to the end, turn around, and walk back here as quickly as you can.* Then, the researcher will demonstrate the walk and path, then will say *I am going to time you. Go as fast as you feel safe and comfortable. If you use a can or a walker, you may use it if you feel more comfortable, Ready? Begin.*

Scoring: Timing starts when the examinee picks up first foot, and stopped when the last foot reached start/finish point. The total time to traverse the 3 meter patch back and forth will be manually recorded by researcher, using a stopwatch.

Time ____________________

Foot Tap Task

Task Description: An open 3 inch binder will be placed on the floor in front of a chair, where the participant is sitting, oriented such that the rings will be crosswise in front of them, and such that the participant could place his/her foot flat on the floor beside the rings while seated in the chair with the right foot extended slightly forward of the knee.

Instructions: *Please place your feet on each side of the binder. Now move your left foot under the chair so it will be out of the way.* The researcher then will tap across the rings, alternating touching the floor on each side, as an example, while continuing with the following instructions: *when I say go, move your right foot back and forth, lifting it over the rings, alternately tapping the floor on each side of the binder. Tap each side five times for a total of 10 taps. I will time how quickly you can do this. Ready? Go.*

Scoring: The total time to complete the foot tapping task will be manually recorded by researcher, using a stopwatch.

Time ____________________

Neck Rotation Task

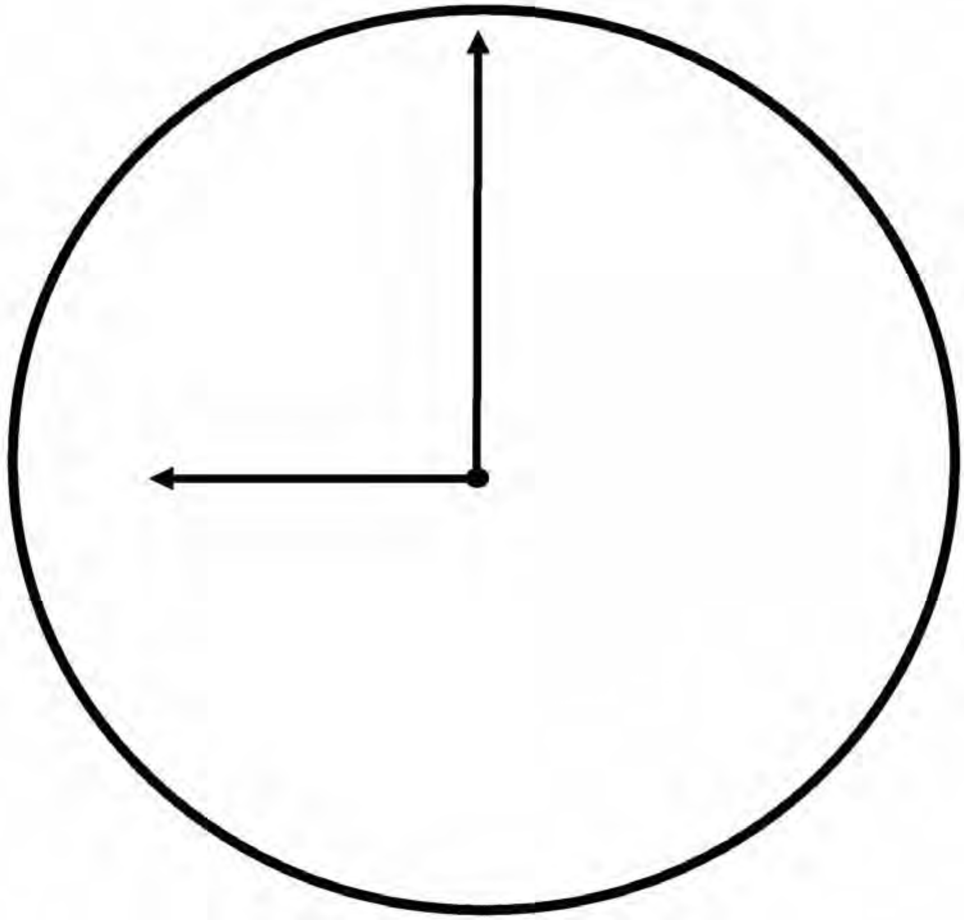
Task Description: The participant will sit in an armed chair and will be asked to sit with his/her back against the chair with his/her arms on the armrest. The researcher will then move to a position that is 3 meters behind the participant and will hold p a cardboard clock face with the hands set to 3:00 or 9:00 position

Instructions: *While sitting with your back against the chair and your arms on the armrest please turn your head and look over your right (left) shoulder and read the time on the clock face I am holding behind you.* After completing over the right shoulder, repeat having them look over the left shoulder.

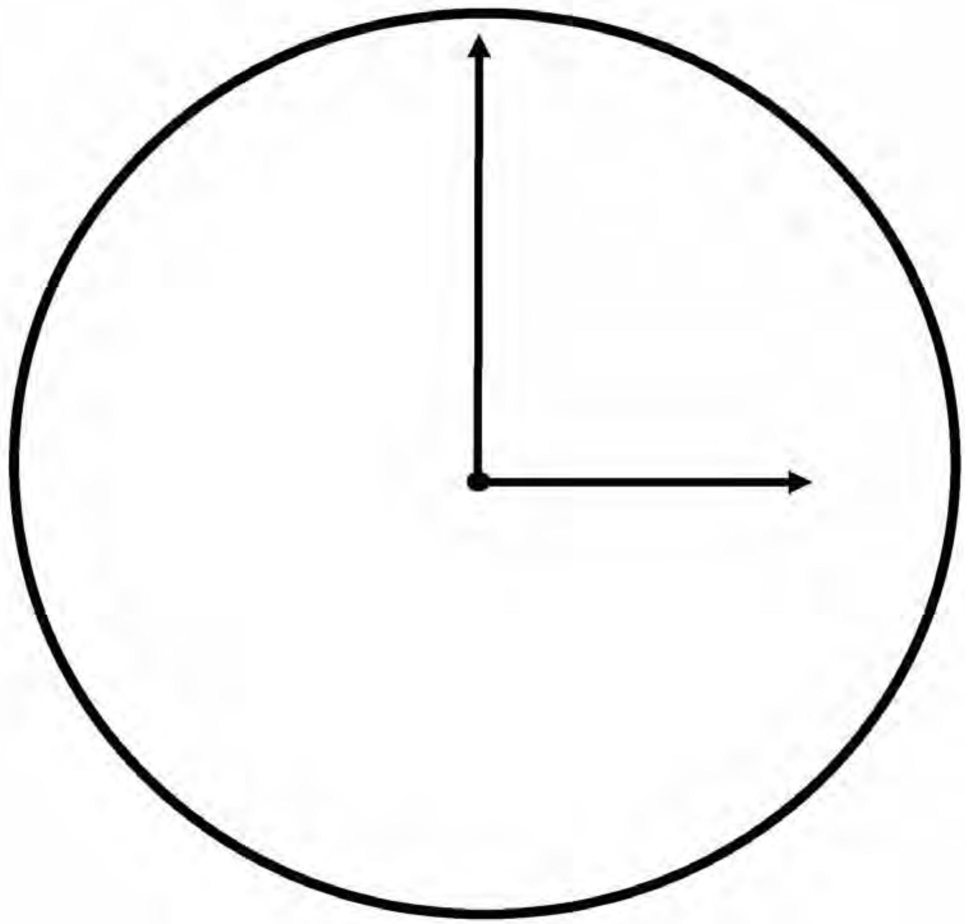
Scoring: if the participant can read the time, it will be recorded as "pass" and if he/she cannot, it will be recorded as "fail" manually recorded by the researcher.

Right: PASS or FAIL Comments: ____

Left: PASS or FAIL Comments: ____



9:00



3:00

APPENDIX 11: PTSD CHECKLIST

Study: ODSS
Date: ________
Participant #: «Participant_ID»

PTSD Checklist – Civilian Version (PCL-C)

Instructions: Below is a list of problems and complaints that people sometimes have in response to stressful life experiences. Please read each one carefully, put an "X" in the box to indicate how much you have been bothered by that problem *in the last month*.

No.	Response:	Not at all (1)	A little bit (2)	Moderately (3)	Quite a bit (4)	Extremely (5)
1.	Repeated, disturbing *memories, thoughts*, or *images* of a stressful experience from the past?					
2.	Repeated, disturbing *dreams* of a stressful experience from the past?					
3.	Suddenly *acting* or *feeling* as if a stressful experience *were happening again* (as if you were reliving it)?					
4.	Feeling *very upset* when *something reminded* you of a stressful experience from the past?					
5.	Having *physical reactions* (e.g., heart pounding, trouble breathing, or sweating) when *something reminded* you of a stressful experience from the past?					
6.	Avoid *thinking about* or *talking about* a stressful experience from the past or avoid *having feelings* related to it?					
7.	Avoid *activities* or *situations* because *they remind you* of a stressful experience from the past?					
8.	Trouble *remembering important parts* of a stressful experience from the past?					
9.	Loss of *interest in things that you used to enjoy?*					
10.	Feeling *distant* or *cut off* from other people?					
11.	Feeling *emotionally numb* or being unable to have loving feelings for those close to you?					
12.	Feeling as if your *future* will somehow be *cut short?*					
13.	Trouble *falling* or *staying asleep*?					
14.	Feeling *irritable* or having *angry outbursts*?					
15.	Having *difficulty concentrating*?					
16.	Being *"super alert"* or watchful on guard?					
17.	Feeling *jumpy* or easily startled?					

Weathers, F.W., Huska, J.A., Keane, T.M. *PCL-C for DSM-IV*. Boston: National Center for PTSD – Behavioral Science Division, 1991

This is a Government document in the public domain.

APPENDIX 12: TRAIL MAKING B

Study/Participant : ODSS2009_ ODSS2009_P1001AS

Date:____________

Trail Making B Instructions

Given Verbally:

Now I will give you paper and pencil. On the paper are the numbers 1 through 4 and the letters A through D, scattered across the page. (Demonstrate as you tell him/her) Start with 1, then draw a line to A, then continue the line to 2, then to B, then 3-C, 4-D, alternating back and forth between numbers and letters. You should not lift your pencil from the paper. You should do this as fast as you can. This is practice and it will not be timed.

After pointing out any errors and insuring that the participant understands the test requirement, say: "Now we are going to do a timed version. If you turn the sheet over you will see the numbers 1 through 13 and the letters A through L. They are mixed up in the same way as the practice. Start with the number 1; draw a continuous line that alternates between numbers and letters, until you finish with the number 13. You should not lift your pencil from the paper. Say “are you ready?” Wait for response. “Go," (while directing them to place his/her pencil at starting point (number one)).

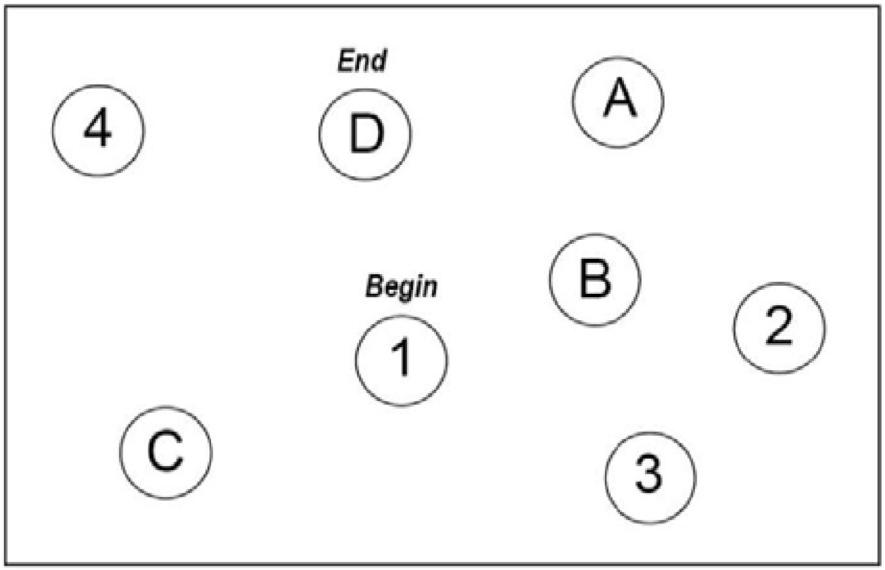
Sources:

http://www.brainmetric.com/pdfs/trailsall.pdf

Study/Participant : ODSS2009 «Participant_ID»

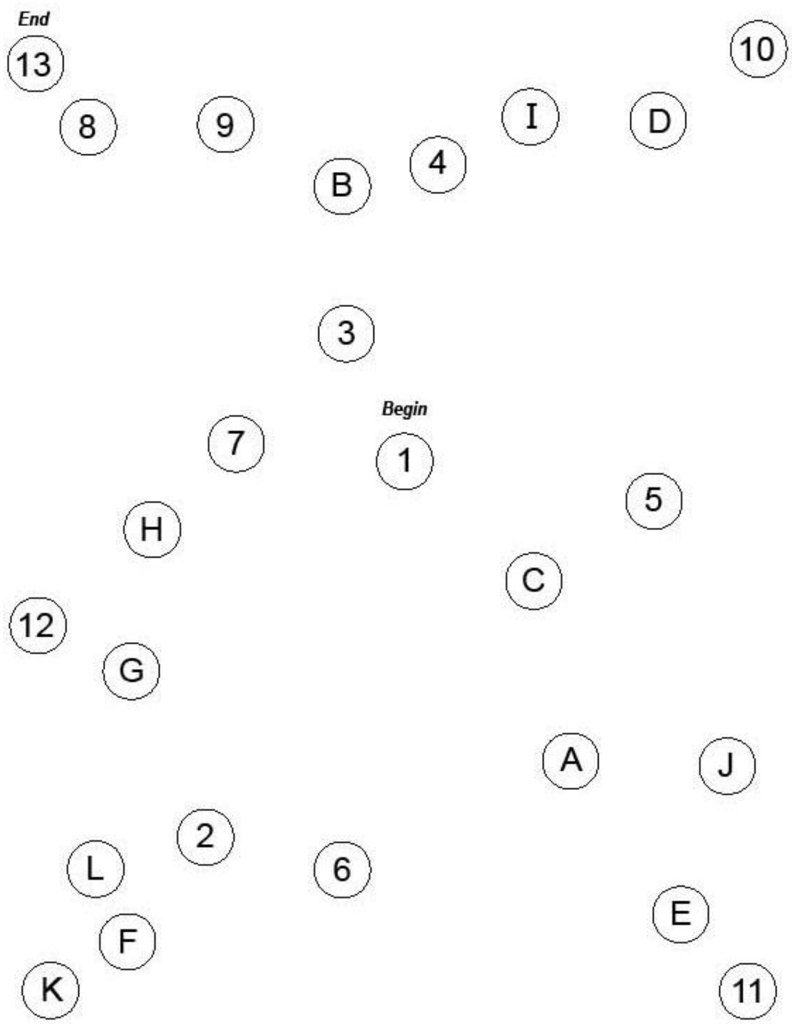
Date:___________

Sample



Study/Participant : ODSS2009 «Participant_ID»

Date:___________



APPENDIX 13: CLOCK-DRAWING

Participant ID: ODSS2009_P1001AS

Clock-Drawing Task

Instructions to be given verbally:

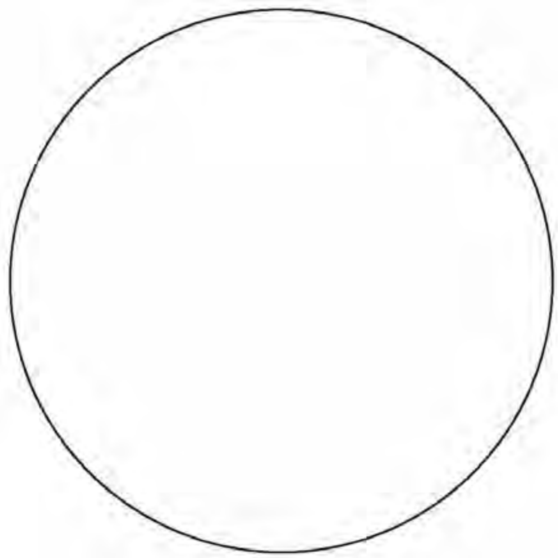
This circle represents a clock face. Please put in the numbers so that it looks like a clock and set the time to 10 minutes past 11.

Source: Shulman KI. Clock-drawing: is it the ideal cognitive screening test? International Journal of Geriatric Psychiatry. 2000;15:548-61

Participant ID: «Participant_ID»

Study/Participant: ____________

Date: ____________



APPENDIX 14: ORIENTATION


Seat Adjustments
The National Advanced Driving Simulator


Fasten Seatbelt
The National Advanced Driving Simulator

Resting Position

Eye Tracking Cameras

Mirrors

You may adjust the mirrors by using the control panel on the door. Set the side mirrors in much the same way as you would set the mirrors on your car. Wait to adjust the mirrors until the beginning of your drive. The control panel should be pressed firmly. If you need assistance, please ask the researcher in the simulator for some help.

Study Drive

The study drive is a drive through town. You will be driving on a four-lane city street. The speed limit is 35 mph. Several times during your drive you will be asked to adjust the CD player. The CD player is described on the next slide.

The study drive starts with your car parked on the side of the road. When it is time to begin, shift into Drive, and merge into traffic when it is safe to do so. Continue driving until you hear the recording telling you it is time to stop. The drive is approximately 20 minutes long.


CD Player
Selection Lever
At several points in your drive you will be asked to adjust the CD player. You will use only the selection lever on the CD player. Do not press the Mode button.
A voice prompt will play asking you to adjust the CD player. Click the to hear an example of the prompt.


Changing the CD Track
Selection Lever
Track Number
To change the CD track, move the selection lever up to go to a higher numbered track and down to go to a lower numbered track. Move the selection lever up or down once for each track.
For example, to change the CD from track 2 to track 5 you should move the selection lever up three times.

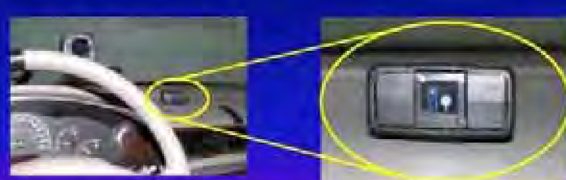
CD Task

A portion of the $30 you will be paid depends on your ability to change the CD track as requested during your study drive.

Specifically, $10 of your pay will be based on whether you change the CD track the correct number of tracks in a timely manner. The amount you receive will be proportional to the number of times you quickly and accurately change the CD track when asked.

Intersection Safety System

You may or may not have the system during your drive. If you do, a blue light on the dash of the car will come on when the safety system detects an intersection ahead.



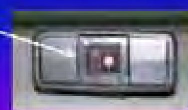
Intersection Safety System

After detecting an intersection the safety system in the car will warn you when you are about to run a stop light or stop sign in 3 ways:

- A voice alert - click on each speaker icon to hear these

  "stop light"   "stop sign"

- A visual alert in the box on the dash
  - The blue light changes to flashing red



- Mild braking you will be able to feel

Overview of Drives

We are interested in all aspects of your drive today and we are looking at general driving behavior in various environments.

The speed is 35 mph and it is important that you drive as close to the speed limit as possible.

When asked, change the CD track as quickly and accurately as possible.

A recording will tell you when it is time to start and stop your drive.


Intercom System
The car has an intercom system which allows the researchers to hear you. It is already adjusted for the drive today. If for any reason you want to stop driving, please tell us. The operator will hear you and can end the drive in just a few seconds.


Conclusion
This concludes the briefing presentation. We can answer any questions you may have at this time.

APPENDIX 15: PRE-DRIVE SURVEY

Study: ODSS
Date: ______
Participant: «Participant ID»

Pre-Drive Survey

Please read each question carefully. If something is unclear, ask the research assistant for help. You do not have to answer any questions you do not wish to answer.

1) When driving, how **frequently** do you perform each of the following tasks/maneuvers? (Check the most appropriate answer for each task/maneuver)

	Never	Rarely	Occasionally	Often	Not Applicable
Drive at night	☐	☐	☐	☐	☐
Drive in fog	☐	☐	☐	☐	☐
Drive in rain	☐	☐	☐	☐	☐
Drive in snow or sleet	☐	☐	☐	☐	☐
Drive in heavy traffic	☐	☐	☐	☐	☐
Drive on highways or interstates	☐	☐	☐	☐	☐
Change lanes on multiple-lane highways or interstates	☐	☐	☐	☐	☐
Change lanes in town	☐	☐	☐	☐	☐
Keep up with traffic on interstates	☐	☐	☐	☐	☐
Keep up with traffic on two-lane highways	☐	☐	☐	☐	☐
Keep up with traffic in town	☐	☐	☐	☐	☐
Pass other cars on interstates	☐	☐	☐	☐	☐
Pass other cars on two-lane highways	☐	☐	☐	☐	☐
Make left turns at uncontrolled intersections (intersections without traffic signs or lights)	☐	☐	☐	☐	☐
Exceed the speed limit	☐	☐	☐	☐	☐
Not read traffic signs	☐	☐	☐	☐	☐
Drive when tired	☐	☐	☐	☐	☐
Not wear a safety belt	☐	☐	☐	☐	☐
Veer from your lane	☐	☐	☐	☐	☐
Keep less than the suggested following distance between you and the car in front of you	☐	☐	☐	☐	☐
Drive while smoking	☐	☐	☐	☐	☐
Drive after drinking alcohol	☐	☐	☐	☐	☐
Drive with children	☐	☐	☐	☐	☐
Adjust your radio settings	☐	☐	☐	☐	☐
Read a map	☐	☐	☐	☐	☐
Use an in-vehicle navigation systems, such as TomTom®	☐	☐	☐	☐	☐
Use a wireless phone	☐	☐	☐	☐	☐

1

2) When driving, how **confident** do you feel when you perform each of the following tasks/maneuvers? (Check the most appropriate answer for each task/maneuver)

	Very Hesitant	Slightly Hesitant	Moderately Confident	Very Confident	Not Applicable
Drive at night	☐	☐	☐	☐	☐
Drive in fog	☐	☐	☐	☐	☐
Drive in rain	☐	☐	☐	☐	☐
Drive in snow or sleet	☐	☐	☐	☐	☐
Drive in heavy traffic	☐	☐	☐	☐	☐
Drive on highways or interstates	☐	☐	☐	☐	☐
Change lanes on multiple-lane highways or interstates	☐	☐	☐	☐	☐
Change lanes in town	☐	☐	☐	☐	☐
Keep up with traffic on interstates	☐	☐	☐	☐	☐
Keep up with traffic on two-lane highways	☐	☐	☐	☐	☐
Keep up with traffic in town	☐	☐	☐	☐	☐
Pass other cars on interstates	☐	☐	☐	☐	☐
Pass other cars on two-lane highways	☐	☐	☐	☐	☐
Make left turns at uncontrolled intersections (intersections without traffic signs or lights)	☐	☐	☐	☐	☐
Exceed the speed limit	☐	☐	☐	☐	☐
Not read traffic signs	☐	☐	☐	☐	☐
Drive when tired	☐	☐	☐	☐	☐
Not wear a safety belt	☐	☐	☐	☐	☐
Veer from your lane	☐	☐	☐	☐	☐
Keep less than the suggested following distance between you and the car in front of you	☐	☐	☐	☐	☐
Drive while smoking	☐	☐	☐	☐	☐
Drive after drinking alcohol	☐	☐	☐	☐	☐
Drive with children	☐	☐	☐	☐	☐
Adjust your radio settings	☐	☐	☐	☐	☐
Read a map	☐	☐	☐	☐	☐
Use an in-vehicle navigation systems, such as TomTom®	☐	☐	☐	☐	☐
Use a wireless phone	☐	☐	☐	☐	☐

3) Have you taken any medication in the past 48 hours? (Check only one)

- ☐ No
- ☐ Yes (Please list all) ______________________________

4) Have you consumed any alcohol or other drugs in the past 24 hours? (Check only one)

- ☐ No
- ☐ Yes (Please list all) ______________________________

APPENDIX 16: WELLNESS SURVEY

Study: ODSS

Date:____

Participant #: «Participant_ID»

#1

WELLNESS SURVEY

Directions: Circle one option for each symptom to indicate whether that symptom applies to you right now.

1. General Discomfort .... None .... Slight .... Moderate .... Severe
2. Fatigue .... None .... Slight .... Moderate .... Severe
3. Headache .... None .... Slight .... Moderate .... Severe
4. Eye Strain .... None .... Slight .... Moderate .... Severe
5. Difficulty Focusing .... None .... Slight .... Moderate .... Severe
6. Salivation Increased .... None .... Slight .... Moderate .... Severe
7. Sweating .... None .... Slight .... Moderate .... Severe
8. Nausea .... None .... Slight .... Moderate .... Severe
9. Difficulty Concentrating .... None .... Slight .... Moderate .... Severe
10. "Fullness of the Head" .... None .... Slight .... Moderate .... Severe
11. Blurred Vision .... None .... Slight .... Moderate .... Severe
12. Dizziness with Eyes Open .... None .... Slight .... Moderate .... Severe
13. Dizziness with Eyes Closed ...... None .... Slight .... Moderate .... Severe
14. *Vertigo .... None .... Slight .... Moderate .... Severe
15. **Stomach Awareness .... None .... Slight .... Moderate .... Severe
16. Burping..................................... None .... Slight .... Moderate .... Severe
17. Vomiting.................................... None .... Slight .... Moderate.........Severe
18. Other ________________ ..... None .... Slight .... Moderate.........Severe

* Vertigo is experienced as loss of orientation with respect to vertical upright.

** Stomach awareness is a feeling of discomfort which is just short of nausea.

Study: ODSS

Date: ______________________________

Participant #: «Participant_ID»

#2

WELLNESS SURVEY

Directions: Circle one option for each symptom to indicate whether that symptom applies to you right now.

1. General Discomfort .... None .... Slight .... Moderate .... Severe
2. Fatigue .... None .... Slight .... Moderate .... Severe
3. Headache .... None .... Slight .... Moderate .... Severe
4. Eye Strain .... None .... Slight .... Moderate .... Severe
5. Difficulty Focusing .... None .... Slight .... Moderate .... Severe
6. Salivation Increased .... None .... Slight .... Moderate .... Severe
7. Sweating .... None .... Slight .... Moderate .... Severe
8. Nausea .... None .... Slight .... Moderate .... Severe
9. Difficulty Concentrating .... None .... Slight .... Moderate .... Severe
10. "Fullness of the Head" .... None .... Slight .... Moderate .... Severe
11. Blurred Vision .... None .... Slight .... Moderate .... Severe
12. Dizziness with Eyes Open .... None .... Slight .... Moderate .... Severe
13. Dizziness with Eyes Closed ..... None .... Slight .... Moderate .... Severe
14. *Vertigo .... None .... Slight .... Moderate .... Severe
15. **Stomach Awareness .... None .... Slight .... Moderate .... Severe
16. Burping..................................... None .... Slight .... Moderate .... Severe
17. Vomiting.................................... None .... Slight .... Moderate.........Severe
18. Other _______________ ..... None .... Slight .... Moderate.........Severe

* Vertigo is experienced as loss of orientation with respect to vertical upright.

** Stomach awareness is a feeling of discomfort which is just short of nausea.

APPENDIX 17: REALISM SURVEY

Study: ODSS
Date______________________________
Participant # «Participant_ID»

REALISM SURVEY

For each of the following items, circle the number that best indicates how closely the simulator resembles an actual car in terms of appearance, sound, and response. If an item is not applicable, circle NA.

	General Driving	Not at all realistic						Completely Realistic	
1	Response of the seat adjustment levers	0	1	2	3	4	5	6	NA
2	Response of the mirror adjustment levers	0	1	2	3	4	5	6	NA
3	Response of the door locks and handles	0	1	2	3	4	5	6	NA
4	Response of the fans	0	1	2	3	4	5	6	NA
5	Response of the gear shift	0	1	2	3	4	5	6	NA
6	Response of the brake pedal	0	1	2	3	4	5	6	NA
7	Response of accelerator pedal	0	1	2	3	4	5	6	NA
8	Response of the speedometer	0	1	2	3	4	5	6	NA
9	Response of the steering wheel while driving straight	0	1	2	3	4	5	6	NA
10	Response of the steering wheel while driving on curves	0	1	2	3	4	5	6	NA
11	Feel when accelerating	0	1	2	3	4	5	6	NA
12	Feel when braking	0	1	2	3	4	5	6	NA
13	Feel when passing other cars	0	1	2	3	4	5	6	NA
14	Feel when driving straight	0	1	2	3	4	5	6	NA
15	Feel when driving on curves	0	1	2	3	4	5	6	NA
16	Ability to read road and warning signs	0	1	2	3	4	5	6	NA
17	Appearance of roads and road markings	0	1	2	3	4	5	6	NA
18	Appearance of signs	0	1	2	3	4	5	6	NA
19	Appearance of car interior	0	1	2	3	4	5	6	NA
20	Appearance of roadside scenery	0	1	2	3	4	5	6	NA
21	Appearance of other vehicles	0	1	2	3	4	5	6	NA
22	Appearance of rear-view mirror image	0	1	2	3	4	5	6	NA
23	Sound of the car	0	1	2	3	4	5	6	NA
24	Sound of other vehicles	0	1	2	3	4	5	6	NA
25	Overall feel of the car when driving	0	1	2	3	4	5	6	NA
26	Overall similarity to real driving	0	1	2	3	4	5	6	NA
	Urban Arterial Driving								
27	Feel of approximate speed when driving 35 in town	0	1	2	3	4	5	6	NA
28	Appearance of urban scenery	0	1	2	3	4	5	6	NA
29	Appearance of rural scenery	0	1	2	3	4	5	6	NA
30	Appearance of pedestrians	0	1	2	3	4	5	6	NA
31	Ability to stop the vehicle	0	1	2	3	4	5	6	NA
32	Ability to respond to other vehicles	0	1	2	3	4	5	6	NA
33	Ability to keep straight in your lane	0	1	2	3	4	5	6	NA
34	Ability to change lanes	0	1	2	3	4	5	6	NA
35	Ability to respond to lighted intersections	0	1	2	3	4	5	6	NA
36	Overall appearance of driving scenes	0	1	2	3	4	5	6	NA

APPENDIX 18: POST-DRIVE QUESTIONNAIRE (WITH SYSTEM)

Study: ODSS
Date: ___________
Participant #: «Participant_ID»

Post Drive Questionnaire

The following questions ask about your thoughts on the warning system. Please read each question carefully and circle the number that best represents your answer, unless otherwise directed. If something is unclear ask the research assistant for help. You do not have to answer any questions you do not wish to answer.

1) How confident would you feel driving in the following conditions or performing the following maneuvers **with this warning system?** (Check the most appropriate answer for each condition)

	Very Hesitant	Slightly Hesitant	Moderately Confident	Very Confident	Not Applicable
Drive at night	❐	❐	❐	❐	❐
Drive in fog	❐	❐	❐	❐	❐
Drive in rain	❐	❐	❐	❐	❐
Drive in snow or sleet	❐	❐	❐	❐	❐
Drive in heavy traffic	❐	❐	❐	❐	❐
Drive on highways or interstates	❐	❐	❐	❐	❐
Change lanes on multiple-lane highways or interstates	❐	❐	❐	❐	❐
Change lanes in town	❐	❐	❐	❐	❐
Keep up with traffic on interstates	❐	❐	❐	❐	❐
Keep up with traffic on two-lane highways	❐	❐	❐	❐	❐
Keep up with traffic in town	❐	❐	❐	❐	❐
Pass other cars on interstates	❐	❐	❐	❐	❐
Pass other cars on two-lane highways	❐	❐	❐	❐	❐
Make left turns at uncontrolled intersections (intersections without traffic signs or lights)	❐	❐	❐	❐	❐
Exceed the speed limit	❐	❐	❐	❐	❐
Not read traffic signs	❐	❐	❐	❐	❐
Drive when tired	❐	❐	❐	❐	❐
Not wear a safety belt	❐	❐	❐	❐	❐
Veer from your lane	❐	❐	❐	❐	❐
Keep less than the suggested following distance between you and the car in front of you	❐	❐	❐	❐	❐
Drive while smoking	❐	❐	❐	❐	❐

Study: ODSS
Date: ___________
Participant #: «Participant_ID»

	Very Hesitant	Slightly Hesitant	Moderately Confident	Very Confident	Not Applicable
Drive after drinking alcohol	❒	❒	❒	❒	❒
Drive with children	❒	❒	❒	❒	❒
Adjust your radio settings	❒	❒	❒	❒	❒
Read a map	❒	❒	❒	❒	❒
Use an in-vehicle navigation systems, such as TomTom©	❒	❒	❒	❒	❒
Use a wireless phone	❒	❒	❒	❒	❒

Study: ODSS
Date: ___________
Participant #: «Participant_ID»

Circle one in each row	Strongly Agree	Mildly Agree	Agree and Disagree Equally	Mildly Disagree	Strongly Disagree
2) I am familiar with the operation of the warning system.	1	2	3	4	5
3) I trust the warning system.	1	2	3	4	5
4) The warning system is reliable.	1	2	3	4	5
5) I am confident with my ability to drive a car safely without the warning system.	1	2	3	4	5
6) I knew when the warning system was activated and when it was not activated.	1	2	3	4	5
7) The warning system made driving safer for me and for others on the roadway.	1	2	3	4	5
8) The warning system would help me drive more carefully than I normally would in typical daily driving.	1	2	3	4	5
9) The warning was annoying.	1	2	3	4	5
10) The system is too intrusive.	1	2	3	4	5
11) The warning came too late for me to safely respond to my driving environment.	1	2	3	4	5
12) The warning system helped me avoid a potential crash.	1	2	3	4	5
13) I won't use the warning system, but other drivers in my household would benefit from its use.	1	2	3	4	5

Study: ODSS
Date: ___________
Participant #: «Participant_ID»

14) My judgments of the system are... (please check a box on every line)

useful	|__|__|__|__|__|	useless
pleasant	|__|__|__|__|__|	unpleasant
bad	|__|__|__|__|__|	good
nice	|__|__|__|__|__|	annoying
effective	|__|__|__|__|__|	superfluous
irritating	|__|__|__|__|__|	likable
assisting	|__|__|__|__|__|	worthless
undesirable	|__|__|__|__|__|	desirable
raising alertness	|__|__|__|__|__|	sleep inducing

15) If you could only have 6 of these options which would you select for your vehicle: (check 6 items)

- Heated seats
- Intersection violation warning system
- Satellite Radio
- Leather Seats
- Side Impact Airbags
- A sunroof
- MP3 player integration
- Adaptive Cruise Control
- Electronic Stability Control
- Bluetooth phone integration
- Tire Pressure Monitoring Gauge
- HID headlamps
- A navigations system
- A backup camera

16) What is the maximum price you would pay for this warning system? ___________

Study: ODSS
Date: ___________
Participant #: «Participant_ID»

17) At the actual price of $300, how likely would you be to consider purchasing this warning system? (Circle one)

Definitely would **not** consider		Might or might not consider		Definitely would consider
1	2	3	4	5

Study: ODSS
Date: ___________
Participant #: «Participant_ID»

18. Did you receive a warning from the system during your drive?

- ☐ No (end of questionnaire)
- ☐ Yes

19. What parts of the alert did you notice and which did you notice first?

20. What did you think of the timing of the alert?

APPENDIX 19: POST-DRIVE QUESTIONNAIRE (WITHOUT SYSTEM)

Study: ODSS
Date: ________
Participant #: «Participant_ID»

Post Drive Questionnaire

The following questions ask about your thoughts on the warning system. Please read each question carefully and circle the number that best represents your answer, unless otherwise directed. If something is unclear ask the research assistant for help. You do not have to answer any questions you do not wish to answer.

1) I am familiar with the operation of the warning system.

1	2	3	4	5
Strongly Agree	Mildly Agree	Agree and Disagree Equally	Mildly Disagree	Strongly Disagree

2) I am confident with my ability to drive a car safely without the warning system.

1	2	3	4	5
Strongly Agree	Mildly Agree	Agree and Disagree Equally	Mildly Disagree	Strongly Disagree

3) adway.

1	2	3	4	5
Strongly Agree	Mildly Agree	Agree and Disagree Equally	Mildly Disagree	Strongly Disagree

4) The warning system would help me drive more carefully than I normally would in typical daily driving.

1	2	3	4	5
Strongly Agree	Mildly Agree	Agree and Disagree Equally	Mildly Disagree	Strongly Disagree

5) I won't use the warning system, but other drivers in my household would benefit from its use.

1	2	3	4	5
Strongly Agree	Mildly Agree	Agree and Disagree Equally	Mildly Disagree	Strongly Disagree

Study: ODSS
Date: ___________
Participant #: «Participant_ID»

I would like the next car I purchase to have this warning system.

Study: ODSS
Date: ___________
Participant #: «Participant_ID»

6) How confident would you feel driving in the following conditions or performing the following maneuvers? (Check the most appropriate answer for each condition

	Very Hesitant	Slightly Hesitant	Moderately Confident	Very Confident	Not Applicable
Drive at night	☐	☐	☐	☐	☐
Drive in fog	☐	☐	☐	☐	☐
Drive in rain	☐	☐	☐	☐	☐
Drive in snow or sleet	☐	☐	☐	☐	☐
Drive in heavy traffic	☐	☐	☐	☐	☐
Drive on highways or interstates	☐	☐	☐	☐	☐
Change lanes on multiple-lane highways or interstates	☐	☐	☐	☐	☐
Change lanes in town	☐	☐	☐	☐	☐
Keep up with traffic on interstates	☐	☐	☐	☐	☐
Keep up with traffic on two-lane highways	☐	☐	☐	☐	☐
Keep up with traffic in town	☐	☐	☐	☐	☐
Pass other cars on interstates	☐	☐	☐	☐	☐
Pass other cars on two-lane highways	☐	☐	☐	☐	☐
Make left turns at uncontrolled intersections (intersections without traffic signs or lights)	☐	☐	☐	☐	☐
Exceed the speed limit	☐	☐	☐	☐	☐
Not read traffic signs	☐	☐	☐	☐	☐
Drive when tired	☐	☐	☐	☐	☐
Not wear a safety belt	☐	☐	☐	☐	☐
Veer from your lane	☐	☐	☐	☐	☐
Keep less than the suggested following distance between you and the car in front of you	☐	☐	☐	☐	☐
Drive while smoking	☐	☐	☐	☐	☐
Drive after drinking alcohol	☐	☐	☐	☐	☐
Drive with children	☐	☐	☐	☐	☐
Adjust your radio settings	☐	☐	☐	☐	☐
Read a map	☐	☐	☐	☐	☐
Use an in-vehicle navigation systems, such as TomTom®	☐	☐	☐	☐	☐
Use a wireless phone	☐	☐	☐	☐	☐

Study: ODSS
Date: ___________
Participant #: «Participant_ID»

Circle one in each row.	Strongly Agree	Mildly Agree	Agree and Disagree Equally	Mildly Disagree	Strongly Disagree
7) I am familiar with the operation of the warning system.	1	2	3	4	5
8) I am confident with my ability to drive a car safely without the warning system.	1	2	3	4	5
9) The warning system made driving safer for me and for others on the roadway.	1	2	3	4	5
10) The warning system would help me drive more carefully than I normally would in typical daily driving.	1	2	3	4	5
11) I won't use the warning system, but other drivers in my household would benefit from its use.	1	2	3	4	5

APPENDIX 20: DEBRIEFING STATEMENT

Debriefing

This study is about how the warning system may help drivers obey stop lights and stop signs. Some of the stop signs in the drive were hard to see so we could find out if the warning system would help drivers. We could not tell you about the hard to see stop signs before you drove because that might change the way you drive and we would not be able to see if the warning system was the reason you drove the way you drove in the study.

The incentive payment for changing the CD track while you drive was a part of the study design but was not real. We do not have an incentive payment system. You will be paid the full amount, $30, for being in this study. We told you that there was an incentive payment for performance because part of what we want to understand about the system is whether it helps drivers who are distracted by other tasks.

You will be paid $30 for your time and effort. You will be paid by the University of Iowa accounts payable office with a check sent to the address you provided on the payment voucher. If you chose not to accept payment and not provide your Social Security Number, thank you for your time and effort in completing the study procedures.

We need drivers to be surprised by what happens in the study drive and to believe that the payment for performance plan is real, so please do not tell others about what happens during the study drive or that their pay is not dependent on what happens during their drive until after April 2010 when we expect this study to be over.

APPENDIX 21: POST-DRIVE QUESTIONNAIRE RESPONSES

Table 21-1 Post-drive questionnaire responses – with system condition

	Mean	Median	Mode	Min	Max	[1]
General System Questions[2]						
I am familiar with the operation of the warning system	2.39	1.50	1.00	1	5	*
I trust the warning system	2.22	2.00	2.00	1	5	
The warning system is reliable	2.11	2.00	2.00	1	5	
I am confident with my ability to drive a car safely without the warning system	1.56	1.00	1.00	1	4	*
I knew when the warning system was activated and when it was not	1.78	2.00	2.00	1	4	
The warning system made driving safer for me and others	1.94	2.00	1.00	1	4	*
The warning system would help me drive more carefully than I normally would	2.28	2.00	1.00	1	4	*
The warning system was annoying	3.33	3.50	2.00	1	5	
The system was too intrusive	3.67	4.00	4.00	2	5	
The warning came too late for me to safely respond	3.28	3.50	4.00	1	5	
The warning system helped me avoid a potential crash	2.94	3.00	3.00	1	5	
I won't use the warning system, but other drivers in my household would benefit	3.11	3.00	3.00	1	5	*
My assessment of the system are						
Usefulness/Useless[3]	-0.94	-1.00	-2.00	-2	1	
Pleasant / Unpleasant[3]	-0.35	0.00	0.00	-2	1	
Bad / Good[4]	-0.94	-1.00	-1.00	-2	0	
Nice / Annoying[3]	-0.35	-1.00	-1.00	-2	2	
Effective / Superfluous[3]	-0.82	-1.00	-2.00	-2	1	
Irritating / Likeable[4]	-0.12	0.00	0.00	-2	1	
Assisting / Worthless[3]	-0.82	-1.00	-1.00	-2	2	
Undesirable / Desirable[4]	-0.76	-1.00	-1.00	-2	2	
Raising alertness / Sleep-inducing[3]	-1.18	-1.00	-2.00	-2	2	
Usefulness Scale[3]	-0.94	-1.00	-1.80	-2	1.2	
Satisfying score[3]	-0.40	-0.25	-0.50	-2	1	

	Mean	Median	Mode	Min	Max [1]
Vehicle Options[5]					
If you could have 6 options, which 6 would you choose:					
Heated seats	0.47	0.00	0.00	0	1
Intersection violation warning system	0.47	0.00	0.00	0	1
Satellite radio	0.35	0.00	0.00	0	1
Leather seats	0.29	0.00	0.00	0	1
Side impact airbags	0.88	1.00	1.00	0	1
Sunroof	0.12	0.00	0.00	0	1
MP3 player	0.18	0.00	0.00	0	1
Adaptive Cruise control	0.71	1.00	1.00	0	1
Electronic stability control	0.59	1.00	1.00	0	1
Bluetooth phone integration	0.12	0.00	0.00	0	1
Tire pressure monitoring gauge	0.59	1.00	1.00	0	1
HID headlamps	0.29	0.00	0.00	0	1
Navigation system	0.53	1.00	1.00	0	1
Backup camera	0.35	0.00	0.00	0	1
System Specific Questions					
What is the maximum price you would pay for this warning system?	$470.00	$450.00	$500.00	$0.00	$2,000.00
At the actual price of $300, how likely would be to consider purchasing this warning system?[6]	3.28	4.00	4.00	1	5
Did you receive a warning from the system during your drive?[7]	0.94	1.00	1.00	0	1
Which parts of the alert did you notice and which did you notice first?[8]	Noticed Verbal warning, light too small Sometimes noticed the light first, but was more aware of the voice The noise Blue Light (first) Voice Noticed light first (blue). Also noticed red light and voice alert Change cd player; stop sign Brake verbal warning 1. Blue light; sound Blinking blue light Blue Light (1st), voice & red flashing light the light Voice NA blue light				

	Mean	Median	Mode	Min	Max [1]
	Blue light-voice				
	Intersections/stop signs				
	The light (noticed first) and the voice				
What did you think of the timing of the alert?	about right				
	The voice could come sooner				
	too late, noise should be earlier				
	Suitable for the speed I was going				
	could maybe used 1-2 additional seconds, but as drive progressed, I got used to using it and the timing seemed ok				
	stop sign took me by surprise				
	Okay				
	blue light came on a bit early for my taste				
	It was about right. It allowed enough time to react-had to adjust stopping with the slow braking system.				
	Good				
	Ok				
	The timing was good.				
	Good				
	NA				
	Ok				
	Ok				
	Good				
	excellent timing				

[1] Also asked on the post-drive questionnaire without system

[2] Rating scale: 1=strongly agree, 2= mildly agree, 3=agree and disagree equally, 4= mildly disagree, 5=strongly disagree

[3] Rating scale**:** -2 to + 2

[4] Rating scale : +2 to -2

[5] Response code: 0=would not choose, 1=would choose

[6] Rating scale: 1=definitely would not consider, 2, 3=might or might not consider, 4, 5=definitely would consider

[7] Response code: 0=No, 1=Yes

[8] One participant chose not to answer this question.

Table 21-2 Post-drive questionnaire responses – without system

	Mean	Median	Mode	Min	Max
General Questions[1]					
I am familiar with the operation of the warning system	2.83	2	2	1	5
I am confident with my ability to drive a car safely without the warning system	2.00	1	1	1	5
The warning system made driving safer for me and others	3.67	4	5	1	5
The warning system would help me drive more carefully than I normally would	3.11	3	3	1	5
I won't use the warning system, but other drivers in my household would benefit	3.28	3	3	2	5
I would like the next car I purchase to have this warning system.[2]	Yes				
	Not sure…some systems may be very beneficial				
	No				
	Yes				
	no, because I didn't notice it. If it did, it would need to do something to get my attention better				
	Yes				
	Maybe				
	Yes				
	Not sure				
	Yes				
	Don't know				
	Not really				
	Did not see the system operate				
	yes				
	no				

[1] Rating scale: 1=strongly agree, 2= mildly agree, 3=agree and disagree equally, 4= mildly disagree, 5=strongly disagree

[2] Three participants chose not to answer this question.

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