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16. Abstract

Imagine yourself driving along a dark foggy road, you are lost, are becoming worried, and refuse to pull over for any period of time in an unfamiliar area. To belay fears you switch on the in-vehicle map. This should help you to determine where you are and how to return to familiar territory. When you are scrolling through menu options your cell phone rings and you answer. At the same time your child in the back seat starts to cry and a buzzer in the vehicle is warning of a potential engine failure. All of a sudden, in the fog you see a vehicle approaching youÖ in your lane! While this example is exaggerated, it is a situation where a driver is presented with a variety of distracters that singularly or in concert may detract from the driving task and detract from a driverís ability to react to an emergency event. Previous research has shown that singular distracters, such as cell phones, can significantly detract from the driverís ability to perform the driving task. However, despite the marked influence on the driving task, little research has evaluated the relative influence of differing levels of distracter complexity influence driver behavior. The purpose of the two experiments presented here was to perform preliminary tests to determine if varying levels of distracter complexity differentially influence driver behavior. A second purpose was to determine the influence of varying levels of distracter complexity on driversí ability to react to an emergency event. Results of the studies indicate that driver performance was degraded with the introduction of a distracter and when the distracter is presented through a visual information delivery mode driver performance was degraded differentially with differing levels of distracter complexity. Results also indicate that when drivers are presented with an emergency response scenario their primary reaction is to brake. However, the number of participants who braked increased with the inclusion of a distracter and was differentially influenced by the level of complexity of the distracter. These results lend support to the contention that driver performance is negatively influenced by the inclusion of and increasing levels of complexity of a distraction and that this may be due to increasing amount of attentional resources that are captured with the introduction of a distracter.

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EFFECTS OF IN-VEHICLE DISTRACTER COMPLEXITY

ON DRIVING AND EMERGENCY RESPONSE PERFORMANCE

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ABSTRACT

Imagine yourself driving along a dark foggy road, you are lost, are becoming worried, and refuse to pull over for any period of time in an unfamiliar area. To belay fears you switch on the in-vehicle map. This should help you to determine where you are and how to return to familiar territory. When you are scrolling through menu options your cell phone rings and you answer. At the same time your child in the back seat starts to cry and a buzzer in the vehicle is warning of a potential engine failure. All of a sudden, in the fog you see a vehicle approaching youÖ in your lane! While this example is exaggerated, it is a situation where a driver is presented with a variety of distracters that singularly or in concert may detract from the driving task and detract from a driverís ability to react to an emergency event. Previous research has shown that singular distracters, such as cell phones, can significantly detract from the driverís ability to perform the driving task. However, despite the marked influence on the driving task, little research has evaluated the relative influence of differing levels of distracter complexity on driver behavior. The purpose of the two experiments presented here was to perform preliminary tests to determine if varying levels of distracter complexity differentially influence driver behavior. A second purpose was to determine the influence of varying levels of distracter complexity on driversí ability to react to an emergency event. Results of the studies indicate that driver performance was degraded with the introduction of a distracter and when the distracter is presented through a visual information delivery mode driver performance was degraded differentially with differing levels of distracter complexity. Results also indicate that when drivers are presented with an emergency response scenario their primary reaction is to brake. However, the number of participants who braked increased with the inclusion of a distracter and was differentially influenced by the level of complexity of the distracter. These results lend support to the contention that driver performance is negatively influenced by the inclusion of and increasing levels of complexity of a distraction and that this may be due to increasing amount of attentional resources that are captured with the introduction of a distracter.

EXECUTIVE SUMMARY

Driver distraction, according to Stutts, Reinfurt, Staplin, and Rodgman (2001) ìoccurs when a driver is delayed in the recognition of information needed to safely accomplish the driving task because some event, activity, object, or person within or outside the vehicle compels or induces the driverís shifting attention away from the driving task.î Previous research examining the influence of distracters on driving performance has indicated that, in general, various aspects of driving performance degrade with the introduction of a distracter (Brown & Poulton, 1961; Lamble, Kauranun, Laasko, & Summala, 1999; Reed & Green, 1999; Serafin, Wen, Paelke, & Green, 1993). Most recently, with the popularity of cellular telephones and the conception that they detract from the task of driving, many research efforts have been directed at examining their influence on the driving task (Alm & Nilsson, 1994; Alm & Nilsson, 1995; Briem, & Hedman, 1995; Brookhuis, De Vries, & De Waard, 1991; Kames, 1978; Lamble, Kauranun, Laasko, & Summala, 1999; McKnight & McKnight, 1993; Redelmeier & Tibshirani, 1997; Reed & Green, 1999; Serafin, Wen, Paelke, & Green, 1993; Stein, Parseghian, & Allen, 1987; Zwahlen, 1998). Additionally, the results of some studies (Briem & Kedman, 1995; McKnight & McKnight, 1993) lend support to the contention that varying levels of cognitive demands may differentially influence driver performance. A limitation to these studies is that they did not directly address the influence of varying levels of complexity of a single distracter presented via a single information delivery mode such as vision or audition. Without directly comparing various degrees of complexity of a single distracter, any veridical conclusions drawn about the influence of varying levels of complexity of a distracter would be tenuous. A purpose of the present investigation is to determine if varying levels of complexity of a single distracter differentially influence various aspects of general driver performance.

It is not difficult to imagine that the influence of a distracter may play an increasingly significant role as the driving situation becomes increasingly more dangerous. If the results of previous distraction research are extrapolated to emergency response events, such as a head on collision, it is expected that driver performance would be negatively impacted by the addition of a distracter.

The purpose of the two experiments presented here was to perform preliminary tests to determine if varying levels of distracter complexity differentially influence driver behavior. A second purpose was to determine the influence of varying levels of distracter complexity on driversí ability to react to an emergency event. A total of 60 drivers participated in two studies: one study examined the influence of an auditory distracter and one study examined the influence of a visual distracter on general driving performance and on emergency event response performance. General driving performance consisted of straight line driving on a generic suburban roadway while the emergency event consisted of a motorcycle approaching the driver in their lane. Results of the studies indicate that driver performance was degraded with the introduction of a distracter and when the distracter is presented through a visual information delivery mode driver performance was degraded differentially with differing levels of distracter complexity. Results also indicate that when drivers are presented with an emergency response scenario their primary reaction is to brake. However, the number of participants who braked increased with the inclusion of a distracter and was differentially influenced by the level of complexity of the distracter. These results lend support to the contention that driver performance is negatively influenced by the inclusion of and increasing levels of complexity of a distraction, and that this may be due to increasing amount of attentional resources that are captured with the introduction of a distracter.

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CHAPTER ONE - REVIEW OF LITERATURE

Imagine yourself driving along a dark foggy road, you are lost, becoming worried, and refuse to pull over for any period of time in an unfamiliar area. To belay fears you switch on the in-vehicle map. This should help you to determine where you located and how to return to familiar territory. When you are scrolling through menu options your cell phone rings and you answer. At the same time your child in the back seat starts to cry and a light in the vehicle is indicating low fuel. All of a sudden, in the fog you see a vehicle approaching youÖ in your lane! This is a situation where a driver is presented with a variety of distracters that singularly or in concert may detract from the driving task and detract from a driverís ability to react to an emergency event. The ability to focus in an environment without distraction is generally desirable when trying to successfully complete visual, behavioral, and/or cognitive tasks and, as indicated in the example, in a driving environment this ability may be critical to a driverís safety and survival. The effect of distracters on the driving task and the rates of crashes can be extensive. According to estimates from the National Highway Traffic Safety Administration driver inattention is involved in a minimum of 25% of crashes: half of these crashes involve a form of inattention called driver distraction. It is because distracters play a significant role in the ability to successfully operate a vehicle and avoid crashes and because distracters potentially account for a significant number of crashes that it is necessary to understand the extent of their influence under a variety of normal and emergency driving situations.

Driver distraction, according to Stutts, Reinfurt, Staplin, and Rodgman (2001) ìoccurs when a driver is delayed in the recognition of information needed to safely accomplish the driving task because some event, activity, object, or person within or outside the vehicle compels or induces the driverís shifting attention away from the driving task.î Examples of driver attention variables in that report included attentive, distracted, looked but did not see, sleepy/fell asleep, and unknown or no driver. Examples of driver distraction variables included eating or drinking, outside person/object/event, adjusting radio/cassette/CD, other occupants in vehicle, moving object in vehicle, smoking related, talking or listening on cell phone, dialing a cell phone, using a device that was brought into the vehicle, using a device/controls that were integral to the vehicle, adjustment of climate controls, other distraction, and unknown distraction. In the working example the distracters inherent in the situation for the stressed driver included the dark foggy road, the in-vehicle map, the cell phone, the child screaming in the rear seat, and the low fuel indication light. All of these items served to redirect the attention of the driver away from the task of operating the vehicle and to those specific activities and objects both within and outside the driverís vehicle. While the example is exaggerated it is important to recognize that most typical driving environments contain many of the cited driver distractions that may induce the shifting of attention away from the driving task.

Previous research examining the influence of distracters on driving performance has indicated that, in general, various aspects of driving performance degrade with the introduction of a distracter (Brown & Poulton, 1961; Lamble, Kauranun, Laasko, & Summala, 1999; Reed & Green, 1999; Serafin, Wen, Paelke, & Green, 1993). Most recently with the popularity of cellular telephones and the conception that they detract from the task of driving many research efforts have been directed at examining their influence on the driving task (Alm & Nilsson, 1994; Alm & Nilsson, 1995; Briem, & Hedman, 1995; Brookhuis, De Vries, & De Waard, 1991; Kames, 1978; Lamble, Kauranun, Laasko, & Summala, 1999; McKnight & McKnight, 1993; Redelmeier & Tibshirani, 1997; Reed & Green, 1999; Serafin, Wen, Paelke, & Green, 1993; Stein, Parseghian, & Allen, 1987; Zwahlen, 1998). This research has generally shown that singular distracters, such as cellular phones, can detract significantly from the driverís ability to perform the driving task, presumably by reallocating attentional resources away from the driving task.

If the results of research examining the influence of driver distractions and cellular telephone use were used as a guideline for real world driving situations, it would appear that all potential distractions should be minimized in order to provide the driver with an optimal environment in which to operate his/her vehicle. This type of approach would be consistent with traditional information processing capacity theory that suggests a personsí total amount of attention that can be directed to one or more tasks is limited, that different tasks demand differing amounts of attention, and that when the amount of available attention does not meet task demands performance will degrade (Kahneman, 1973; Keele, 1973). In allied areas participants are encouraged to reduce the number of tasks in order to free up attentional resources (Cox, 1990). However, given the desire for personal liberties eliminating or greatly reducing the number of distracters is not a reasonable goal. One approach might be to reduce the attentional demands of one or more distracters. Research examining this proposition within the context of driver distraction and/or cellular telephone use is limited. The results of some studies (Briem & Kedman, 1995; McKnight & McKnight, 1993) lend support to the contention that varying levels of cognitive demands may differentially influence driver performance. Briem and Hedman (1995) examined the influence of various cellular telephone related activities including answering and dialing a cellular telephone using hands-free mode, tuning a radio, engaging in a casual conversation, or answering cognitively engaging questions on driversí performance. Results indicated that performance degraded slightly when drivers engaged in a casual conversation and that performance could suffer even further when they engaged in cognitively engaging questions. These results are consistent with McKnight and McKnight (1983). In their study drivers experienced four conditions consisting of tuning a radio, manually dialing a cellular telephone, engaging in a casual conversation, and engaging in problem solving while being presented with a series of traffic situations that required a response. The authors indicate that engaging in casual conversation resulted in significantly less performance decrements than engaging in problem solving. These results lend support the limited information processing capacity approach. However, a limitation to these studies is that they did not directly address the influence of varying levels of complexity of a single distracter presented via a single information delivery mode such as vision or audition. Without directly comparing various degrees of complexity of a single distracter any veridical conclusions drawn about the influence of varying levels of complexity of a distracter would be tenuous. A purpose of the present investigation is to determine if varying levels of complexity of a single distracter differentially influence various aspects of general driver performance.

Emergency Response Performance

In our working example, the driver of the vehicle encountered another vehicle approaching them in their own lane. This lane-crossing situation is analogous to a drunk driver, another distracted driver, or to a person performing a passing maneuver in a no-passing zone who may have crossed the centerline without that realization or concern. These types of situations are not common, are non-linear events, and are very short-lived but it is an event most drivers will be required to deal with at some time during their driving tenure. When the margins of safety (Gibson & Crooks, 1938) in these situations are small and sometimes non-existent it would seem tenable that the degradation in driver performance due to the presence of a distracter could have a significant effect on successfully avoiding a potentially catastrophic crash. With regard to the performance of emergency responses in crash likely situations there is a question of ëwhatí behaviors drivers typically exhibit and whether these behaviors facilitated avoidance of the impending crash.

Work performed by Malaterre, Ferrandez, Fleury, and Lechner (1988) involved observing 72 crashes in the Salon-de-Provence region of France and comparing actual emergency response performances against performances that would have resulted in successfully avoiding the crash. Their work indicated that all emergency response maneuvers failed, that the emergency response performed most often was braking, that if drivers did steer they most often did so in the direction of the obstacle, and that 43% of the crashes could have been avoided had at least one driver performed a different emergency response such as a slight sideways movement. The tendency of drivers to typically perform braking maneuvers in emergency situations was confirmed by Hatterick and Bathurst (1976), Lechner and Malaterre (1991), Rice and DellíAmico (1974), who found that 62.8%, 67%, and 70.5% of drivers, respectively, began by braking in an emergency maneuver. More recently Adam, Flannagan, and Sivak (1995) and Kloeppel, Peters, James, Fox, and Alicandri (1995) examined emergency response performances in an interactive driving simulator. In their work Adams, Flannagan, and Sivak attempted to identify the various behaviors drivers perform when attempting to avoid an obstacle on the road given relatively short preview distances and relatively high travel speeds and were also interested in examining the influence of driver age and sex on emergency response behaviors. Drivers were assigned to either a younger (16-19 yrs), middle age (31-47 yrs), or older age group (64-70 yrs) with each age group divided equally by sex. Drivers were placed in the driving environment simulator and viewed two-lane roadways consisting of straights, curves, and hills with the background of each area consisting of mountains. During the experimental session, while drivers were cresting a hill, they encountered a rock in the middle of their lane that they were not aware of ahead of time. After responding to this emergency event, participants continued to drive the simulated world and encountered additional rocks about 50% of the time. Results of the investigation indicated emergency response performance for the first rock occurrence consisted of eight drivers steering, three drivers braking and steering, and one subject braking only. Successfully missing the rock was accomplished by steering only, but only five drivers performed this action and were successful. Sex did not affect the type of response behavior. For the remainder of the rock events that were anticipated drivers braked and steered, steered only, and braked only 51%, 46%, and 3% of the time, respectively. In addition, the emergency maneuver that produced the highest success rate was braking and steering (96%), followed by steering only (67%), followed by braking only (0%). These results are in contrast to other real world and driving environment simulator studies that indicated braking was the primary reaction to an emergency situation. The significant propensity of drivers to steer away form the obstacle may be due to the relatively small size of the rock. Earlier examinations of driver performance in emergency situations typically have used or observed real-vehicles.

In a similar study Kloeppel, Peters, James, Fox, and Alicandri (1995) investigated the emergency response performances of younger, middle age, and older age male and female drivers (n=36) in response to two different emergency events each presented at two difficulty levels. The emergency events consisted of an oncoming vehicle performing a left turn maneuver in front of the driverís vehicle and of a vehicle pulling out suddenly from the right side. Varying the amount of time the drivers had to react created the two difficulty levels. Results of the study indicated no significant differences in the number of crashes for age, sex, event type, or event difficulty, indicated non-significant reaction times for both age and sex, and indicated that all drivers performed braking maneuvers and few drivers performed braking and steering.

Collectively the results of these studies and earlier studies (Barrett, Kobayashi, & Fox 1966; Hatterick & Bathurst 1976; Lechner & Malaterre 1991; Limpert & Gamero

1974; Malaterre, Ferrandez, Fleury & Lechner 1988) (see also Ferrandez, Fleury & Lepesant 1984; Fleury, Ferrandez, Lepesant & Lechner 1988; Malaterre, Peytavin, Jaumier & Kleinmann 1987; Rundkvist 1973 cited in Adams 1994) are generally consistent and indicate that emergency response behaviors for most drivers consisted of braking and further indicate that the most successful emergency response behavior exhibited by drivers was steering or braking and steering combined. It is counter-intuitive that most drivers attempt to avoid an emergency event by applying the brakes due to the fact that braking does little to alter the lateral location of driverís vehicle thus removing them from harmís way. In addition, under heavy braking the front wheels of the vehicle have a higher propensity for ëlocking upí which quite effectively eliminates any control the driver may have had over the vehicle and subsequently avoiding the event.

Distraction, Response Performance, and Emergency Response Performance

With a substantial increase in cellular telephone use within the last decade there is the question of the influence of this type of distracter on events where a driver response is required in a very short period of time to avoid future problems. Alm and Nilsson (1994) examined the influence of a cellular telephone task that included having the driver answer a phone and complete a standard cognitive test and the influence of two levels of driving environment difficulty on driving performance in a driving environment simulator. Drivers were to apply the brakes of their vehicle when a red square was shown in the driving scene. Results of their study indicated the inclusion of the phone answering and cognitive test task negatively impacted response time to the appearance of the red square. These results provide initial support for the contention that driving performance, in particular, reaction to an event becomes degraded when a driver is presented with an in-vehicle distracter. Additional support for this contention was presented in 1995 by Alm and Nilsson who examined the influence of cellular telephone use on driver performance when following a lead vehicle in a driving environment simulator. Drivers were assigned to either a telephone answering/cognitive task condition or a no telephone task condition and were instructed to follow the lead vehicle and brake or engage the left-turn signal when the lead vehicle either braked or engaged the right turn signal, respectively. Results indicated when drivers engaged in the telephone answering/cognitive task their response time to the change in state of the lead vehicle increased significantly compared to the no telephone task. In another car following experiment Lamble, Kauranun, Laasko, and Summala (1999) investigated the degree of influence a cognitive task and a cellular telephone dialing task on driving performance when following a lead vehicle that eventually decelerated. Results of the investigation support the contention that event response capabilities are compromised when drivers are presented with a secondary task. Specific to the current study, driverís time to collision threshold increased significantly with the inclusion of the cognitive task and with the inclusion of the cellular telephone dialing task. In an examination of the influence of an in-vehicle distracter on a decision making maneuver Hancock, Simmons, Hashemi, Howarth, and Ranney (1999) performed a study on a closed-loop test track. Participants performed a series of trials in which they drove the track and were required to obey a lighted red-yellow-green traffic signal. On 30 of the 60 trials drivers were not presented with the distraction task or presented with a changing traffic signal. Ten of the trials consisted of the driver being presented with a distraction task that consisted of determining if there was a match between a presented number and a number that had been presented previous to the trial, and then confirming a match/no-match condition on a touch screen. Ten of the trials required the driver to make a sudden stop when the traffic signal changed from green to red. The final ten trials presented the driver with both the distraction task and the sudden stop at the traffic signal. Results of their work indicated brake response times were slower for the sudden stop at the traffic signal when the distracter was presented. While stopping times decreased for the sudden stop at the traffic signal while the distracter was present, there was an approximately 25% reduction in stationary distance from the intersection. The authors indicate decreased levels of performance for distracter response accuracy and number recall accuracy that lends support to the contention that there was a competing task for drivers while performing the decision at the traffic signal. While the driverís task in this situation is not an emergency response event, it does represent a situation where the driver must make a decision in a very short period of time and implement that decision to avoid breaking the law and potentially being involved in a serious crash.

It is not difficult to imagine that the influence of a distracter may play an increasingly significant role as the driving situation becomes increasingly more dangerous. This type of situation is exemplified in the example presented earlier where our driver was being distracted and was required to perform the correct emergency response in order to prevent a collision with the approaching vehicle. Given the potentially significant impact of these situations little is known of how drivers respond to a true emergency event while being distracted. However, if the results of previous distraction research are extrapolated to emergency response events, such as a head on collision, it is expected that driver performance would be negatively impacted by the addition of a distracter. One study may provide initial insight into these behaviors. Crawford, Manser, Jenkins, Court, and Sepulveda (2001) examined the influence of high and low complexity conversations and hand-held and hands-free cellular telephone use on general driving performance and emergency response performance. As part of the study, drivers navigated their vehicle down a standard two lane road and engaged in one of four cellular telephone conditions: high intensity conversation while using a hands free cellular telephone, high intensity conversation while using a hand held cellular telephone, low intensity while using a hands free cellular telephone, and a low intensity conversation while using a hand held cellular telephone. At the conclusion of the cellular telephone conversation a white delivery truck suddenly appeared directly in front of the driverís vehicle with a time to collision of 2.6 seconds. Drivers were not informed ahead of time about the emergency event. No performance benefits for were observed during the emergency event for hand free versus hand held cellular telephone use and no decrement in performance was observed for the high intensity versus the low intensity conversation. Results did indicate females exhibited significantly greater response times than their male counterparts. In general though, these results are inconsistent with previous distraction research examining general driving behaviors and inconsistent with the limited information processing capacity approach that would postulate the addition of one or more tasks would demand more attentional capacity and result in performance decrements. The results may be due to several methodological constraints. In particular, the authors indicated challenges in creating and sustaining high complexity naturalistic conversations. This challenge was compounded by the fact a baseline condition in which drivers responded to the emergency event without a distracter was not included in the study. This limits the ability of the study to confirm the basic influence of a distracter on driving performance. Finally, previous research has shown that the presentation of ecologically invalid artificial driving scenarios can significantly impact how drivers respond to a driving event (Hancock & Manser, 1997; Manser & Hancock, 1996). Relative to Crawford et al, driver performance may have been significantly impacted by the ecologically invalid sudden appearance of the white van.

Purpose of this Study

The purpose of the pilot work presented here was to determine if varying levels of complexity of a single in-vehicle distracter delivered via an auditory information delivery mode would differentially influence general driving performance and emergency response performance. With regard to general driving performance the present study sought to confirm previous results indicating the degradation of general driving performance with the introduction of a distracter and to examine the influence of the various levels of complexity of a distracter. If performance degrades markedly more when drivers experience a high complexity distracter relative to a low-complexity distracter, it would indicate that markedly more attentional resources were being directed away from the driving task. This would also indicate that the distracters should be designed to minimize complexity for the user.

An additional purpose of the pilot work presented here was to examine the influence of various levels of complexity of a distracter on emergency response performance and sought to address the challenges associated with Crawford et al. If the ability of drivers to respond to an emergency event is differentially affected with the introduction of a distracter it would support the contention that valuable attentional resources redirected from the driving task.

CHAPTER TWO - EXPERIMENT ONE METHODLOGY

Experimental Participants

Participants in this study were fifteen males (mean age = 30.1, standard deviation = 9) and fifteen females (mean age = 33, standard deviation = 14.5) between 18 and 71 years of age. Participants were recruited from Texas Transportation Institute staff and from the surrounding community. All participants possessed a valid drivers license, 20/40 vision or corrected to 20/40 vision via contact lenses or glasses, and possessed no apparent physical or cognitive limitations that would have affected performance in this study.

Experimental Apparatus

The apparatus used for this study was a driving environment simulator (DESi). DESi consisted of three white polypropylene screens (each screen was 2.28 m (90 in) in height and width, a 1995 Saturn SC2 complete vehicle, three image generation computers, one data collection computer, and three liquid crystal display projectors. The driving scene presented to participants was generated by GlobalSim Corporation Hyperdrive software (Version 1.2) and projected through three Proxima 6810 liquid crystal display projectors to the screens. The three separate images projected onto the screens were aligned so they appeared as one single image covering a 150∫ field of view horizontally and a 50∫ field of view vertically for the driver. Participants sat in the driverís seat of the 1995 Saturn SL2, positioned in the center of the DESi (see Figure 1. for a schematic). Participantsí performance measures were collected via the data collection computer connected to the vehicle's steering column, brake pedal, and gas pedal at a sampling rate of 60 times per second. Driver performance data collected as part of this experiment included vehicle velocity, vehicle lane position, time and magnitude of brake application, and time and magnitude of gas pedal application.

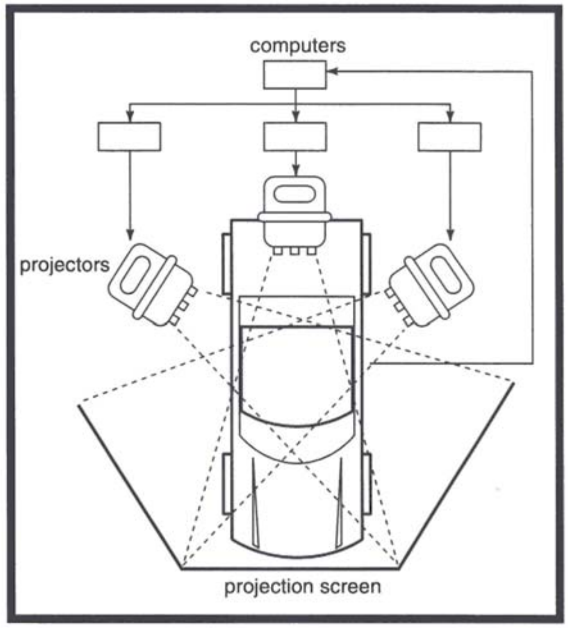

Figure 1. Schematic of the driving environment simulator at the Texas Transportation Institute.

Experimental Procedures

Upon entering the DESi, participants read and then signed the Human Subjects Consent form and were then seated in the Saturn. Each participant was randomly assigned to one of three groups with an equal number of females and males in each group. The three groups were a control no distraction group, a low-complexity distraction group, and a high-complexity distraction group. Participants assigned to the low-complexity and high-complexity distraction groups then performed baseline addition tasks. Participants in the low-complexity distraction group were presented with simple addition tasks, one at a time for a period of two minutes, via an intercom system linking the interior of the Saturn to the experimental control station. For example, participants might have been told ìPlease add 10 plus 40î. A full list of the addition tasks employed for this group can be found in the Appendix section. If a participant did not respond eight seconds after the addition task was presented, the experimenter read out the next addition task. Participantsí number of correct responses and total number of responses were recoded. Procedures for the high-complexity distraction group were identical except participants were presented with addition tasks read to them as ìPlease add 13 plus 48î. A full list of the addition tasks employed for this group can be found in the Appendix section. The low-complexity and high-complexity addition tasks were randomly generated, were identical for all participants within a specific distraction group, and were presented in the same order for each participant within a specific distraction group.

Participants then performed a five-minute practice drive to become familiar with the control and operation of the vehicle. The practice drive consisted of having the participant follow a lead vehicle that traveled at 56 km/h (35 mph) for five minutes on a road consisting of straight and curved two-lane highway sections replete with traffic and roadside features such as houses, barns, fields, etc. to the side of the roadway.

Additional instructions were then provided to each participant regarding their experimental task. In particular, participants were told to drive in a normal fashion, to maintain a speed of 64 km/h (40 mph), to obey all traditional and observable traffic laws, and to respond appropriately and ëas best they couldí to the two two-minute addition tasks. The experimental drive then began. The computer generated driving scenario of the experimental drive consisted of an 8 km (5 miles) two-lane roadway with the first 4 km being straight roadway, the fifth km consisting of a large curve, and the last 3 km consisting of a long deep decline (valley) followed by a steep hill. As the participant drove up and then began cresting the steep hill a motorcycle appeared on the horizon in the center of the participantís lane driving directly toward the participantís vehicle. The period of time between the appearance of the motorcyclistís helmet on the horizon and collision between the two vehicles was 2.8 seconds. To create the 2.8-second time to collision, the speed of the motorcycle was continually modulated based on the driverís speed. The 2.8 seconds time to collision was chosen because it afforded drivers an opportunity to avoid the collision successfully if they performed the correct driving maneuvers while not affording an excessive amount of time. Participants were not provided with information regarding the motorcycle event. Unknown to all participants when they reached 3 km into the driving world, a straight section of roadway, performance data was collected for a period of two minutes (same two minute period when drivers in the low and high level of complexity distraction conditions preformed math tasks). When participants reached the bottom of the hill, approximately 7 km into the drive, performance data was again collected from that point until approximately ten seconds after the motorcycle appeared on the horizon.

Participants assigned to the no distraction control group simply drove through the experimental drive without performing any addition problems. Participants assigned to the low and high complexity distraction groups completed new low and high complexity randomly generated addition tasks respective to each group during each of the two performance data collection zones. The low and high complexity addition tasks for the experimental drive can be found in the Appendix section. Immediately following the completion of the first two-minute data collection zone drivers in each of the three distraction conditions performed a Modified Cooper-Harper mental workload assessment. The purpose of the assessment was to verify that driversí mental workload was significantly higher in the no distraction condition as compared to the low level of complexity distraction condition and significantly higher in the high level of complexity distraction condition. Assessing mental workload after the second two minute data collection zone was not possible as driversí estimates of mental workload would be confounded due to the stress imposed by the emergency event response. Immediately following the emergency event response participants finished the experiment and exited the vehicle.

Experimental Design

General driving performance data (data collected during the first and the second two-minute driving sections) consisted of mean velocity, standard deviation of velocity, mean lane position, and standard deviation of lane position and were analyzed in a 2 x 3 (sex by level of distraction) analysis of variance with sex and level of distraction (no distraction, low distraction, high distraction) as the between-subjects variables. The alpha level was set at .05 and significant differences were distinguished using Tukeyís Honestly Significant Difference (HSD) post hoc test.

Emergency response performance data consisted of discrete driver actions that included accelerator (acceleration or no acceleration), brake (braking or no braking), and steering behavior (steered left, right, or continued straight) in relation to the no distraction, low complexity distraction, and high complexity distraction conditions for both females and males that were analyzed in a series of chi square tests. The chi square tests compared the discrete driver action variables with the levels of distraction complexity and driver sex. The alpha level was set at .05.

Mental workload scores consisted of a discrete Modified Cooper-Harper score between 0 and 10. Participant scores for level of complexity of distracter (no distraction, low level of complexity of distraction, and high level of complexity) were analyzed using a single variable ANOVA. The alpha level was set at .05 and significant differences were distinguished using Tukeyís Honestly Significant Difference (HSD) post hoc test.

As a further test of the mental demands of the math test and driving task, the percentage of math problems completed by drivers (relative to the total amount that could be performed) and the percentage of correct responses for math problems attempted in the low and high level of complexity distraction conditions for the first of the two data collection zones were analyzed in a single variable ANOVA. The alpha level was set at .05 and significant differences were distinguished using Tukeyís Honestly Significant Difference (HSD) post hoc test.

CHAPTER THREE - EXPERIMENT ONE RESULTS

General Driving Performance

There was a sex main effect for standard deviation of velocity, where $F = 5.75$, $p < .05$, with the means for females and males being 3.00 and 2.13 standard deviations, respectively. These results indicate that females in Experiment One varied more in velocity than did males.

Emergency Response Performance

Results from the chi square tests indicated significant differences between some driver responses and levels of distraction complexity for either males or females. However, as expected the limited number of driver responses (less than five) in several categories compromised the validity of the results and the ability to make veridical conclusions based on the results. However, presenting descriptive statistics can still facilitate a general understanding of driversí emergency response performance. In general, emergency event steering response performance while no distracter was presented to drivers consisted mainly of steering either left or right when presented with the approaching motorcycle. When this data is divided by driver sex (see Figures 2 and 3 for females and males respectively) it is evident that under the no distraction condition females steered only to the left or right but when presented with either a low or high complexity distracter females steered either right or continued to drive straight toward the motorcycle. In contrast males steered employed steering left, right, and straight in all three level of complexity distraction conditions but, in general, as level of complexity of the distracter increased males tended to steered to the left less often and continue to drive straight more often.

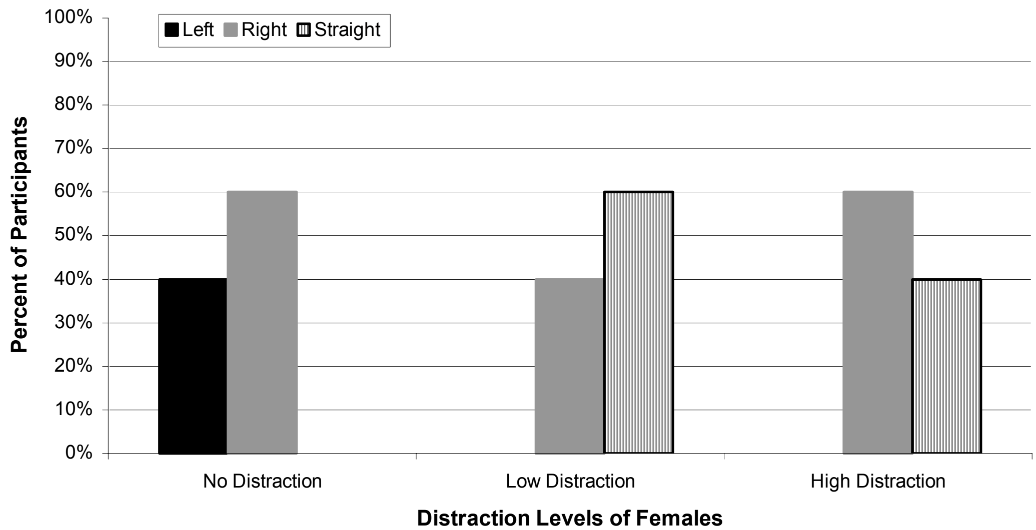

Figure 2. Experiment one emergency event steering responses for females. Under the no distraction condition none of the females drove straight when presented with the emergency response event. However, with the addition of a distracter of either low or high levels of complexity females changed behavior dramatically by splitting steering behavior between steering either right or not steering at all.

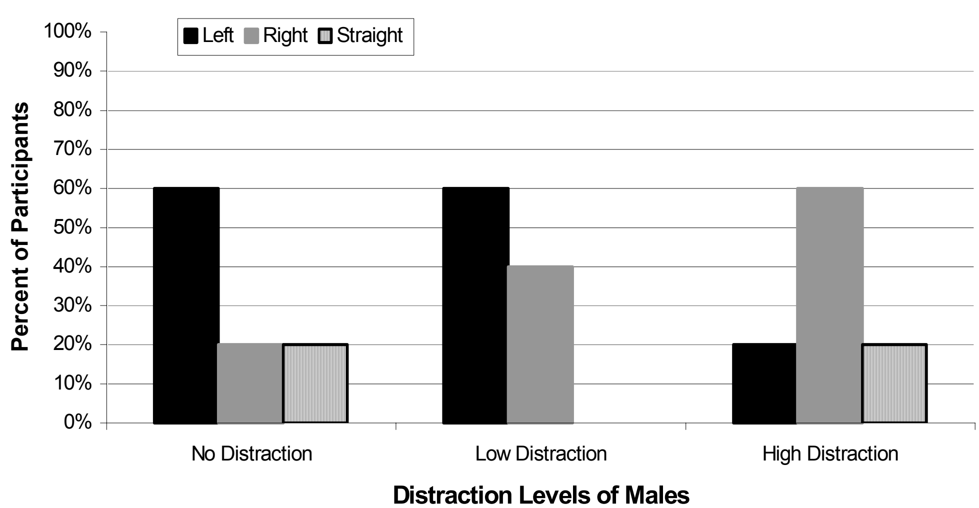

Figure 3. Experiment one emergency event steering response for males. The percent of male participants driving to the left

decreases and the percent of male participant driving to the right increases as the level of complexity of the distracter increases.

Emergency event brake responses for both males and females indicated the majority of drivers applied the brakes when presented with the motorcycle event in the no distraction and low complexity distraction conditions and that an equal number of drivers applied the brakes or maintained acceleration in the high complexity distraction condition. When the data are presented according to driver sex (see Figure 4 and 5 for females and males respectively) it is evident that for the no distraction and low complexity distraction conditions femalesí emergency event braking performance is primarily braking and that in the high complexity distraction condition braking and acceleration are the primary responses. Conversely, males do not have a primary braking behavior under any of the distraction complexity conditions.

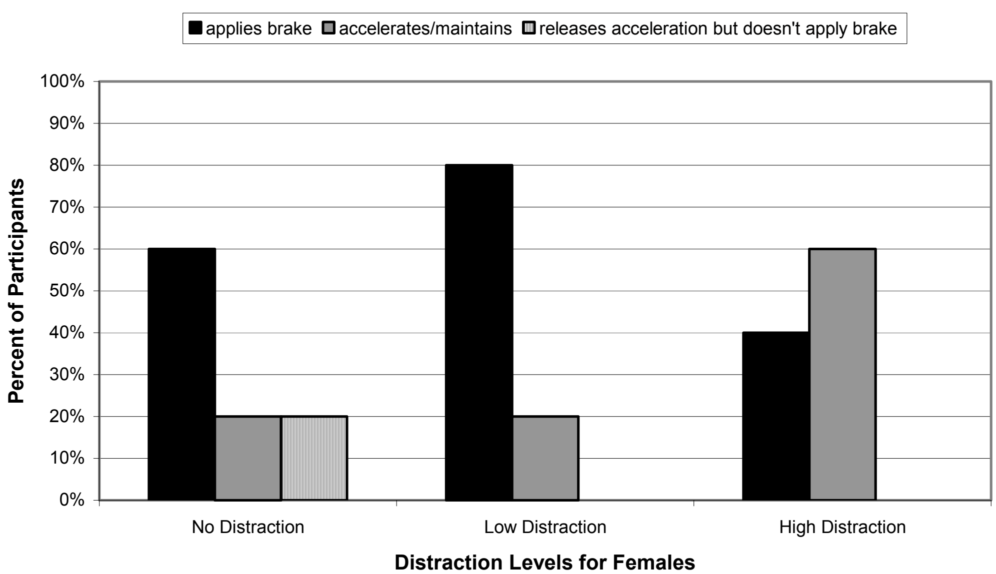

Figure 4. Experiment one emergency event braking responses for females. Consistent with previous research the most common maneuver was to apply the brakes.

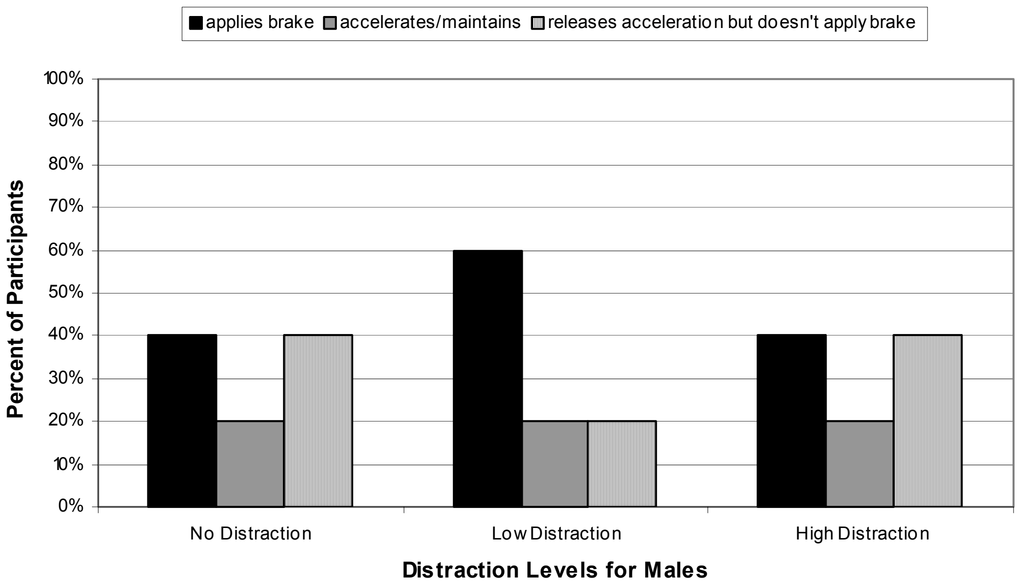

Figure 5. Experiment one emergency event braking responses for males. Note: consistent with previous research the most common maneuver was to apply the brakes.

The number of collisions occurring as a result of the emergency response event for males and females are presented in Tables 1 and 2 coincident with a presentation of emergency event steering and braking responses. In general, 56.7% (17 out of 30) of the emergency response events for drivers resulted in a collision with the approaching motorcycle. When the data are examined according to the driver response it is seen that 10% (3 of 30), 23.4% (7 of 30), and 23.4% (7 of 30) of the drivers collided with the approaching motorcycle when they steered left, steered right, or continued straight, respectively. In general more females collided with the motorcycle than males.

		% Steering Left	**% Steering Right**	**% No Steering**
no complexity	Releases acceleration and applies brake	1 = 20% (1)	2 = 40% (2)	0 = 0% (0)
	Accelerates / Maintains	0 = 0% (0)	1 = 20% (1)	0 = 0% (0)
	Releases acceleration but does not apply brake	1 = 20% (0)	0 = 0% (0)	0 = 0% (0)
low complexity	Releases acceleration and applies brake	0 = 0% (0)	1 = 20% (1)	3 = 60% (3)
	Accelerates / Maintains	0 = 0% (0)	1 = 20% (0)	0 = 0% (0)
	Releases acceleration but does not apply brake	0 = 0% (0)	0 = 0% (0)	0 = 0% (0)
high complexity	Releases acceleration and applies brake	0 = 0% (0)	0 = 0% (0)	2 = 40% (2)
	Accelerates / Maintains	0 = 0% (0)	3 = 60% (1)	0 = 0% (0)
	Releases acceleration but does not apply brake	0 = 0% (0)	0 = 0% (0)	0 = 0% (0)

Table 1. Experiment one emergency response performance for females. Note, for example, 1 = 20%(1) indicates that one driver performed the action, that one driver represented 20% of the drivers for a particular level of distraction complexity condition, and that one of the drivers collided with the motorcycle.

		% Steering Left	% Steering Right	% No Steering
no complexity	Releases acceleration and applies brake	1 = 20% (0)	0 = 0% (0)	1 = 20% (1)
	Accelerates / Maintains	0 = 0% (0)	1 = 20% (0)	0 = 0% (0)
	Releases acceleration but does not apply brake	2 = 40% (1)	0 = 0% (0)	0 = 0% (0)
low complexity	Releases acceleration and applies brake	3 = 60% (1)	0 = 0% (0)	0 = 0% (0)
	Accelerates / Maintains	0 = 0% (0)	1 = 20% (0)	0 = 0% (0)
	Releases acceleration but does not apply brake	0 = 0% (0)	1 = 20% (1)	0 = 0% (0)
high complexity	Releases acceleration and applies brake	0 = 0% (0)	1 = 20% (0)	1 = 20% (1)
	Accelerates / Maintains	0 = 0% (0)	1 = 20% (0)	0 = 0% (0)
	Releases acceleration but does not apply brake	1 = 20% (0)	1 = 20% (1)	0 = 0% (0)

Table 2. Experiment one emergency response performance for males. Note, for example, 1 = 20%(0) indicates that one driver performed the action, that one driver represented 20% of the drivers for a particular level of distraction complexity condition, and that none of the drivers collided with the motorcycle.

Mental Workload, Number and Accuracy of Math Problems Performed

There was a main effect for mental workload, $F = 5.90$, $p < .05$, with the no distraction, low level of complexity distraction, and high level of complexity distraction means being 1.6, 2.8, and 3.6, respectively. Post hoc analysis indicated each mean was significantly different from each other. There was a main effect for the percentage of math problems attempted for the low and high level of complexity distraction tasks, $F = 37.38$, $p < .05$, with means of 44.02% and 19.25%, respectively. There was a main effect for the percentage of correct math problems for the low and high level of complexity distraction tasks, $F = 3.81$, $p < .05$, with means of 98% and 70.6%, respectively. These results provide initial support for the contention that drivers mental effort increased significantly with the introduction of the low level of complexity distracter and significantly more with the introduction of the high level of complexity distracter and that the difficulty of the high level of complexity math problems was significantly greater than the low level of complexity math problems.

CHAPTER FOUR - EXPERIMENT TWO

The purpose of the second experiment was to determine if the results of Experiment one extend to a different type of information delivery mode. If general driving behavior is degraded when drivers are presented with a manual distraction task of various levels of complexity it would confirm results of previous studies indicating that when drivers perform a manual cellular telephone task or other computer based manual task various aspects of general driving behavior can be degraded. Additionally, the purpose of the second experiment was to determine if the emergency event responses observed in Experiment one extend to a manual distraction task of various levels of complexity.

CHAPTER FIVE - EXPERIMENT TWO METHODOLOGY

Experiment two methodology was identical to experiment one methodology with the exception of the following items.

Experimental Participants

Participants in this study were males (mean female age = 25.5, standard deviation = 5) and females (mean male age = 28.9, standard deviation = 13.9) between 18 and 75 years of age.

Experimental Procedures

Participants assigned to the low-complexity distraction group were presented with simple multiple of ten math problems, one at a time, on a 24 mm by 18 mm ELO touch-screen located in the cockpit of the vehicle just to the right of the driver. For example the screen would indicate:

30	1	2	3	enter
+50	4	5	6	
	7	8	9	
		0		

The participantís task was to press the correct answer with their finger and then select an enter button on the touch screen. After selecting the enter button, the next math problem was presented. If the participant did not answer after eight seconds the next problem was presented automatically. Math problems were presented continuously for two minutes. Participants in the high-complexity distraction group performed identical activities except the math problems were more complex. For example, participants would be presented with the numbers 43 and 79. All math problems were randomly generated and were identical for all participants within a specific group.

CHAPTER SIX - EXPERIMENT TWO RESULTS

General Driving Performance

There was a sex main effect for standard deviation of lane position, a level of complexity main effect for standard deviation of lane position, and sex by level of complexity interaction for standard deviation of lane position. The sex main effect for standard deviation of lane position, $F = 10.05$, $p < .05$, with the means for females and males being .32 and .40 meter (1.05 and 1.31 foot) standard deviations, respectively. There was a level of complexity main effect for standard deviation of lane position, $F = 31.00$, $p < .05$. Means for the no distraction, low complexity distraction, and high complexity distraction groups were .23, .47, and .37 meter (.75, 1.54, and 1.21 foot) standard deviations respectively. Post hoc analysis indicated each mean was significantly different from each other. Lastly, there was a sex by level of complexity interaction for standard deviation of lane position, $F = 8.16$, $p < .05$. The average lane position standard deviation for females in the no distraction, low distraction, and high distraction groups was on average .26, .39, and .30 meters, (.85, 1.28, and .98 feet) respectively. The average lane position standard deviation for males in the no distraction, low distraction, and high distraction groups on average were .20, .55, and .44 meters (.66, 1.80, and 1.44 feet) respectively. Figure 6 presents the main effect for sex, the main effect for distraction complexity, and the sex by level of complexity interaction for standard deviation of lane position. The interaction indicates that males and females performed similarly under no distraction conditions but that standard deviation of lane position for males is greater than females under low and high complexity distraction conditions. These results provide initial confirmation of previous research indicating the introduction of a distracter can degrade general driving performance and provide initial support for the contention that various degrees of complexity of a single distracter presented via a single information delivery mode can differentially impact general driving performance.

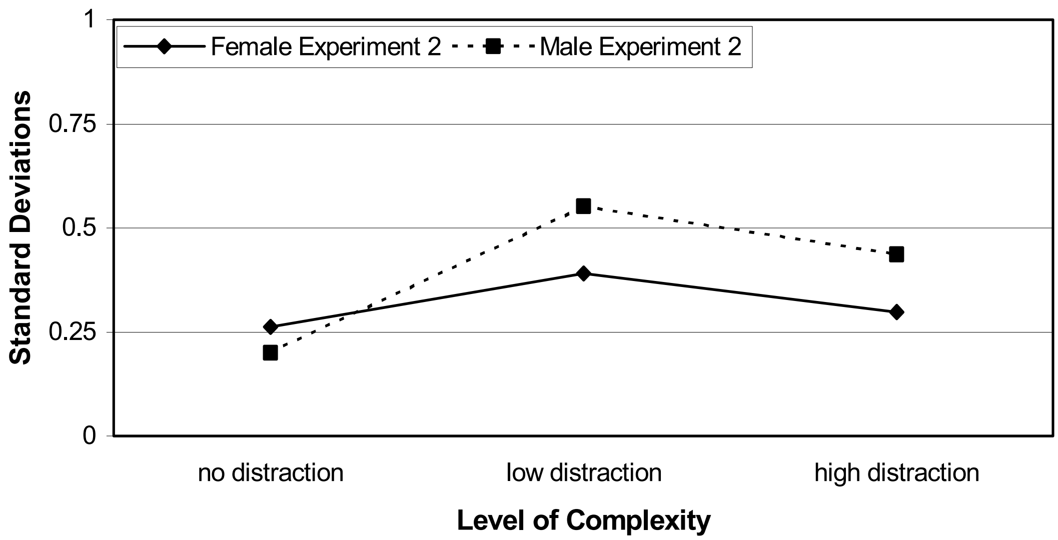

Figure 6. Experiment two sex by level of complexity interaction for standard deviation of lane position. The interaction indicated males and females performed similarly under no distraction conditions but the standard deviation of lane position for males was greater than females under low and high complexity distraction conditions.

Emergency Response Performance

Results from the chi square tests indicated significant differences between some driver responses and levels of distraction complexity for either males or females. However, like Experiment one, the limited number of driver responses (less than five) in several categories compromised the validity of the results and the ability to make veridical conclusions based on the results. Descriptive statistics indicated that in general emergency event steering response performance while no distracter was presented to drivers consisted mainly of continuing to drive straight when presented with the approaching motorcycle. When this data is divided by driver sex (see Figures 7 and 8 for females and males, respectively) it is evident that under the no distraction and low complexity distraction conditions females steered left, right, and continued to drive straight but when presented with a high complexity distraction task all females continued to drive straight toward the approaching motorcycle. In contrast males steered left, right, and straight in the no distraction condition and steered to the left and continued straight in the low and high complexity distraction conditions but did not steer right.

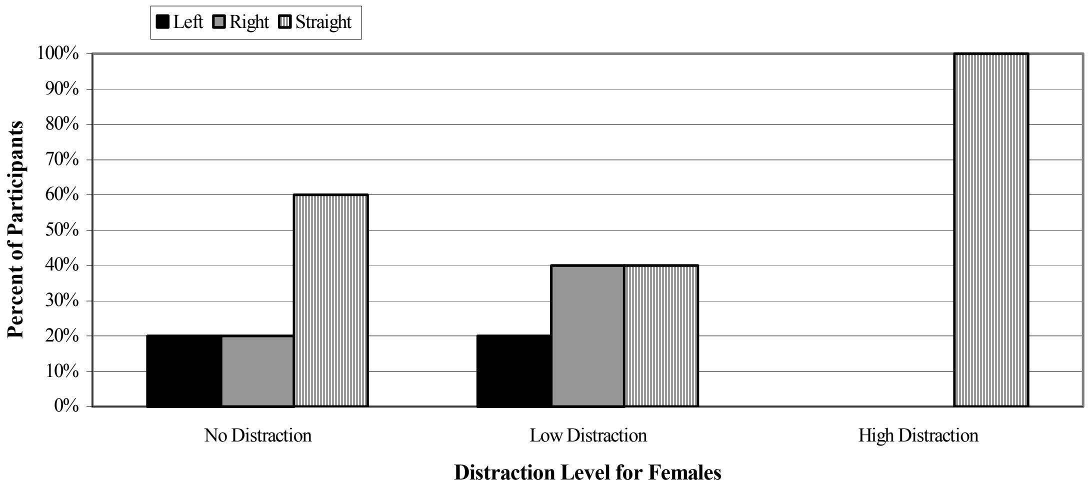

Figure 7. Experiment two emergency event steering responses for females. Note, when females were attempting to avoid the emergency event when performing a high complexity distraction task none of them steered to either the left or right, but instead continued to drive straight into the event.

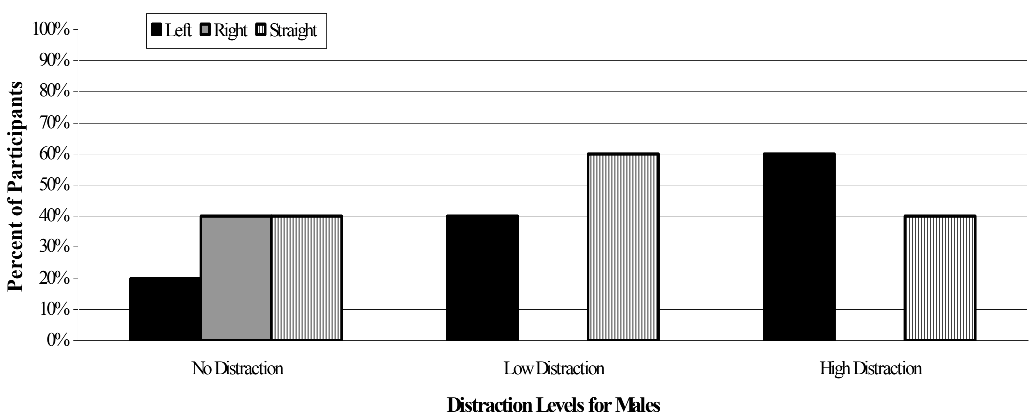

Figure 8. Experiment two emergency event steering responses for males. Note, when a driver is presented with a distracter of either low or high complexity no drivers steered to the right to avoid the oncoming motorcycle.

Consistent with Experiment one emergency event brake responses for both males and females indicated the majority of drivers applied the brakes when presented with the motorcycle event in the no distraction and low complexity distraction conditions and inconsistent with Experiment one that nearly all drivers applied the brakes in the high complexity distraction condition. This provides initial support for the contention that emergency event response behaviors can be influenced by the presence of an in-vehicle distracter. When the data are presented according to driver sex (see Figure 9 and 10 for females and males respectively) it is evident that when either of the level of complexity distraction conditions are presented to either females or males their emergency event braking performance is primarily braking as compared a no distracter condition.

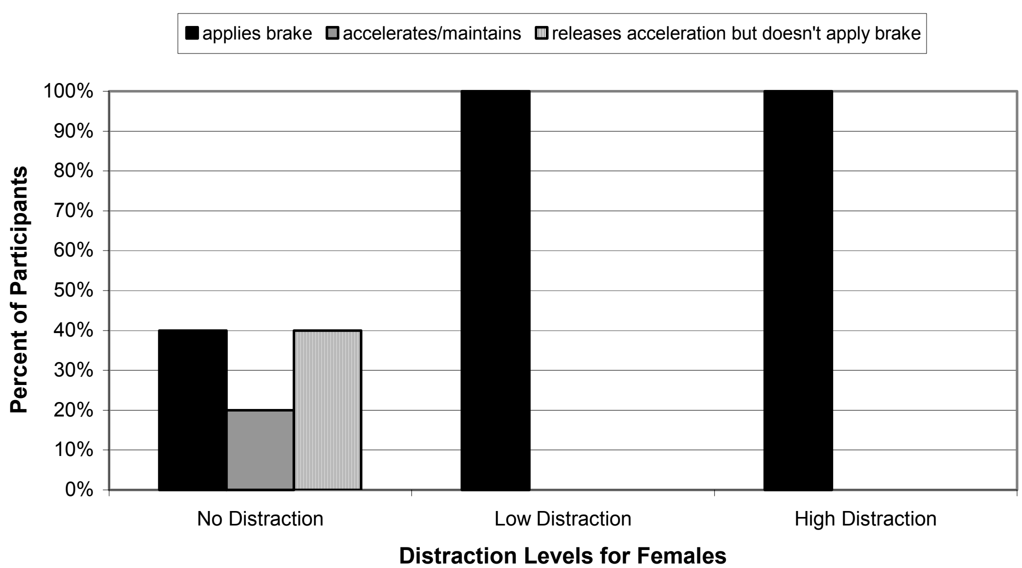

Figure 9. Experiment two emergency event braking maneuvers for females. Note, overwhelmingly female drivers applied the brakes when presented with either a low or high complexity distraction task.

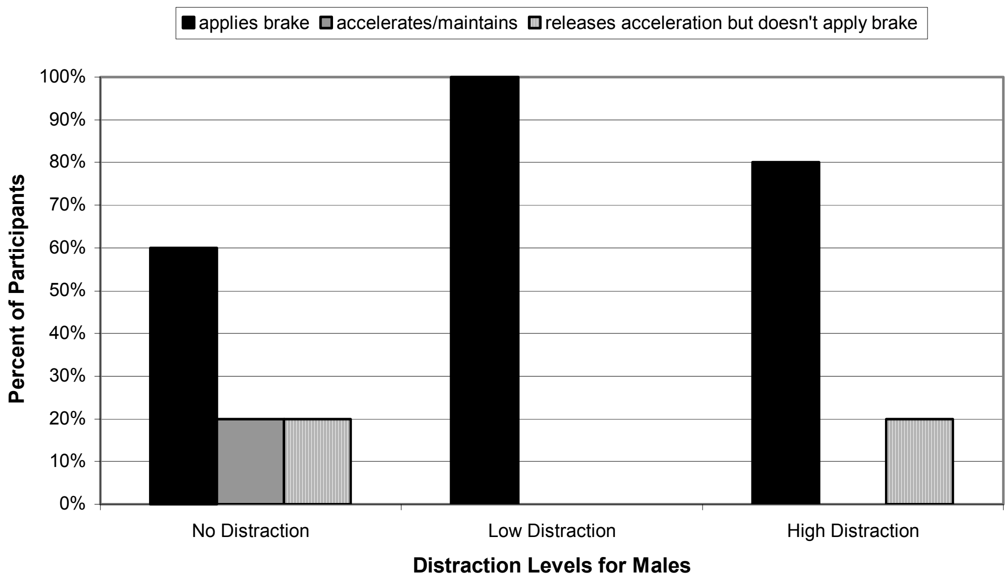

Figure 10. Experiment two emergency event braking maneuvers for males. Note, overwhelmingly male drivers applied the brakes when presented with either a low or high complexity distraction task.

The number of collisions occurring as a result of the emergency response event for males and females are presented in Tables 3 and 4 coincident with a presentation of emergency event steering and braking responses. In general, 70% (21 out of 30) of the emergency response events for drivers resulted in a collision with the approaching motorcycle. When the data are examined according to the driver response it is seen that 10% (3 of 30), 3.3% (1 of 30), and 60% (18 of 30) of the drivers collided with the approaching motorcycle when they steered left, steered right, or continued straight, respectively. In general more females collided with the motorcycle than males and the rate of collisions increased as the level of complexity of the distraction increased.

		% Steering Left	% Steering Right	% No Steering
no complexity	Releases acceleration and applies brake	0 = 0% (0)	0 = 0% (0)	2 = 40% (2)
	Accelerates / Maintains	0 = 0% (0)	0 = 0% (0)	1 = 20% (1)
	Releases acceleration but does not apply brake	1 = 20% (0)	1 = 20% (0)	0 = 0% (0)
low complexity	Releases acceleration and applies brake	1 = 20% (1)	2 = 40% (1)	2 = 40% (2)
	Accelerates / Maintains	0 = 0% (0)	0 = 0% (0)	0 = 0% (0)
	Releases acceleration but does not apply brake	0 = 0% (0)	0 = 0% (0)	0 = 0% (0)
high complexity	Releases acceleration and applies brake	0 = 0% (0)	0 = 0% (0)	5 = 100% (5)
	Accelerates / Maintains	0 = 0% (0)	0 = 0% (0)	0 = 0% (0)
	Releases acceleration but does not apply brake	0 = 0% (0)	0 = 0% (0)	0 = 0% (0)

Table 3. Experiment two emergency response performance for females. Note, for example, 1 = 20%(1) would indicate that one driver performed the action, that one driver represented 20% of the drivers for a particular level of distraction complexity condition, and that one of the drivers collided with the motorcycle.

		% Steering Left	% Steering Right	% No Steering
no complexity	Releases acceleration and applies brake	0 = 0% (0)	1 = 20% (0)	2 = 40% (2)
	Accelerates / Maintains	1 = 20% (1)	0 = 0% (0)	0 = 0% (0)
	Releases acceleration but does not apply brake	0 = 0% (0)	1 = 20% (0)	0 = 0% (0)
low complexity	Releases acceleration and applies brake	2 = 40% (0)	0 = 0% (0)	3 = 60% (3)
	Accelerates / Maintains	0 = 0% (0)	0 = 0% (0)	0 = 0% (0)
	Releases acceleration but does not apply brake	0 = 0% (0)	0 = 0% (0)	0 = 0% (0)
high complexity	Releases acceleration and applies brake	2 = 40% (1)	0 = 0% (0)	2 = 40% (2)
	Accelerates / Maintains	0 = 0% (0)	0 = 0% (0)	0 = 0% (0)
	Releases acceleration but does not apply brake	1 = 20% (0)	0 = 0% (0)	0 = 0% (0)

Table 4. Experiment two emergency response performance for males. Note, for example, 1 = 20%(0) would indicate that one driver performed the action, that one driver represented 20% of the drivers for a particular level of distraction complexity condition, and that none of the drivers collided with the motorcycle.

Mental Workload, Number and Accuracy of Math Problems Performed

There was a main effect for mental workload, F = 15.27, $p < .05$, with the no distraction, low level of complexity distraction, and high level of complexity distraction means being 1.3, 5.1, and 4.6, respectively. Post hoc analysis indicated each mean was significantly different from each other. There was a main effect for the percentage of math problems attempted for the low and high level of complexity distraction tasks, F = 3.31, $p < .05$, with means of 32% and 15%, respectively. There was a main effect for the percentage of correct math problems for the low and high level of complexity distraction tasks, F = 3.56, $p < .05$, with means of 90% and 35.7%, respectively.

Experiment One and Two Comparison

A comparison between Experiments one and two was not conducted as part of this research effort due to the fact that Experiment two was designed and conducted based on the results of Experiment one. As such we would expect unanticipated and unintentional methodological differences between the two experiments that would limit significantly the ability to interpret and draw veridical conclusions from the data.

CHAPTER SEVEN - DISCUSSION

General Driving Performance

The main effect for distraction level of complexity (Experiment two) for the performance measure of standard deviation of lane position indicated that when drivers performed the low and high complexity distraction task their ability to maintain position within their own lane was compromised as compared to a no distraction task. When driver responses are expressed as the standard deviation of lane position the scores for the no distraction, low complexity distraction, and high complexity distraction conditions were .23, .47, and .37 meters, (.75, 1.54, and 1.21 feet) respectively, with the post hoc analysis indicating each of the means for level of distracter complexity were significantly different from each other. In general, these results are consistent with previous research (Alm & Nilsson, 1994; Alm & Nilsson, 1995; Briem, & Hedman, 1995; Brookhuis, De Vries, & De Waard, 1991; Kames, 1978; Lamble, Kauranun, Laasko, & Summala, 1999; McKnight & McKnight, 1993; Redelmeier & Tibshirani, 1997; Reed & Green, 1999; Serafin, Wen, Paelke, & Green, 1993; Stein, Parseghian, & Allen, 1987; Zwahlen, 1998) and suggest driver performance is degraded with the introduction of a distracter. These results further suggest that varying levels of complexity of a distracter can differentially influence driver performance in that the result for Experiment two indicated that standard deviation of lane position increased significantly with the introduction of a low complexity distraction task but that as the level of complexity of the distraction task continued to increase standard deviation of lane position decreased slightly.

These significant differences exhibited in lane keeping consistency for varying levels of complexity of a distracter are valuable for research investigation into attentional resources. They suggest that a distracter can facilitate a shift of critical attention away from the driving task. However, contrary to the research hypothesis and a strict information processing capacity approach (Kahneman, 1973), results indicated lane keeping consistency was slightly better when the level of complexity of the distracter increased which would initially suggest that increasing the level of complexity of a distraction would reduce the attentional demands placed on a driver, would allow more attention to be redirected to the driving task, and would ultimately facilitate improved driving performance. One of the implications of these findings is that if designers create a device that may serve as a distracter they should design their products with high levels of complexity in order to facilitate performance. While this approach is counterintuitive it may be tenable. When drivers are not presented with a distracter they are free to continually focus the majority or all attentional resources to the task of driving which results in consistent driving performance. The introduction of a low complexity distracter forces a division and continuing redirection of attentional resources between the task of driving and the distracter in a back and forth fashion ultimately resulting in a degradation of driving performance because driver is implementing new behaviors to navigate the vehicle each time their attention is redirected to the task of driving. However, when a distraction is highly complex it may redirect substantial amounts of attentional resources to the distracter and serve to attenuate the amount of new behaviors used to navigate the vehicle. At present, continuing research efforts are attempting to either confirm or refute this proposition. However, other researchers are strongly encouraged to examine the influence of varying levels of complexity of a distracter, their impact on driving performance, and the underlying reasons for their influence so that distracters can be more effectively designed to reduce any negative influences on driving performance.

Emergency Response Performance

Previous work has indicated that driversí typical emergency response performance consists of applying the brakes of their vehicle (Hatterick & Bathurst, 1976; Kloeppel, Peters, James, Fox, & Alicandri, 1995; Lechner & Malaterre, 1991; Malaterre, Ferrandez, Fleury, & Lechner, 1988; Rice & DellíAmico, 1974). Findings from the present investigations also indicated that driversí emergency event responses typically consisted of braking and that these responses are influenced by the addition of and complexity of a distracter and by the sex of the driver. In Experiment one under the no distraction and low complexity distraction conditions femalesí emergency event braking performance consisted primarily of braking and that in the high complexity distraction condition braking and acceleration are the primary responses. In contrast, males do not have a primary braking behavior under any of the distraction complexity conditions. In Experiment two regardless of the level of complexity of distraction for either females or males emergency event braking performance is primarily braking as compared a no distracter condition. Similarly dramatic steering behaviors existed. In Experiment one, females steered only to the left or right when no distracter was present but when presented with either a low or high complexity distracter females steered either right or continued to drive straight toward the motorcycle. In contrast as level of complexity of the distracter increased males tended to steered to the left less often and continued to drive straight more often. In Experiment two under the no distraction and low complexity distraction conditions females steered left, right, and continued to drive straight. However, when performing the high complexity distraction task all females continued to drive straight toward the approaching motorcycle. In contrast males steered left, right, and straight in the no distraction condition and steered to the left and continued straight in the low and high complexity distraction conditions.

Results also indicate a significant percentage of drivers would have collided with the approaching motorcycle given their emergency event responses and that level of complexity of distraction can influence this percentage. In Experiments one and two 56.7% and 70% of the drivers collided with the oncoming motorcycle. Relative to level of complexity of distracter, in general a lower percentage of drivers collided with the oncoming motorcycle when no distraction was present (10% for both Experiments one and two) as compared to the low and high levels of complexity distracters (23.4% and 23.4% for Experiment one respectively and 3.3% and 60% for Experiment two).

These results provide initial support for the contention that the addition of a distraction or the increase in a distracterís level of complexity in the driving environment can negatively impact the ability of a driver to successfully avoid a collision in an emergency event. While it is surmised, the reason for the negative impact is related to the introduction of the distracter and the reallocation of attentional resources no theories detailing the relationship have been introduced in the literature. These performance trends are disturbing in light of the fact that simply applying brakes in an emergency event or continuing to drive straight will do little to facilitate avoidance of a collision. In addition, steering to the left potentially puts drivers in the path of an additional oncoming vehicle. In both experiments anecdotal evidence presented by females indicated they thought the oncoming vehicle would steer away from them in order avoid the collision.

However, they did not indicate why they did not steer to the right. These findings have a direct impact on driver distraction/driver performance research in that there appear to be additional measures of driver performance beyond that of lane position, steering wheel reversals, speed, and others traditional measures that are markedly influenced by the presence of in-vehicle distracters, the presence of an in-vehicle distracter can markedly influence driver behavior in emergency response situations by presumably redirecting or reallocating attentional resources, and that driver training protocols intended to teach drivers what actions to perform in emergency event situations may need to be revisited as it is evident drivers cannot practice what is preached.

Sex Differences

Previous work investigating the influence of cellular telephone use on general driving performance has indicated differences between males and females for with males driving closer to the centerline and males exhibiting greater mean steering input, mean accelerator input, and mean speed (Crawford, Manser, Jenkins, Court, & Sepulveda, 2001). The results of Experiment one indicated that males exhibited greater standard deviation of velocity than their female counterparts. While the variables that proved to be significant between the two studies were not identical they lend tentative support the contention that males and females general driving performance differ significantly. However, the results of Experiment two indicated females exhibited greater standard deviation of lane position than their male counterparts. Results further indicated that males and females performed similarly when no distraction was present but that standard deviation of lane position for males was greater than females under the low and high level of complexity distraction condition. One potential reason for the inconsistent findings may be the mode of information delivery employed. For example, in Crawford, Manser, Jenkins, Court, and Sepulveda (2001) and in Experiment one of the current work the distraction task was delivered via an auditory information delivery mode to males and females while in Experiment two a visual mode of information delivery was used.

Results of previous research examining emergency response performance of male and female drivers while being presented with distracter indicated that response time to the sudden appearance of a van for females were faster than males. While it was not possible to examine response times in the current experiments, the results do provide continuing support for the contention that males and females exhibit dramatically different emergency event response performances. For example, in Experiment one when a distracter was being presented via a visual information delivery mode when the approaching motorcycle appeared in the driversí lane females not presented with a distracter steered only to the left or right and when presented with low and high level of complexity distracters they steered only to the right or continued to drive straight. In comparison, males employed all three steering variations but tended to steer left less often and drive straight more often and the level of complexity of distraction increased. The differences were even more dramatic when the distracter was presented via a visual information delivery mode. For example, females exhibited all three steering behaviors when performing the no distraction and low level of complexity distraction tasks. However, all females continued to drive straight when performing the high level of complexity distraction task. In contrast males exhibited all three steering behaviors when performing the no distraction task and steered only to the left and straight when performing the low and high level of complexity distraction tasks. Currently, there is little literature which that indicate the reasons for the differences between females and males emergency event response performances.

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APPENDIX A

Experiment One and Experiment Two
Human Subjects Consent Form

THE EFFECT OF DISTRACTION ON DRIVER BEHAVIOR
INFORMED CONSENT: Page 1 of 3

I have been invited to participate in an experiment designed to collect normative driving data in a driving environment simulator. I am being asked to drive in a normal fashion obeying all traffic laws. The experiment is to take place in a driving environment simulator in Room 320 of the Gibb Gilchrist Building. I am aware the experiment will last approximately 60 minutes. I am being selected as a possible participant because I have normal or corrected to normal vision, I am at least 18 years of age, I possess a valid driverís license, and I have no apparent limitations impeding my ability to drive. I am aware there will be a total of 80 participants in this study and that data collection will occur from June 20, 2001 until June 30 2002. I have been instructed to read this form and ask any questions I may have before agreeing to participate in the study.

This experiment is being conducted by Michael P. Manser, of the Texas Transportation Institute (TTI), part of the Texas A&M University System. The Southwest University Transportation Consortium is funding this experiment.

Background Information: The purpose of this study is to collect normative driving data in a driving environment simulator.

Procedures: If I agree to be in this study, I am asked to participate in an introductory session, a practice session, an experiment session, and a debriefing session.

If I agree to be in this study, I voluntarily agree to be videotaped during the practice session and the experiment session during my drives. The videotape will include a view of my head and shoulders, my hands as they interact with the steering wheel, my feet as they interact with the accelerator and brake peddles, and the computer generated world in which I am driving. I understand the information added to each tape will include an identification number for me, my age, my sex, the title of the experiment, and that no other personal information will be included. I understand that the tapes will be used only to determine my behavioral responses to driving and for the purposes of documentation (verification the experiments were conducted). The individuals who will have access to these tapes to determine behavior responses will include Michael P. Manser and Jacqueline Jenkins. The tapes will be kept for a period of three years in a locked file cabinet in Room 308 Gibb Gilchrist Building. After data is collected and the three-year period has elapsed the tapes will be erased using a magnetic tape eraser. I understand that portions of the video/audio tape may be used for presentation purposes at professional conferences. I understand that if I refuse to be video/audio taped I cannot participate in this study.

___ Initial

___ Date

Introductory Session: During the introductory session I will read the consent form. I will indicate my willingness to continue with the experiment by signing the form. Before proceeding, I will receive a copy of the form. I will also be asked to complete a simulator-induced discomfort pre-screening questionnaire, a general driving questionnaire, a standard visual acuity test, a standard contrast sensitivity test, and a standard color vision test.

Practice Session: During the practice session I will be provided an information sheet about the simulator and instructions on performing the practice session. This practice session is to provide me the opportunity to become familiar with the touch screen computer screen and driving the simulator. This session will last approximately five minutes.

Experiment Session: During the experiment, which will be conducted in the simulator, I will be asked to drive through a computer generated world, to interact with a touch screen computer screen performing addition tasks, and to count the number of construction cones in the environment.

Debriefing Session: Following the experiment, I will be asked to complete a Post-Experiment Simulator Induced Discomfort Questionnaire. The purpose of the questionnaire is to determine the extent of simulator induced discomfort occurrences exhibited by those who participate in experiments involving the driving environment simulator. In addition, before leaving, I will be provided a debriefing packet, which will detail information regarding all aspects of the study and will provide contact information.

Possible Discomforts: I understand that the only risk associated with this study is a temporary condition named 'Simulator Induced Discomfort' (SID) which is characterized by feelings of dizziness and increased body temperature. The potential for this discomfort is minimal as it only affects about 3 or 5 persons out of every 100 under the driving conditions to be tested. I understand that I am to indicate to the investigator if I experience any of these symptoms, and that the study will be stopped to prevent any further discomfort to me. I also understand that it is my right to stop the study at any time for any reason without any repercussion.

Confidentiality: I understand the records of this study and the video footage will be kept private. In any sort of report that might be published, no information will be included which may make it possible to identify me. I understand the research records will be kept in a locked file, accessible only to the principal investigator.

Voluntary Nature of the Study: My decision whether or not to participate will not affect my current or future relations with the Texas Transportation Institute, Texas A&M University, or the Texas A&M University System. If I decide to participate, I am free to withdraw at any time without affecting those relationships.

___ Initial ____ *Date*

Payment: I understand that if I accept payment for participating in this study, the fact that I participated in this study may be obtained under the Texas Open Records Act, even though any information that I gave to the investigator is confidential.

As a non-Texas Transportation Institute employee, I understand that upon the completion of the introductory session, the practice session, the experiment session, and the debriefing session, I will receive payment of $10 for participation. However, if after reading the Simulator Induced Discomfort Pre-Screening Questionnaire, I wish not to participate in the experiment I will still receive $10. If the any of the three vision tests precludes my participation, I will still receive payment of $10. If I experience Simulator Induced Discomfort during the practice session or any portion of the experiment session, the experiment will be stopped and I will receive $10.

If I decide not to complete all portions of the experiment for other reasons, compensation will not be awarded. If I choose to refuse to be video/audio taped the experiment will be stopped and I will not receive compensation.

I understand that payment will be included with the debriefing packet, which I will receive prior to leaving the test location. I will acknowledge receipt of payment by signing a receipt form.

As an employee of the Texas Transportation Institute I understand that I will not receive any compensation, credit, compensation time, or any other rewards for participating in this study.

Contacts and Questions: The researcher conducting this study is Michael P. Manser. If I have questions now or later, I may contact Michael P. Manser at the Texas Transportation Institute, Texas A&M University, College Station, TX 77843-3135, (979) 862-3311.

I will be given a copy of this form for my records.
A copy of this form will be given to me prior to my proceeding with the experiment.

I understand this research study has been reviewed and approved by the Institutional Review Board - Human Subjects in Research, Texas A&M University. For research-related problems or questions regarding subjects' rights, the Institutional Review Board may be contacted through Dr. Michael W. Buckley, Director of Support Services, Office of the Vice President for Research at (979) 458-4067.

Statement of Consent: I have read and understand the explanation provided me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study. I have been given a copy of this consent form.

_______________________________ ___________
Signature of Research Participant Date

_______________________________ ___________
Signature of Principal Investigator Date

APPENDIX B

Practice Session Instructions for Experiment One No Math group

THE EFFECT OF DISTRACTION ON DRIVER BEHAVIOR
PRACTICE SESSION

Currently, you are seated in the driving environment simulator (DESi). It is an interactive simulator, which means the driving scenes you experience react to your steering and pedal inputs to provide a realistic driving experience. During your drive in the simulator, please drive in a normal fashion and obey all traffic laws.

For the practice session your task is to get comfortable with driving in a simulated driving environment. The driving scene that will be presented to you begins with the simulator vehicle stopped at the side of a road. You are to start the vehicle, put it into ëdriveí, and proceed through the driving environment by following the car traveling in front of you. Please continue to follow the lead car at a comfortable distance. After a couple minute the lead car will pull off the road. Your task is to continue driving down the road. After a couple more minutes the screens will turn black. At that time please turn your attention to the experimenter. The practice session will take approximately five minutes.

For the second part of the practice session it is also your task to become familiar with the touch screen and the mental workload questions. Please look at the touch screen and read through the questions.

If you have any questions regarding the practice session please consult the experimenter. Otherwise, acknowledge that you are ready by telling the experimenter to begin the driving scene.

APPENDIX C

Practice Session Instructions for Experiment One
Simple Math group and Complex Math group

THE EFFECT OF DISTRACTION ON DRIVER BEHAVIOR
PRACTICE SESSION I

Currently, you are seated in the driving environment simulator (DESi). It is an interactive simulator, which means the driving scenes you experience react to your steering and pedal inputs to provide a realistic driving experience. During your drive in the simulator, please drive in a normal fashion and obey all traffic laws.

For the first part of the practice session your task is to perform an addition task. The experimenter will present to you a series of numbers. Your task is to add the numbers and then tell the experimenter the answer. For example, you may be asked to add 20 and 30. For the practice session you will be asked to perform this task for two minutes. Please direct your attention to the experimenter to perform them now.

THE EFFECT OF DISTRACTION ON DRIVER BEHAVIOR
PRACTICE SESSION II

For the second part of the practice experiment your task is to get comfortable with driving in a simulated driving environment. The driving scene that will be presented to you begins with the simulator vehicle stopped at the side of a road. You are to start the vehicle, put it into ëdriveí, and proceed through the driving environment by following the car traveling in front of you. Please continue to follow the lead car at a comfortable distance. After a couple minute the lead car will pull off the road. Your task is to continue driving down the road. After a couple more minutes the screens will turn black. At that time please turn your attention to the experimenter. The practice session will take approximately five minutes.

For the second part of the practice session it is also your task to become familiar with the touch screen and the mental workload questions. Please look at the touch screen and read through the questions.

If you have any questions regarding the practice session please consult the experimenter. Otherwise, acknowledge that you are ready by telling the experimenter to begin the driving scene.

APPENDIX D

Experiment One Experiment Session Instructions for the No Math group

THE EFFECT OF DISTRACTION ON DRIVER BEHAVIOR
EXPERIMENT INSTRUCTIONS

You are now asked to complete an experimental driving scene. Your task is to drive through the scene as you normally would drive in the real world at 40 mph. As before, drive through the scenes in a normal fashion obeying all traffic signs and laws. Please do not deviate from the directed course. If you reach an intersection please obey all traffic signs and proceed straight through the intersection as you would under normal driving circumstances.

Task One
Your task is to drive through the scene, obeying all traffic signs, traffic laws, and directional signs. Please try to complete the scenarios as you would normally in the real world. Do not drive with undue aggression or undue conservatism.

When the driving scene begins, the simulator vehicle will be stopped on the side of the roadway. Place the vehicle in ëdriveí, drive onto the roadway, and proceed through the driving environment at 40 mph.

Task Two
At two different times during the experiment you will be asked questions regarding your mental workload. This will be presented on the touch screen to your side. Please select the most applicable answer and please answer these questions honestly.

At the end of the experimental driving scene, there will be two vehicles positioned across the roadway. When you reach these vehicles, please bring the vehicle to a complete stop, place it in ëparkí, and direct your attention to the investigator. This experiment session will take approximately 20 - 25 minutes.

If you have any questions regarding your task in the experiment consult the experimenter. Otherwise, acknowledge that you are ready by telling the experimenter to begin the driving scene.

APPENDIX E

Experiment One Session Instructions for the Simple Math and Complex Math groups

THE EFFECT OF DISTRACTION ON DRIVER BEHAVIOR
EXPERIMENT INSTRUCTIONS

You are now asked to complete an experimental driving scene. Your task is to drive through the scene as you normally would drive in the real world at 40 mph. As before, drive through the scenes in a normal fashion obeying all traffic signs and laws. Please do not deviate from the directed course. If you reach an intersection please obey all traffic signs and proceed straight through the intersection as you would under normal driving circumstances.

Task One
Your task is to drive through the scene, obeying all traffic signs, traffic laws, and directional signs. Please try to complete the scenarios as you would normally in the real world. Do not drive with undue aggression or undue conservatism.

When the driving scene begins, the simulator vehicle will be stopped on the side of the roadway. Place the vehicle in ëdriveí, drive onto the roadway, and proceed through the driving environment at 40 mph.

Task Two
You are asked to perform an addition task using two numbers as presented by the experimenter and then tell the experimenter the correct answer within 8 seconds. For example, you may be asked to add 20 and 30. This task will be presented twice and each time the task will last approximately two minutes.

Task Three
At two different times during the experiment you will be asked questions regarding your mental workload. This will be presented on the touch screen to your side. Please select the most applicable answer and please answer these questions honestly.

At the end of the experimental driving scene, there will be two vehicles positioned across the roadway. When you reach these vehicles, please bring the vehicle to a complete stop, place it in ëparkí, and direct your attention to the investigator. This experiment session will take approximately 20 - 25 minutes.

If you have any questions regarding your task in the experiment consult the experimenter. Otherwise, acknowledge that you are ready by telling the experimenter to begin the driving scene.

APPENDIX F

Experiment One Driving Data
for the No Math, Simple Math, and Complex Math groups

subject	mean velocity	standard deviation of mean velocity	mean lane position	standard deviation of mean lane position
C002F48	22.50498	3.150834	-0.22332	0.164074
C011F29	20.66326	3.613264	-0.58447	0.200852
C013F48	19.13605	2.766633	-0.25415	0.132748
C014F21	18.91948	4.241627	-0.07497	0.192764
C015F18	17.81804	2.631759	-0.24813	0.320621
C018M25	21.18749	4.080416	-0.22434	0.162193
C021M22	18.01801	1.930717	-0.37134	0.152045
C024M49	21.2859	2.811133	-0.09338	0.11467
C025M32	17.65892	2.913268	-0.4048	0.203359
C027M29	20.38541	2.549957	-0.02265	0.105655
N003F31	17.80575	3.020262	-0.01913	0.168558
N004F27	19.72574	2.810695	-0.37	0.158325
N007F33	19.04472	3.073978	0.092426	0.219906
N009F47	18.11805	2.300164	-0.05186	0.159197
N010F26	20.81026	3.105609	-0.13865	0.198374
N019M24	17.95359	1.717519	-0.69128	0.184809
N023M26	18.9941	1.191842	0.093877	0.153442
N026M26	20.58063	2.921944	-0.4305	0.252187
N029M23	18.74789	1.055396	-0.30688	0.128506
N028M34	18.37341	0.805211	-0.24356	0.273932
S001F19	20.31039	2.144364	-0.42184	0.132759
S005F23	17.47337	3.576013	-0.30348	0.148375
S006F24	21.56317	2.002452	-0.19223	0.12406
S008F30	18.58128	3.647611	-0.13962	0.225778
S012F71	16.7068	2.925916	-0.19053	0.196642
S016M29	18.43779	1.217367	-0.08219	0.143357
S017M27	16.78616	5.042295	-0.06186	0.204115
S020M50	19.34787	1.644158	-0.21024	0.218515
S022M20	17.30656	1.533454	-0.17286	0.165824
S030M36	22.48046	1.601504	0.298432	0.150522

Key:
Under the subject heading the code for each subject is:
C = complex math N = no math S= simple math
The next three numbers indicate the actual order in which the subject was run in the experiment.
The M or the F following the three numbers indicates that the subject was either male or female.
The last two numbers is the subjectís age.

APPENDIX G

Experiment One and Two Math Problems for the Two Simple Math groups

Simple Math Baseline ***Test*** ID

1	40	70	70	70	50
	70	10	50	40	80
	110	80	120	110	130
2	100	50	90	10	10
	20	100	50	50	90
	120	150	140	60	100
3	80	40	30	70	30
	10	60	30	90	20
	90	100	60	160	50
4	80	100	50	40	100
	90	20	60	60	60
	170	120	110	100	160
5	100	70	30	100	100
	30	20	40	10	80
	130	90	70	110	180
6	40	70	90	30	30
	90	40	40	60	10
	130	110	130	90	40
7	50	40	100	70	30
	20	60	40	80	10
	70	100	140	150	40
8	50	20	10	60	60
	40	100	60	20	70
	90	120	70	80	130

9	60	20	60	30	90
	100	100	30	20	50
	160	120	90	50	140
10	100	10	20	60	100
	40	20	100	10	70
	140	30	120	70	170
11	50	30	80	10	80
	10	50	50	50	80
	60	80	130	60	160
12	30	100	90	90	40
	80	50	80	10	100
	110	150	170	100	140
13	50	100	90	80	90
	40	50	20	70	40
	90	150	110	150	130
14	50	60	70	20	10
	90	70	20	50	80
	140	130	90	70	90
15	10	100	10	90	70
	30	80	50	30	40
	40	180	60	120	110
16	70	90	60	70	90
	50	90	80	20	60
	120	180	140	90	150
Sim Test 1					
1	60	50	80	100	50
	20	90	100	40	90
	80	140	180	140	140

2	50 60 110	100 60 160	50 40 90	30 100 130	70 10 80
3	50 90 140	30 90 120	100 80 180	40 50 90	60 90 150
4	40 60 100	30 60 90	10 90 100	50 80 130	90 100 190
5	60 90 150	90 30 120	90 40 130	90 90 180	100 90 190
6	30 60 90	50 50 100	40 70 110	40 40 80	100 40 140
7	10 70 80	30 70 100	70 80 150	60 60 120	60 40 100
8	20 20 40	30 80 110	50 100 150	50 40 90	50 20 70
9	40 100 140	70 90 160	80 20 100	40 10 50	20 90 110
10	50 30 80	80 80 160	60 60 120	10 60 70	30 10 40
11	10 50	30 80	50 90	50 50	60 40

	60	110	140	100	100
12	70	90	70	20	50
	30	10	100	90	20
	100	100	170	110	70
13	40	30	60	20	90
	80	10	20	100	60
	120	40	80	120	150
14	60	50	30	60	90
	90	40	100	20	10
	150	90	130	80	100
15	70	30	50	10	100
	20	30	40	20	80
	90	60	90	30	180
16	70	100	50	10	60
	70	50	20	50	40
	140	150	70	60	100

Sim Test 2

1	60	10	40	100	10
	10	50	40	30	70
	70	60	80	130	80
2	60	10	50	50	10
	50	10	80	90	30
	110	20	130	140	40
3	100	10	60	10	70
	100	30	50	80	20
	200	40	110	90	90
4	30	100	90	70	70
	40	100	30	30	60
	70	200	120	100	130

5	20	60	20	50	60
	30	60	10	40	100
	50	120	30	90	160
6	10	100	80	40	20
	60	20	100	60	20
	70	120	180	100	40
7	90	60	20	30	50
	40	20	100	50	50
	130	80	120	80	100
8	20	50	30	40	70
	90	100	10	60	90
	110	150	40	100	160
9	50	10	40	60	30
	100	50	40	20	90
	150	60	80	80	120
10	50	20	60	90	60
	70	100	100	100	70
	120	120	160	190	130
11	80	60	70	10	100
	40	100	60	90	100
	120	160	130	100	200
12	80	60	70	70	100
	100	50	30	80	60
	180	110	100	150	160
13	20	20	80	90	90
	30	60	100	100	70
	50	80	180	190	160
14	90	30	100	10	100
	10	90	70	40	40
	100	120	170	50	140

15	80	50	40	90	30
	10	50	30	100	10
	90	100	70	190	40
16	50	80	10	10	10
	70	80	20	70	70
	120	160	30	80	80

APPENDIX H

Experiment One and Experiment Two Math Problems for the Complex Math groups

Complex Math ID

Baseline Test

1	26	77	84	46	15
	72	47	73	91	78
	98	124	157	137	93
2	93	49	75	13	85
	22	84	41	28	88
	115	133	116	41	173
3	21	78	62	43	34
	64	59	30	87	76
	85	137	92	130	110
4	45	62	11	25	85
	55	18	41	91	98
	100	80	52	116	183
5	91	93	45	84	57
	32	69	42	25	39
	123	162	87	109	96
6	85	89	36	80	59
	99	100	72	96	80
	184	189	108	176	139
7	79	73	16	93	68
	76	78	31	51	10
	155	151	47	144	78
8	17	98	30	91	21
	95	88	81	67	98
	112	186	111	158	119

9	49	12	43	30	22
	54	93	49	52	69
	103	105	92	82	91
10	50	13	88	48	58
	28	85	57	92	19
	78	98	145	140	77
11	72	27	48	90	25
	43	31	37	37	20
	115	58	85	127	45
12	58	74	69	33	97
	15	46	64	43	33
	73	120	133	76	130
13	90	11	37	10	73
	43	66	65	54	18
	133	77	102	64	91
	55	71	93	84	35
14	69	29	52	49	31
	124	100	145	133	66
15	40	16	88	33	61
	15	46	38	37	83
	55	62	126	70	144
16	36	29	30	21	95
	38	50	37	81	14
	74	79	67	102	109
Sim Test 1					
1	78	63	65	78	16
	21	79	57	15	25
	99	142	122	93	41

2	39	92	50	58	55
	50	44	18	45	95
	89	136	68	103	150
3	87	95	72	16	69
	28	35	59	58	31
	115	130	131	74	100
4	94	71	14	88	45
	32	51	46	95	38
	126	122	60	183	83
5	24	85	24	27	20
	71	88	26	15	45
	95	173	50	42	65
6	76	91	97	43	83
	84	18	92	93	30
	160	109	189	136	113
7	35	59	35	12	89
	39	88	58	89	11
	74	147	93	101	100
8	67	45	28	18	95
	53	73	57	59	62
	120	118	85	77	157
9	51	73	10	33	54
	61	94	66	62	71
	112	167	76	95	125
10	24	89	36	52	20
	14	57	67	53	15

	38	146	103	105	35
11	24	98	15	39	96
	51	16	16	43	55
	75	114	31	82	151
12	71	62	62	43	70
	83	19	31	59	90
	154	81	93	102	160
13	16	80	30	99	26
	22	32	24	67	85
	38	112	54	166	111
14	66	96	62	39	48
	43	97	49	56	93
	109	193	111	95	141
15	75	88	67	81	84
	87	81	19	55	79
	162	169	86	136	163
16	57	35	17	89	25
	31	75	34	26	81
	88	110	51	115	106
Sim Test 2					
1	96	93	99	26	47
	28	71	30	66	26
	124	164	129	92	73
2	51	88	39	93	82
	93	44	54	79	29
	144	132	93	172	111

3	12	30	77	13	29
	91	46	28	57	86
	103	76	105	70	115
4	88	66	56	37	39
	83	12	79	18	30
	171	78	135	55	69
5	50	75	41	54	61
	89	95	33	31	100
	139	170	74	85	161
6	29	30	38	56	33
	35	89	52	67	42
	64	119	90	123	75
7	48	10	55	52	27
	75	42	97	34	30
	123	52	152	86	57
8	30	20	98	48	46
	12	13	45	97	74
	42	33	143	145	120
9	40	52	95	75	67
	18	95	53	63	50
	58	147	148	138	117
10	70	38	45	43	94
	58	33	38	34	11
	128	71	83	77	105
11	96	87	45	86	91
	82	47	51	75	45
	178	134	96	161	136

12	83	31	58	32	50
	25	77	86	34	58
	108	108	144	66	108
13	56	46	31	100	58
	51	76	48	62	40
	107	122	79	162	98
14	23	47	15	93	37
	81	51	62	76	26
	104	98	77	169	63
15	22	17	91	48	21
	14	43	94	67	56
	36	60	185	115	77
16	25	92	92	91	53
	19	60	56	40	19
	44	152	148	131	72

APPENDIX I

Experiment One Math Data for Simple and Complex Math groups

Simple Baseline Math Answers

Correct Answer	s001f19	s005f23	s006f24	s008f30	s012f71	s016m29	s017m27	s020m50	s022m20	s030m36
110	---	130	110	110	110	110	110	110	110	110
80		80	80	80	80	80	80	80	80	80
120		120	120	120	120	120	120	120	120	120
110		111	110	110	110	110	110	110	110	110
130		130	130	130	130	130	130	130	130	130
120		120	120	120	120	120	120	120	120	120
150		150	150	150	150	150	150	150	150	150
140		140	140	140	140	140	140	140	140	140
60		60	60	60	60	60	60	60	60	60
100		100	100	100	100	100	100	100	150	100
90		90	90	90	90	90	90	90	90	90
100		100	100	100	100	100	100	100	100	100
60		60	60	60	60	60	60	60	60	60
160		160	160	160	160	160	160	160	160	160
50		50	50	50	50	50	50	50	50	50
170		170	170	170	170	170	170	170	170	170
120		120	120	120	120	120	120	120	120	120
110		110	110	110	100	110	110	110	110	110
100		100	100	100	110	100	100	100	100	100
160		160	160	160	160	160	160	160	160	160
130		130	130	130		130	130	130	130	130
90		90	90	90		90	90	90	90	90
70		70	70	70		70	70	70	70	70
110		110	110	110		110	110	110	110	110
180		180	180	180		180	180	180	180	180
130		130	130	130		130	130	130	130	130
110		110	110	110		110	110	110	110	110
130		130	130	130		130	130	130	130	130
90			90	90		90	90	90	90	90
40			40			40	40	40	40	40
70			70			70	70	70	70	70
100			100			100	100	100	100	100
40			40			40	40	40	40	40
150			150			150	150	150	150	150
40			40			40	40	40		40
90			90			90	90	90		90
120			120			120	120	120		
70			70			70		70		

80			80			80		80		
130			130			130		130		
160			160			160				
120			120			120				
90			90			90				
50			50							
140			140							
140										
30										
120										
70										
170										
60										
80										
130										
60										
160										
110										
150										
170										
100										
140										
90										
150										
110										
150										
130										
140										
130										
90										
70										
90										
40										
180										
60										
120										
110										
120										
180										
140										
90										
150										
80 total answers										
%	---	35%	56.25	36.25	25%	53.75%	46.25%	50%	42.50%	45%

answered			%	%						
% correct	---	92.86	100%	100%	90%	100%	100%	100%	97.05%	100%

Simple Test 1 Math
Answers

Correct Answer	s001 f19	s005 f23	s006 f24	s008 f30	s012 f71	s016 m29	s017 m27	s020 m50	s022 m20	s030 m36
80	---	80	80	80	80	80	80	80	80	80
140		140	140	140	140	140	140	140	140	140
180		180	180	180	180	180	180	180	180	180
140		140	140	140	140	140	140	140	140	140
140		140	140	140	140	140	140	140	140	140
110		110	110	110	110	110	110	110	110	110
160		160	160	160	160	160	160	160	160	160
90		90	90	90	90	90	90	90	90	90
130		130	130	130	130	130	130	130	130	130
80		80	80	80	80	80	80	80	80	80
140		140	140	140	140	140	140	140	140	140
120		120	120	120	120	120	120	120	120	120
180		180	180	180	180	180	180	180	180	180
90		90	90	90	90	90	90	90	90	90
150		150	150	150	150	150	150	150	150	150
100		100	100	100	100	100	90	100	100	100
90		90	90	90	90	90	90	90	90	90
100		100	100	100	100	100	100	100	100	100
130		130	130	130	130	130	130	130	130	130
190		190	190	190	190	190	190	190	190	180
150		150	150	150	150	150	150	150	150	150
120		120	120	120	120	120	120	120	120	120
130		130	130	130	130	130	110	130	130	130
180		180	180	180	180	180	180	180	180	180
190		190	190	190	190	190	190	190	190	190
90		90	90	90	90	90	90	90	90	90
100		100	100	100	100	100	100	100	100	100
110		130	110	110	110	110	110	110	110	110
80		80	80	80	80	80	70	80	80	80
140		140	140	140		140	140	140	140	140
80		80	80	80		80	80	80	80	80
100		100	100	100		100	100	100	100	100
150		150	150	150		150		150	150	
120		120	120	120		120		120		
100			100			100		100		
40			40			40		40		
110			110			110		110		

150	150	150	150
90	90	90	90
70	70	70	70
140	140	140	
160	160	160	
100	100	100	
50	50		
110	110		
80			
160			
120			
70			
40			
60			
110			
140			
100			
100			
100			
100			
170			
110			
70			
120			
40			
80			
120			
150			
150			
90			
130			
80			
100			
90			
60			
90			
30			
180			
140			
150			
70			
60			
100			
80 total answers			

% answered	---	42.50%	56.25%	42.50%	36.25%	53.75%	40%	50%	41.25%	40%
% correct	---	97.05%	100%	100%	100%	100%	90.63%	100%	100%	96.88%

Simple Test 2 Math
Answers

Correct Answer	s001 f19	s005 f23	s006 f24	s008 f30	s012 f71	s016 m29	s017 m27	s020 m50	s022 m20	s030 m36
70	---	70	70	70	70	70	70	70	70	70
60		60	60	60	60	60	60	60	60	60
80		80	80	80	80	80	60	80	80	80
130		130	130	130	130	130	130	130	130	130
80		80	80	80	80	80	80	80	80	80
110		110	110	110	110	110	110	110	110	110
20		20	20	20	20	20	20	20	20	20
130		130	130	130	130	130	130	130	130	130
140		140	140	140	140	140	140	140	140	140
40		40	40	40	40	40	40	40	40	40
200		200	200	200	200	200	200	200	200	200
40		40	40	40	40	40	40	40	40	40
110		110	110	110	100	110	110	110	110	110
90		90	90	90	90	90	90	90	90	90
90		90	90	90	90	90	90	90	90	90
70		120	70	70	70	70	70	70	70	70
200		200	200	200	200	200	200	200	200	200
120		120	120	120	120	120	120	120	120	120
100		100	100	100	100	100	100	100	100	
130		130	130	130	130	130	130	130	130	
50		50	50	50	50	50	50	50	50	
120		120	120	120	100	120	120	120	120	
30		30	30	30	30	30		30	30	
90			90	90	90	90		90	90	
160			160	160		160		160	160	
70			70	70		70		70		
120			120			120		120		
180			180			180		180		
100			100			100		100		
40			40			40				
130						130				
80						80				
120						120				
80										
100										
110										
150										

40
100
160
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190
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130
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200
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110
100
150
160
50
80
180
190
160
100
120
170
50
140
90
100
70
190
40
120
160
30
80
80
80 total answers

% answered	---	28.75%	37.50%	32.50%	30%	41.25%	27.50%	36.25%	31.25%	22.50%
% correct	---	95.65%	100%	100%	91.67%	100%	95.45%	100%	100%	100%

Complex Baseline Math Answers

Correct Answer	c002 f48	c011 f29	c013 f48	c014 f21	c015 f18	c018 m25	c021 m22	c024 m49	c025 m32	c027 m29
98	98	98	98	98	98	98	103	98	99	98
124	124	154	124	124	124	124	121	128	124	124
157	153	127	157	157	157	161	157	157	155	157
137	137	137	147	137	137	137	137	137	147	131
93	93	95	94	89	93	93	93	93	93	93
115	125	115	104	115	115	115	117	115	115	115
133	123	132	130	233	133	133	133	142	174	132
116	126	116	115	121	116	116	116	116	126	116
41	41	53	41	37	41	41	41	41	41	42
173	173	175	173	173	173	173	193	163	173	173
85	85	85	85	85	85	85	85	85	85	85
137	139	177	137	137	137	137	167	161	167	151
92	92	92		92	92	92	92	92	92	92
130	130			120	130	130	130	130	130	131
110					110	111	110	110		110
100							100	100		100
80							80	80		
52							52	52		
116							116	106		
183										
123										
162										
87										
109										
96										
184										
189										
108										
176										
139										
155										
151										
7										
144										
78										
112										
186										
111										

158
119
103
105
92
82
91
78
98
145
140
77
115
58
85
127
45
73
120
133
76
130
133
77
102
64
91
124
100
145
133
66
55
62
126
70
144
74
79
67
102
109
80 total answers

% answered	17.50%	16.25%	15%	17.50%	18.75%	18.75%	23.75%	23.75%	17.50%	20%

% correct	64.29%	46.15%	58.33%	64.29%	100%	86.67%	73.68%	73.68%	57.14%	68.75%

Complex Test 1 Math Answers

Correct Answer	c002 f48	c011 f29	c013 f48	c014 f21	c015 f18	c018 m25	c021 m22	c024 m49	c025 m32	c027 m29
99	99	99	99	99	98	99	99	99	99	99
142	142	142	140	142	142	142	142	141	142	142
122	122	122	121	123	122	122	122	133	122	122
93	93	93	93	93	92	93	93	93	93	85
41	41	81	46	50	41	41	41	41	41	41
89	89	89	89	89	89	89	89	99	89	89
136	136	136	134	136	136	136	136	136	136	136
68	68	68	68	68	68	68	68	68	68	68
103	122	103	103	103	103	103	103	103	103	105
150	160	150	150	150	150	150	150	150	150	140
115	115	125	114	114	113	115	105	112	115	106
130	130	130		130	130	130	130	120	130	120
131	131	115		159	130	134	131	129	121	141
74	74				74	74	74	73	74	
100	100				99	100	100	100	100	
126	136				138	136	126	126	126	
122	122					122	122			
60	50					60	51			
183						183	183			
83						83	78			
95							95			
173										
50										
42										
65										
160										
109										
189										
136										
113										
74										
147										
93										
101										
100										
120										
118										

85
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157
112
167
76
95
125
38
146
103
105
35
75
114
31
82
151
154
81
93
102
160
38
112
54
166
111
109
193
111
95
141
162
169
86
136
163
88
110
51
115
106
80 total answers

% answered	22.50%	16.25%	13.75%	16.25%	20%	25%	26.25%	20%	20%	16.25 %
% correct	77.78%	76.92%	54.55%	69.23%	62.50%	90%	85.71%	56.25%	93.75%	53.85 %

Complex Test 2 Math
Answers

Correct Answer	c002 f48	c011 f29	c013 f48	c014 f21	c015 f18	c018 m25	c021 m22	c024 m49	c025 m32	c027 m29
124	124	124	124	124	124	124	124	115	124	124
164	164	164	163	164	163	164	164	128	164	154
129	129	129	129	129	129	121	129	129	129	129
92	96	102	84	92	90	92	88	92	92	93
73	73	73	72	73	73	73	53	84	73	70
144	144	154	144	144	144	144	144	144	146	144
132	132	132	132	132	132	132	132	122	132	124
93	93	93	93	93	93	93	93	96	93	92
172	172	169	172	172	158	172	172	167	171	
111			110	107	111	111	101		121	
103				103	107	103	103		103	
76						76	76		76	
105						105	105		95	
70						70	70			
115						115	115			
171							173			
78										
135										
55										
69										
139										
170										
74										
85										
161										
64										
119										
90										
123										
75										
123										
52										
152										
86										
57										
42										
33										

143
145
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147
148
138
117
128
71
83
77
105
178
134
96
161
136
108
108
144
66
108
107
122
79
162
98
104
98
77
169
63
36
60
185
115
77
44
152
148
131
72
80 total answers

% answered	11.25%	11.25%	12.50%	13.75%	13.75%	18.75%	20%	11.25%	16.25%	10%
% correct	88.89%	66.67%	60%	90.91%	63.64%	93.33%	75%	33.33%	69.23%	37.50%

APPENDIX J

Experiment Two Practice Session Instructions for the No Math group

THE EFFECT OF DISTRACTION ON DRIVER BEHAVIOR
PRACTICE SESSION

Currently, you are seated in the driving environment simulator (DESi). It is an interactive simulator, which means the driving scenes you experience react to your steering and pedal inputs to provide a realistic driving experience. During your drive in the simulator, please drive in a normal fashion and obey all traffic laws.

For the practice session your task is to get comfortable with driving in a simulated driving environment. The driving scene that will be presented to you begins with the simulator vehicle stopped at the side of a road. You are to start the vehicle, put it into ëdriveí, and proceed through the driving environment by following the car traveling in front of you. Please continue to follow the lead car at a comfortable distance. After a couple minute the lead car will pull off the road. Your task is to continue driving down the road. After a couple more minutes the screens will turn black. At that time please turn your attention to the experimenter. The practice session will take approximately five minutes.

For the second part of the practice session it is also your task to become familiar with the touch screen and the mental workload questions. Please look at the touch screen and read through the questions.

If you have any questions regarding the practice session please consult the experimenter. Otherwise, acknowledge that you are ready by telling the experimenter to begin the driving scene.

APPENDIX K

Experiment Two Practice Session Instructions
for the Simple Math and Complex Math groups

THE EFFECT OF DISTRACTION ON DRIVER BEHAVIOR
PRACTICE SESSION

Currently, you are seated in the driving environment simulator (DESi). It is an interactive simulator, which means the driving scenes you experience react to your steering and pedal inputs to provide a realistic driving experience. During your drive in the simulator, please drive in a normal fashion and obey all traffic laws.

For the first part of the practice session your task is to perform an addition task. The experimenter will present to you a series of addition tasks on the touch screen. Your task is to add the numbers and then enter the correct answer. You will have a total of eight seconds to perform each addition task. For example, you may be asked to add 20 and 30. For the practice session you will be asked to perform this task for two minutes. Please direct your attention to the experimenter to perform them now.

THE EFFECT OF DISTRACTION ON DRIVER BEHAVIOR
PRACTICE SESSION II

For the second part of the practice session your task is to get comfortable with driving in a simulated driving environment. The driving scene that will be presented to you begins with the simulator vehicle stopped at the side of a road. You are to start the vehicle, put it into ëdriveí, and proceed through the driving environment by following the car traveling in front of you. Please continue to follow the lead car at a comfortable distance. After a couple minute the lead car will pull off the road. Your task is to continue driving down the road. After a couple more minutes the screens will turn black. At that time please turn your attention to the experimenter. The practice session will take approximately five minutes.

For the second part of the practice session it is also your task to become familiar with the touch screen and the mental workload questions. Please look at the touch screen and read through the questions.

If you have any questions regarding the practice session please consult the experimenter. Otherwise, acknowledge that you are ready by telling the experimenter to begin the driving scene.

APPENDIX L

Experiment Two Instructions for the No Math group

THE EFFECT OF DISTRACTION ON DRIVER BEHAVIOR
EXPERIMENT INSTRUCTIONS

You are now asked to complete an experimental driving scene. Your task is to drive through the scene as you normally would drive in the real world at 40 mph. As before, drive through the scenes in a normal fashion obeying all traffic signs and laws. Please do not deviate from the directed course. If you reach an intersection please obey all traffic signs and proceed straight through the intersection as you would under normal driving circumstances.

Task One
Your task is to drive through the scene, obeying all traffic signs, traffic laws, and directional signs. Please try to complete the scenarios as you would normally in the real world. Do not drive with undue aggression or undue conservatism.

When the driving scene begins, the simulator vehicle will be stopped on the side of the roadway. Place the vehicle in ëdriveí, drive onto the roadway, and proceed through the driving environment at 40 mph.

Task Two
At two different times during the experiment you will be asked questions regarding your mental workload. This will be presented on the touch screen to your side. Please select the most applicable answer and please answer these questions honestly.

At the end of the experimental driving scene, there will be two vehicles positioned across the roadway. When you reach these vehicles, please bring the vehicle to a complete stop, place it in ëparkí, and direct your attention to the investigator. This experiment session will take approximately 20 - 25 minutes.

If you have any questions regarding your task in the experiment consult the experimenter. Otherwise, acknowledge that you are ready by telling the experimenter to begin the driving scene.

APPENDIX M

Experiment Two Session Instructions
for the Simple Math and Complex Math groups

THE EFFECT OF DISTRACTION ON DRIVER BEHAVIOR
EXPERIMENT INSTRUCTIONS

You are now asked to complete an experimental driving scene. Your task is to drive through the scene as you normally would drive in the real world at 40 mph. As before, drive through the scenes in a normal fashion obeying all traffic signs and laws. Please do not deviate from the directed course. If you reach an intersection please obey all traffic signs and proceed straight through the intersection as you would under normal driving circumstances.

Task One
Your task is to drive through the scene, obeying all traffic signs, traffic laws, and directional signs. Please try to complete the scenarios as you would normally in the real world. Do not drive with undue aggression or undue conservatism.

When the driving scene begins, the simulator vehicle will be stopped on the side of the roadway. Place the vehicle in ëdriveí, drive onto the roadway, and proceed through the driving environment at 40 mph.

Task Two
You are asked to perform an addition task using two numbers as presented by the experimenter on the touch screen and then enter the correct answer within 8 seconds. For example, you may be asked to add 20 and 30. This task will be presented twice throughout your drive and each time the task will last approximately two minutes.

Task Three
At two different times during the experiment you will be asked questions regarding your mental workload. This will be presented on the touch screen to your side. Please select the most applicable answer and please answer these questions honestly.

At the end of the experimental driving scene, there will be two vehicles positioned across the roadway. When you reach these vehicles, please bring the vehicle to a complete stop, place it in ëparkí, and direct your attention to the investigator. This experiment session will take approximately 20 - 25 minutes.

If you have any questions regarding your task in the experiment consult the experimenter. Otherwise, acknowledge that you are ready by telling the experimenter to begin the driving scene.

APPENDIX N

Experiment Two Driving Data
for the No Math, Simple Math, and Complex Math groups

subject	mean velocity	standard deviation of mean velocity	mean lane position	standard deviation of mean lane position
C012F28	23.1458	2.903964	-0.03966	0.338304
C013F25	21.44574	3.508377	0.068673	0.259002
C017F23	17.98854	3.182811	-0.04327	0.241968
C018F35	14.93726	3.029598	-0.1398	0.406538
C028F30	19.71697	2.944896	-0.22114	0.246829
C010M22	18.6629	1.814586	-0.21828	0.347187
C014M75	20.89076	2.925936	-0.22254	0.464236
C015M26	23.58725	3.435131	-0.28632	0.533859
C016M28	23.64143	3.543463	-0.04554	0.409082
C025M23	19.70194	3.077928	0.036866	0.429673
N023F24	23.66741	4.140942	-0.31927	0.193985
N024F21	26.46673	1.909039	-0.05007	0.327899
N027F22	25.45295	4.0203	-0.25598	0.287111
N029F27	22.93165	2.579321	0.226642	0.243915
N030F20	23.73321	2.671827	-0.31216	0.265219
N019M23	24.82637	3.098621	-0.2334	0.189216
N020M20	18.47223	1.673001	-0.15519	0.183365
N021M24	18.88361	1.459805	-0.49384	0.189182
N022M27	20.2462	2.310206	-0.14964	0.296784
N026M24	19.63478	1.573769	0.068058	0.146165
S003F36	22.29183	3.4244	-0.0563	0.406076
S006F20	17.31402	2.223464	0.309254	0.318421
S007F23	27.58089	3.002919	-0.17094	0.521262
S008F22	22.36204	3.967196	-0.01883	0.421126
S011F26	21.74602	2.415309	-0.09715	0.289705
S001M18	26.11674	3.246653	-0.74435	0.544691
S002M22	19.39811	4.923862	0.007384	0.467559
S004M29	22.29425	1.978286	0.032053	0.630145
S005M31	16.42919	4.248093	-0.14882	0.593891
S009M41	25.47379	3.926116	-0.30008	0.526447

Key:
Under the subject heading the code for each subject is:
C = complex math N = no math S= simple math
The next three numbers indicate the actual order in which the subject was run in the experiment.
The M or the F following the three numbers indicates that the subject was either male or female.
The last two numbers is the subjectís age.

APPENDIX O

Experiment Two Math Data
for the Simple Math and Complex Math groups

Simple Baseline Math Answers

Correct Answer	s001 m18	s002 m20	s003 f36	s004 s29	s005 m31	s006 f36	s007 f23	s008 f22	s009 m41	s011 f26
110	110	---	110	110	110	110	110	110	110	---
80	80		0	80	80	80	0	80	90	
120	120		0	120	120	120	120	120	120	
110	110		110	110	110	110	110	110	10	
130	113		130	130	130	130	120	130	130	
120	120		120	120	120	120	120	120	120	
150	150		150	150	150	150	150	150	150	
140	140		14	140	140	140	140	140	140	
60	60		60	60	60	60	60	60	60	
100	100		100	100	100	100	100	100	100	
90	90		90	90	90	90	90	90	0	
100	100		100	100	100	100	100	100	100	
60	60		60	60	60	60	60	60	60	
160	150		160	160	10	160	160	160	160	
50	50		50	50	50	50	50	50	50	
170	170		170	170	170	170	170	150	170	
120	120		120	120	120	120	120	120	120	
110	110			110	110	110	110	110	110	
100	100			100	100	100	100	100	100	
160	160			160	160	160	160	160	160	
130	130			130	130	130	130	130	130	
90	90			90	90	90	90	90	90	
70	70			70	70	0	70	70	70	
110	110			110	110	110	110	110	110	
180	180			180	180	180	180	180	180	
130	130			130	130	130	130		130	
110	110			110	110	110	110		130	
130	130			130	130	130	130		130	
90	90			90	90	90	90		90	
40	40			40	40	40	40		40	
70	70								70	
100	100								100	
40									140	
150									160	
40									40	
90									90	
120									120	
70									70	

80									80	
130									150	
160									160	
120									120	
90									90	
50									50	
140									140	
140									140	
30									30	
120									120	
70									70	
170									170	
60									60	
80									80	
130										
60										
160										
110										
150										
170										
100										
140										
90										
150										
110										
150										
130										
140										
130										
90										
70										
90										
40										
180										
60										
120										
110										
120										
180										
140										
90										
150										
80 total answers										
%	40%	---	21.25%	37.50%	37.50%	37.50%	37.50%	31.25%	65%	---

answered										
% correct	93.75%	---	82.35%	100%	96.67%	96.67%	93.33%	96%	86.54%	---

Simple Test 1 Math Answers

Correct Answer	s001 m18	s002 m20	s003 f36	s004 s29	s005 m31	s006 f36	s007 f23	s008 f22	s009 m41	s011 f26
80	140	80	80	80	80	8	80	80	8	---
140	140	140	140	140	140	140	140	90	140	
180	180	180	18	180	180	180	180	180	180	
140	140	140	10	140	140	140	140	140	140	
140	140	140	140	140	140	140	140	140	40	
110	110	110	110	110	110	110	110	110	110	
160	160	160	6	160	160	160	160	16	60	
90	90	90	9	90	90	90	90	90	0	
130	130	130	13	130	130	130	130	130	130	
80	80	80	80	80	80		80	80	0	
140	140	140	140	140	140		140	140	140	
120	120	120	120	120	120		120	120	120	
180	180	180	180	180	180		180	180	180	
90	90	90	9	90	90		90	90	9	
150	150	150	150	150	150		150	150	150	
100	100	10	100	100	100		100	100	100	
90	90	90	90	90	90		90	90	90	
100	100	100	100	100	100		100	100	100	
130	130	130	10	130			130		120	
190	190	190	190	190			190		190	
150	150	150	150	150			150		150	
120	120	120		120			120		10	
130	130	130		130			130		130	
180	180	180		180			180			
190	190	190		190			190			
90	90	90		90			90			
100	100	100		100			100			
110	110	110					110			
80	60						80			
140	140						140			
80										
100										
150										
120										
100										
40										
110										

150
90
70
140
160
100
50
110
80
160
120
70
40
60
110
140
100
100
100
100
170
110
70
120
40
80
120
150
150
90
130
80
100
90
60
90
30
180
140
150
70
60
100
80 total answers

% answered	37.50%	35%	26.25%	33.75%	22.50%	11.25%	37.50%	22.50%	28.75%	---
% correct	93.33%	96.43%	66.67%	100%	100%	88.89%	100%	88.89%	65.22%	---

Simple Test 2 Math
Answers

Correct Answer	s001 m18	s002 m20	s003 f36	s004 s29	s005 m31	s006 f36	s008 f22	s007 f23	s009 m41	s011 f26
70	70	70	0	70	130	70	---	70	0	70
60	60	60	606	60	60	60		60	70	60
80	80	80	80	80	80	80		80	80	80
130	130	130	13	130	130	130		130	0	130
80	88	80	80	80	80	80		80	0	80
110	110	110	110	110	110	110		110	110	110
20	20	20	20	20	20	20		20	20	20
130	130	130		130	130	130		130	130	130
140	140	140		140	140	140		140	140	140
40	40	40		40	40	40		40	4	40
200	200			200	200	200		200	200	
40	40			40	40	40		40		
110	110			110	110	110		110		
90	90			90	90	90		90		
90	90			90	90			90		
70	70			70	70			70		
200	200				200					
120	120				120					
100	100									
130										
50										
120										
30										
90										
160										
70										
120										
180										
100										
40										
130										
80										
120										
80										
100										
110										
150										

40
100
160
150
60
80
80
120
120
120
160
190
130
120
160
130
100
200
180
110
100
150
160
50
80
180
190
160
100
120
170
50
140
90
100
70
190
40
120
160
30
80
80
80 total answers

% answered	23.75%	12.50%	8.75%	20%	22.50%	17.50%	---	20%	13.75%	12.50%
% correct	94.74%	100%	57.14%	100%	94.44%	100%	---	100%	55%	100%

Complex Baseline Math Answers

Correct Answer	c010 m22	c012 f28	c013 f25	c014 m75	c015 m26	c016 m28	c017 f23	c018 f35	c025 m23	c028 f30
98	---	---	98	98	---	9	9	0	98	92
124			124	124		4	142	14	124	124
157			157	17		17	122	157	157	157
137			137	137		137	93	3	37	137
93			93	93		0	41	9	83	93
115			115	115		0	89	5	115	115
133			133	133		133	136	133	133	133
116			116	116		113	68	6	116	116
41			41	41		1	103	4	41	41
173			173	173		3	140	173	153	177
85			85	85			115	0	85	88
137			137	137			110	3	127	137
92			92	92			131	0	92	92
130			130	130				1	130	137
110			110	110				0	110	110
100			100	100				1	100	100
80			80	80				80		80
52				52				2		52
116								11		
183								1		
123										
162										
87										
109										
96										
184										
189										
108										
176										
139										
155										
151										
7										
144										
78										
112										
186										
111										

158
119
103
105
92
82
91
78
98
145
140
77
115
58
85
127
45
73
120
133
76
130
133
77
102
64
91
124
100
145
133
66
55
62
126
70
144
74
79
67
102
109
80 total answers

%	---	---	21.25%	22.50%	---	12.50%	16.25%	25%	20%	22.50%

answered										
% correct	---	---	100%	94.44%	---	20%	0%	20%	75%	77.78%

Complex Test 1 Math
Answers

Correct Answer	c010 m22	c012 f28	c013 f25	c014 m75	c015 m26	c016 m28	c017 f23	c018 f35	c025 m23	c028 f30
99	---	---	---	---	---	99	9	9	---	---
142						142	142	0		
122						0	122	122		
93							93	9		
41							41	41		
89							89	89		
136							136	136		
68							68	8		
103							103	10		
150							140	15		
115							115	11		
130							110	0		
131							131	0		
74										
100										
126										
122										
60										
183										
83										
95										
173										
50										
42										
65										
160										
109										
189										
136										
113										
74										
147										
93										
101										
100										
120										
118										

85
77
157
112
167
76
95
125
38
146
103
105
35
75
114
31
82
151
154
81
93
102
160
38
112
54
166
111
109
193
111
95
141
162
169
86
136
163
88
110
51
115
106
80 total

answers										
% answered	---	---	---	---	---	3.75%	16.25%	16.25%	---	---
% correct	---	---	---	---	---	66.67%	76.92%	30.76%	---	---

Complex Test 2 Math
Answers

Correct Answers	c010 m22	c012 f28	c013 f25	c014 m75	c015 m26	c016 m28	c017 f23	c018 f35	c025 m23	c028 f30
124	---	124	124	---	124	124	134	741	124	99
164		164	164		164	164	164	16	184	142
129		129	129		129	129	129	19	129	122
92		92	92		92	0	94	9	92	93
73		73	73		73	93	73	7	73	41
144		144	144		144	0	144	144	144	89
132		132	132			122	132	2	132	136
93			93			93	93	89	3	
172			172			0	172	17	93	
111						0	111	11	111	
103								12	103	
76								0	7	
105								10	105	
70								70	70	
115									115	
171									171	
78									78	
135									15	
55									55	
69										
139										
170										
74										
85										
161										
64										
119										
90										
123										
75										
123										
52										
152										
86										
57										
42										
33										

143
145
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148
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117
128
71
83
77
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178
134
96
161
136
108
108
144
66
108
107
122
79
162
98
104
98
77
169
63
36
60
185
115
77
44
152
148
131
72
80 total answers

% answered	---	8.75%	11.25%	---	7.50%	12.50%	12.50%	17.50%	23.75%	8.75%
% correct	---	100%	100%	---	100%	40%	80%	14.29%	73.68%	0%