Mobile Phone Use in a Driving Simulation Task: Differences in Eye Movements

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Abstract: Every year there are nearly 43,000 traffic fatalities and it is estimated that 25% of crashes involve some degree of driver inattention (NHSTA, 2005, 2000). A recent survey revealed 21% of crashes/near crashes reported by respondents involved at least one driver using a mobile phone (Seo & Torabi, 2004). The current study examined the effects of mobile phone use on drivers' attention and eye movements in a low-fidelity simulator. Sixteen Clemson University undergraduate students viewed 24 driving scenarios and responded to questions about vehicular events in the scenes. Eight participants simultaneously performed a language learning task (simulating a mobile phone conversation). The language learning group answered fewer questions about the driving scenes correctly (M = 9.3) than the non-language group (M = 16). Overall, participants' correctly responded to more scenarios with 4 cars (M = 7.3/12) than with 7 cars (M = 5.3/12). The total number of fixations on the vehicle(s) involved in the critical event in each scenario was greater for the non-language group (M = 471.7) than for the language group (M = 300.5). Additionally, participants in the language group who answered the event question correctly spent the same percentage of the total time looking at the vehicle of interest during the event (M = 13.5%) as those people who answered incorrectly (M = 12.4%). This finding provides support for the 'look but fail to see' phenomenon. The mean duration of total fixations was also greater for people in the non-language group (M = 9574.5 ms) than the language group (M = 6523.4 ms). This study supports previous findings that increasing mental workload (through mobile phone use, and/or increased traffic) decreases driving performance.

Keywords: Driving simulation, eye tracking, mobile phone

CCS: Human Factors, Performance

1. Introduction

Every year there are nearly 43,000 traffic fatalities (NHTSA, 2005). In the US, traffic crashes are responsible for 40 percent of deaths of people aged 15-20 (National Transportation Board, 2005). As this is a large problem, it is important to explore the causes of vehicle collisions. It may be possible, then, to help to reduce the number of traffic related fatalities.

Treat et al. (1979) evaluated 2,258 traffic collisions and found the two leading causes of crashes were inattention and improper lookout. Moreover, inattention and improper lookout, which are aspects of situation awareness (perceiving critical elements of the environment), were cited more frequently as causes of collisions than poor decision making and psychomotor ability. Furthermore, the US Department of Transportation has estimated that of the 6.3 million crashes each year, 25% involve some degree of driver inattention or distraction (NHSTA, 2000).

It has been shown that while driving, when mental workload is increased (e.g. high traffic, visual clutter, etc.) drivers are less able to maintain high situation awareness. This reduction in situation awareness may result in a lowered ability to optimally perform driving tasks (Gugerty 1997). Using a low fidelity PC based driving simulator, Gugerty (1997) examined how participant situation awareness for car locations was affected by working memory load. Participants accurately recalled an average of 3.7, 4.5, 5.0 and 5.5 cars when traffic level was 4, 5, 6, 7 cars respectively. These data suggest that at high traffic levels participants are unable to accurately track many vehicles, possibly because attention is focused on only a subset of traffic immediately surrounding the driver.

In addition to normal aspects of driving, conversing on mobile phones has been shown to dramatically increase mental workload (Recarte & Nunes, 2003). If talking on a mobile phone while driving (TMWD) increases an already elevated mental workload, and a high mental workload results in decreased driving performance, then it is possible that people are unnecessarily increasing the risk of an adverse event while driving and talking on a mobile phone. This is especially troubling due to the recent increase in the popularity of mobile phones (Incisive Interactive Marketing, 2005). What's more, a NHSTA report (1997) revealed that 85% of all mobile phone owners talk on their phones at least occasionally while driving. This is particularly alarming when compounded with the results of a 2004 survey that revealed 21% of crashes or near crashes reported by respondents involved at least one driver using a mobile phone (Seo & Torabi, 2004).

Perhaps because of the distractions caused by mobile phones and the number of collisions involving mobile phones, many countries, including Australia, Japan, South Korea and Spain, have banned the use of mobile phones while driving (Cellular News, 2005). In the US, many cities and states have begun to implement mobile phone bans or partial bans, including Chicago, IL, which has implemented a $50 fine for driving while talking on a mobile phone (Cellular News, 2005). Although this legislation is designed to help to reduce the number of collisions resulting from TMWD, many states only ban the use of hand-held mobile devices (e.g. Connecticut). However, research has shown no improvement in driving performance while using a hands-free device over using a hand-held set (e.g. Treffner and Barrett, 2004; Mazzae et. al, 2004). That is, the act of holding the phone is *not* the aspect of TMWD that decreases driving performance.

A great deal of research conducted throughout the past several years has supported the idea that using *both* hands free and hand held mobile phones negatively affect performance while driving. Strayer & Johnston (2001) found that participants who used a mobile phone (both hand-held and hands free) performed worse in a driving task compared with participants who passively listened to radio broadcasts or books on tape. While previous research (e.g. Briem & Hedman, 1995; Brookhuis, et al., 1991) has shown that handling the mobile phone (e.g. dialing and answering the phone) negatively affects driving performance, an average mobile phone conversation can be up to two times greater in length than the time required to dial or answer the phone. In other words, on average, when engaging in mobile phone use while driving, people spend two times longer talking rather than initiating a call (Strayer et al., 2003). In support of this finding, a 2004 survey revealed that the most frequently cited reason for crashes or near crashes involving mobile phones was drivers TMWD rather than attempting to answer or dial (Seo & Torabi, 2004).

It has, therefore, been well established that TMWD degrades the ability to optimally perform driving tasks. However, it is not as well known precisely which aspects of "good" driving are disrupted while talking on a mobile phone (Gugerty et al., 2004). That is, how does carrying on a conversation with a person in vivo differ from having a similar conversation with a person who is in a remote location? The use of eye trackers in driving and attention research has shown to be an effective way of discovering the underlying reasons for poorer driving while using a mobile phone (e.g. Strayer et al., 2003). Researchers have been able to examine the question of attention in more detail and discover if people do not look at available information (e.g. objects, hazards, and other cars) or if people look at the information available but fail to attend to it (e.g. Gugerty, 1997).

Strayer, et al. (2003) examined how conversations on mobile phones affect drivers' attention to objects encountered while driving. In their research, participants performed several tasks in a high fidelity driving simulator. Participants were asked to follow a lead car that braked at random in either high or low traffic density; these scenarios were performed both with and without engaging in a simulated hands-free mobile phone conversation. Participants' reaction times to braking of the lead car and eye tracking data were collected. After completing the driving task, participants were shown different billboards and asked to determine whether or not they had appeared in the driving scene (participants did not know they would be tested in this manner). Eye tracking data revealed that participants fixated on approximately 2/3 of the presented billboards in both mobile phone and no phone conditions. However, those people who performed the driving task without the mobile phone were more than two-times more likely to recognize billboards on which they had fixated compared to the mobile phone condition. In other words, even when participants fixated on objects in a driving environment, they were less likely to remember those objects when talking on a mobile phone, a phenomenon commonly referred to as a 'look(ed) but fail(ed) to see error.' In a similar study, Strayer, Cooper, and Drews (2004) found that when people were talking on a mobile phone while driving were as probable to fixate on objects as those not talking on a mobile phone while driving.

It has also been shown when tasks while driving become too demanding, [e.g. complex driving maneuvers (Shinar et al., 1977, Muira, 1979), increased speed (Cohen, 1981) and proximity to other vehicles (Hella et al., 1996)] the priorities of selective attention change according to the nature of the demand. This results in decreased fixation durations because drivers are attempting to sample more of the visual scene in order to maintain situation awareness. However, the amount of processing that can be performed during any single fixation is limited when an increased sampling rate of visual search occurs. This occurrence may be responsible for 'looked but failed to see' errors (Crundall et al., 2004). An analysis of traffic collisions by Brown (2002) revealed 'looked but failed to see' errors were among the most frequent causal factors as reported by police officers investigating crashes. Work by Recarte and Nunes (2000 & 2003) supports these findings. Eye tracking data during a simple driving task revealed that as mental work load increases, fixations on the rearview mirror and speedometer decrease.

Although it is known that engaging in TMWD increases driving errors as well as 'looked but failed to see' errors, it is not known how visual search strategies are modified according to the specific driving task. That is, do people recognize hazardous situations while driving and modify visual searching strategies or do search strategies remain the same during high mental workload? Gugerty (1997) has suggested that a shift of focus may occur during hazardous driving situations when TMWD. However, there is not yet eye tracking data to support this hypothesis. As a result, the current study seeks to quantify if/how visual search patterns change both while engaging in a mobile phone conversation as well as combined with potentially hazardous driving situations.

2. Method

2.1 Participants

16 (11 female) Clemson University undergraduate students participated in this experiment. Participants had 20/20 or corrected to 20/20 vision, a valid drivers' license, and at least 2 years driving experience (M = 3.5 years). One person was not able to participate do to the inability to track the persons eye movements.

2.2 Apparatus

A non-invasive Tobii 1750 eye tracker with a sampling rate of 50 hertz and a display of 1280 x 1024 was used to collect data (17" LCD screen). The foreign language learning exercise was played to participants at a comfortable listening volume for each participant. The audio was synced to start at the beginning of each trial and end at the termination of each driving scenario. The driving simulator was developed using C++, OpenGL, and SDL.

2.3 Design

This experiment utilized a between subjects, 2 x 2 design. 8 participants (3 male, 5 female) participated in the mobile phone condition and 8 (2 male, x 6 female) in the non-mobile phone condition. All participants viewed 12 trials with 4 vehicles and 12 trials with 7 vehicles in the scene. Additional information is explained in greater detail in the subsequent sections.

2.4 Stimulus

2.4.1 Computer Based Stimulus

Participants were presented with a low fidelity driving simulator (see Figure 1). The simulator presented an environment in which the driver passively viewed a driving scenario. The driver (participant) was presented with a windscreen, rearview, right and left side mirrors. At the conclusion of each scenario, participants were asked a question about what they had just viewed (e.g. see Figure 2). Participants responded to the question using the computer's keyboard (numbers 1 - 5). Following this question, participants were also asked to report their confidence in the response they just gave (i.e. see Figure 3).

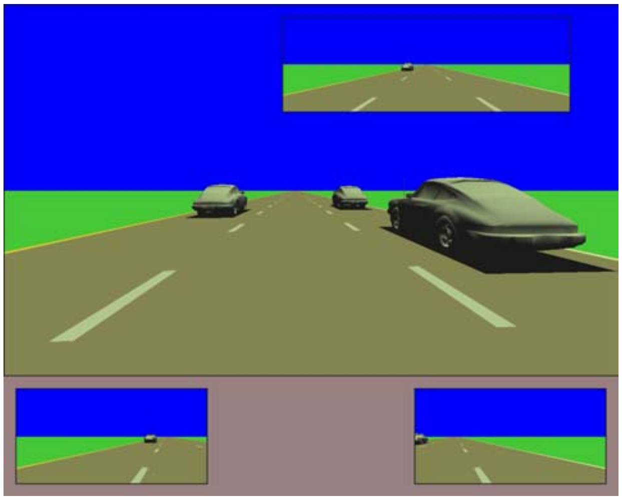

Figure 1. Low Fidelity Driving Simulator. This is what participants saw as they were viewing the driving scenario (with mirrors and windscreen view).

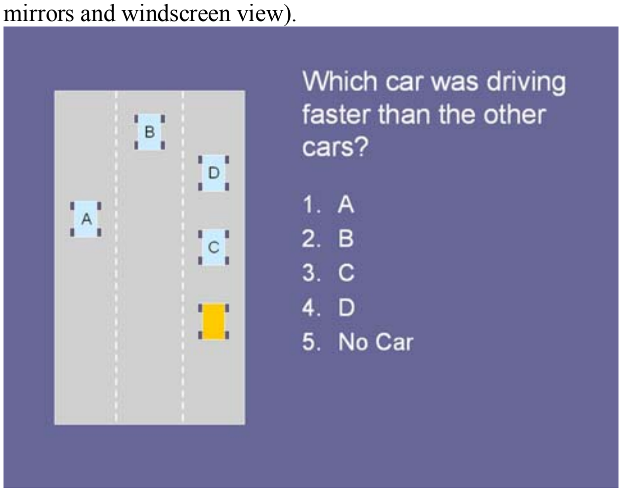

Figure 2. This is an example of a question that participants viewed and responded to after watching a driving scenario.

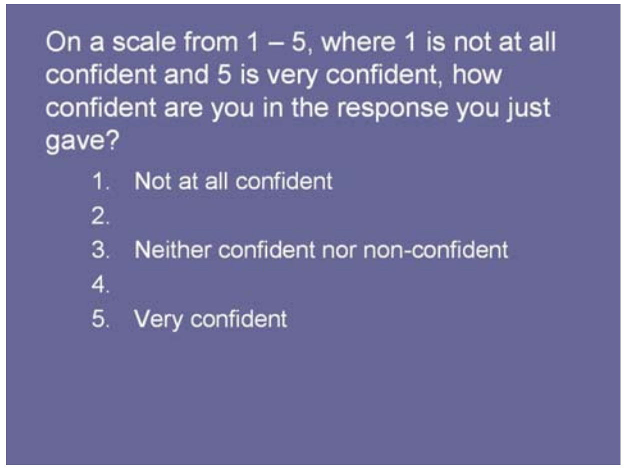

Figure 3. This is the confidence question that participants responded to after the scenario question.

2.4.2 Language Based Stimulus

Participants in the mobile phone condition were also asked to participate in a foreign language learning task to simulate talking on a mobile phone while driving. The Pimsleur Japanese language learning compact disk set for beginners was selected. The language learning task involved 3 aspects of the task: a listening aspect, a repeat the word/phrase aspect, and a generate the correct response aspect. Each of these aspects was evenly distributed throughout the entire session. Participants were giving practice time with the language learning task in order to become familiar and comfortable with the task. The practice involved listening to the introduction to the language learning program (approximately 90sec.) and performing the three previously mentioned aspects of the task. The audio task began synchronously with each driving scenario and concluded at the end of the scenario. That is, participants were not required to be engaged in the language learning portion when responding to the questions about the driving scenarios. Although the driving scenarios were randomized, the audio task was sequential. That is all participants in the language group listened to the language learning lesson in the same sequential order. Upon completion of all trials, participants were asked several questions about the language learning task they had completed (see Appendix C).

2.5 Procedure

After obtaining informed consent, participants were asked to perform several simulated driving scenarios (for detailed instructions see Appendix A). These scenarios involve watching a driving scene (from the first person/driver's perspective) and answering questions about each scene. Each participant was given several practice trials, in order to familiarize themselves with the simulator. After calibration with the eye tracker, participants completed 12 trials, recalibrated and completed 12 more trials. The 'goodness' of the calibration was determined by asking the participant to look at the corners and center of the screen with the eye points visible. If the experimenter was not satisfied with the calibration, the participant was asked to recalibrate. Half of the participants completed the trials while performing a simulated mobile phone task; the other half completed the trials without the mobile phone/audio task. Of the 24 trials, 16 involved another vehicle performing a potentially 'hazardous' action (e.g. tailgating or weaving in and out of a lane). The remaining 8 trials were uneventful (i.e. all vehicles will be moving in a safe manner). These two types of trials (‘hazardous’ and non-’hazardous’) were randomized for each participant. No trial was repeated. After the completion of each trial, participants were asked to identify the ‘hazardous’ vehicle. Each question contained a ‘No Car’ choice. This allowed for consistency in format between 'hazardous' and non-'hazardous' trials. In addition, 12 of the trials contained 4 vehicles (in addition to the driver's vehicle) and 12 contained 7 vehicles. This was counterbalanced between the 'hazardous' and non-'hazardous' trials (i.e. 8 'hazardous' trials contain 4 vehicles and 8 contain 7 vehicles.)

For each participant eye tracking and accuracy data were collected. Those participants in the mobile phone condition were also asked a few short questions to ensure engagement in the language learning task. Finally, participants were asked to complete a questionnaire pertaining to their mobile phone usage and attitudes about mobile phones (see Appendix B). Participants took between 20-30 minutes to complete the experiment.

2.5.1 Mobile phone task

Those participants in the mobile phone condition were asked to partake in an audio based language learning task. This task involved listening to several words/phrases in Japanese, their meanings, repeating and generating the words/phrases. This task was selected to represent engaging in a mobile phone conversation for several reasons. These include: the pace of the 'conversation' cannot be altered (or modified when the driving task becomes more or less difficult), it involves both listening and speaking tasks, it is required that the participant allocate attention to both the driving and mobile phone task, and this ensures that all participants engage in the same 'conversation.'

3. Results

A repeated measured ANOVA revealed a significant difference in the number of post-driving scenario questions answered correctly $F(1, 14) = 49.594$, $p < .001$. On average, those who performed the dual task (i.e. watching the driving scenario and the audio task) responded correctly to 38.5% of the questions and those in the single task (i.e. watching the driving scenario only) responded to 66.7% correctly. Participants in the single task were also more confident in their correct responses than those in the dual task condition $F(1, 200) = 23.314$, $p < .001$. On a scale from 1 – 5, where 1 is not at all confident and 5 is very confident, the mean confidence rating for correct responses in the non-audio condition was 4.03 and 3.18 in the audio condition.

Overall, participants answered more of the questions to scenarios with four cars (60.9%) correctly than with seven cars (44.3%) $F(1, 380) = 11.861$, $p = .001$. This did not differ between those in the audio and non-audio conditions $F(1, 380) = .667$, $p > .005$ (see Figure 4).

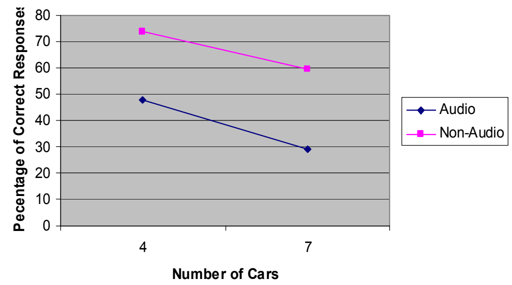

Figure 4. The percentage of correct responses to post-scenario questions by number of cars in the scenario and audio/non-audio conditions.

Survey data revealed that all participants owned a mobile phone. On average, participants reported using their mobile phone sometimes – often while driving, four participants reported using their phone nearly every time they drove. While all participants reported they felt others’ driving performance was degraded when TMWD, 7 of the 16 participants felt their driving performance was only degraded slightly or not at all. (This did not differ between the audio and non-audio groups.) All participants in the non-audio condition felt they would have performed the task more poorly had they been talking on a mobile phone. Similarly all participants in the audio task reported that they would have performed the driving task better had they not been performing the language learning task.

The eye data was sampled at a rate of 1500 points per 30 second trial (3000 points per minute). Playback of eye data allowed verification of the numerical data. (Some of the possible 1500 points were not analyzed for various reasons including blinks, looking off screen, etc.) Those people in the language task had fewer total valid eye tracking points (M = 1284.9) than those in the non-language task (M = 1431.8) $F(1, 14) = 7.331$, $p = .017$. The total number of fixations were also greater for those people in the non-language task (M = 1183.4) than in the language task (M = 1004.2) $F(1, 14) = 6.744$, $p = .021$. The percentage of total points observed that were fixations were not different between the two groups $F(1, 14) = 1.704$, $p > .05$. The mean duration of fixations were also not different between the groups $F(1, 14) = .554$, $p > .05$.

The number of fixations in different areas of the viewing scene did not differ between those in the language group and those in the non-language group. The percentage of total fixations in the windscreen was not different between groups $F(1, 14) = .681$, $p > .05$. There was also not a difference in the percentage of total fixations in the rearview and side view mirrors $F(1, 14) = .163$, $p > .05$ and $F(1, 14) = .771$, $p > .05$ respectively.

ROIs were automatically created by the software for each scenario. Each 3D car model had an associated 3D bounding box, which completely surrounded the car. At each frame, the event related cars’ 3D bounding boxes are projected to 2D space. The maximum and minimum values from this projection were then used to create the 2D ROI. Due to inherent errors associated with eye tracking calibration, small ROIs could lead to misdetection of fixations within in the ROI. To prevent this, the minimum size of the region of interest (ROI) was fixed at 150 x 150 pixels. When two cars were involved in the event (i.e. collision course) both cars generate an ROI around them.

Throughout the entire trial, participants in the non-language group had more fixations in the ROI (M = 471.7) than participants in the language group (M = 300.5), $F(1, 14) = 7.367$, *p* = .017. The percentage of total fixations in the ROI throughout the trial were greater for participants in the non-language group (M = 39.5%) than the language group (M = 29.3%), *F* (1, 14) = 4.986, *p* = .042. The mean time spent in the ROI throughout the trial was also greater for participants in the non-language group (M = 1183.0 ms) than participants in the language group (M = 1005.6 ms), *F* (1, 14) = 6.4, *p* = .024.

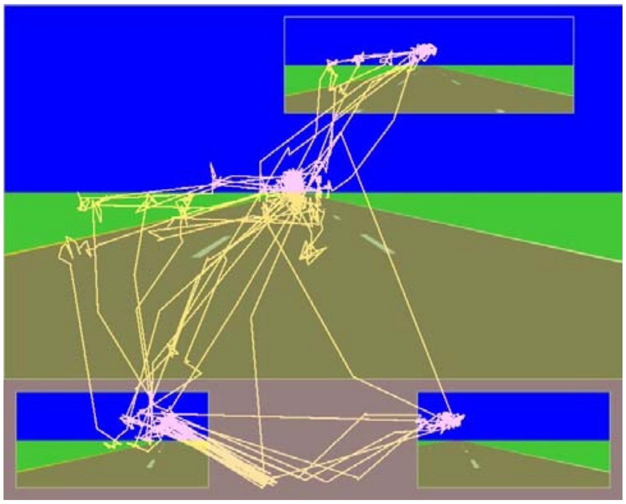

Figure 5. A sample scanpath over an entire trial.

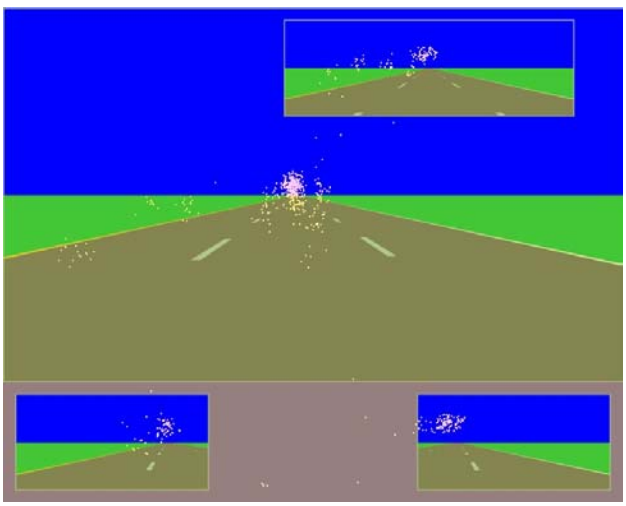

Figure 6. A sample of fixation data from the same trial and participant as Figure 5.

The mean duration of the fixations in the ROI throughout the trial was also longer for the non-language group (M = 9574.5 ms) than the language group (M = 6523.4 ms), *F* (1, 14) = 6.51, *p* = .023. The number of fixations in the region of interest (ROI) during the event took place were significantly different between groups, *F* (1, 14) = 6.966, *p* = .019. People in the language based task had fewer fixations in the ROIs (M = 117.8) than those in the non-language group (M = 185.6).

The percentage of fixations in the ROI during the event were greater for those people in the driving only task (M = 15.6%) than the driving plus language task (M = 11.3%), *F* (1, 14) = 4.937, *p* = .043. The total time spent fixating in the ROI during the event was also longer for those people in the non-language (M = 4755.3 ms) group than in the language group (M = 3514.8 ms), *F* (1, 14) = 7.864, *p* = .014.

Eye data was also analyzed when separated by correct vs. incorrect answers for both groups of participants. The percentage of fixations in the ROI during the event to total points are 13.7% for an incorrect answer in the non-language group, 12.4% for an incorrect answer in the language group, 21.1% for a correct answer in the non-language group, and 13.5% for a correct answer in the language group.

4. Discussion

The language learning task in this experiment is thought to be similar to talking on a mobile phone because of the following: people must generate responses to questions and rate of speech from non-driver does not change due to increased driving difficulty. The language learning method was chosen over other mobile phone simulations (e.g. choosing a conversation by topic of interest) because of a reduced variability in the simulation. Participants in the language group answered fewer questions about the scenarios correct than those in the non-language group. This is in support of the hypothesis that people perform better when they are not talking on a mobile phone while driving.

Confidence ratings for correct responses for both groups indicate that when driving without a mobile phone people are more confident that they are aware of what is occurring / has occurred on the road around them. These results indicate that participants in the mobile phone task were neither confident nor unconfident in their responses even when their responses were correct.

Gugerty (1997) found that when mental workload is increased, drivers are less able to maintain high situation awareness. Our finding that performance decreased when the number of cars increased for both groups was consistent with this. Participants, on average, used their phone at least sometimes when driving. Twenty-five percent of our participants reported using a mobile phone every time they drove. In more demanding driving situations (e.g. heavy traffic) it is possible that people talking on mobile phones are increasing an already high task load. This can result in decreased situation awareness and thus decreased driving performance. Incidentally, nearly half of our participants felt that their driving performance was not degraded slightly or not at all, whereas all reported that others' driving performance is degraded.

Interestingly, people in the non-language group had more total valid points and more fixations than people in the language group. Out of a possible 1500 eye data points (for each trial), the non-language group had an average of 1431 points and the language group had an average of 1284 points. We do not have a firm explanation for this difference. Anecdotally, however, the experimenters noted that many of the participants in the language group tended to look up (and off to the left or right) when generating language responses during the scenarios (resulting in non-valid eye data points). When looking at the percentage of fixations out of total points, however the two groups are equal.

The total number of fixations in the mirrors was not different between the language and non-language groups. This is in contrast to a 'tunnel vision' hypothesis, which would suggest that people on a mobile phone would not use their mirrors as frequently as when not talking on a mobile phone. Due to the nature of our experiment, our results do not discount the 'tunnel vision' hypothesis. That is, participants were specifically looking for adverse events while watching the driving scenario, as opposed to having a 'surprise' memory test at the completion of the experiment.

Participants in the non-language group had more fixations and spent more time in the regions of interest (both during the event and the entire trial) than people in the language group. This is not surprising when taking the number of correct responses for each group into consideration. That is, people in the non-language group appear to fixate on the vehicle involved in the critical event more than those in the language group – keeping 'tabs' on it, so to speak. This is probably due to one of two reasons: an increased mental workload caused the language group to not be able to follow vehicle location after the event occurred, or those in the language group did not see the event occur.

We then examined the possibility of "look but fail to see" errors. This was done by averaging each group's ROI fixations during the event for correct and incorrect responses. It was thought that if a "look but fail to see" error occurred then the percentage of time in the ROI during the event would be equal for correct and incorrect responses in each group. Preliminary analysis revealed that for the language group, this is the case. There appears to be no significant difference in ROI fixation percentage for correct (M = 13.5%) and incorrect (M = 12.4%) responses. As expected, the percentages for the non-language group indicate that there was a minimal number of "look but fail to see errors". The percentage of fixations in the ROI for correct responses (M = 21.1%) appears to be significantly different from incorrect responses (M=13.7%). Interestingly, the mean percentages for incorrect responses for the non-language group are still higher than the percentage of fixations for the audio group.

5. Conclusions

The current research supports previous findings that talking on a mobile phone decreases driving performance. These findings also support the "look but fail to see" phenomenon. We feel that the language learning task is similar to using a hands-free mobile phone. Future research should examine the similarities of a language learning task to an actual cell phone conversation.

We realize the limitations of using a low fidelity driving simulator. This experiment could be improved by using a high fidelity driving simulation. However, it is important to note the dramatic effects of using a language task even when using a low fidelity driving simulator (i.e. not steering, no distractions other than cars on the road, no road signs, etc.). Using a high fidelity driving simulator would be more suited to test the tunnel vision hypothesis as well.

Future research should consider changing car colors and styles to be more realistic. Additional tasks could include having some control of the vehicle (e.g. braking, increasing/decreasing speed). The driving simulation itself could be improved to include distracters such as pedestrians, road signs, trees, etc.

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Appendix A

You will have two tasks, the first task will be to participate in a language learning task. I will play a sample of what you will be doing.

(Play sample)

Please make sure that you repeat the words or phrases in the space provided.

Your second task is to watch several different driving scenes.

Your task is to watch several different driving scenes. The scene is presented from the perspective of the driver of another vehicle on the road. Although you will not be able to move the vehicle in the scene, please look around the scene as if you are actually driving the car. Just like in a normal vehicle, you will have a rear view and side mirrors. *Throughout the scene you will also be performing a language learning task. When the scene stops, the language learning audio will also stop.* After each scene you will be asked two questions. The first question will ask you about the scene you just saw. There are several different types of events that can occur in each scene. I will now show you some examples of these events.

After some scenes you will be asked about an event that did not occur. In this case the appropriate response will be 'no car'. To help you in your response you will be given an image like this - you are the orange car, the top of the screen represents what was in front of you in the scene and the bottom represents what was behind you in the scene. After you answer the question about what just occurred in the scene, you will be asked how confident you are in the response you just gave. Occasionally there may be a delay after your response, but this is o.k. just respond once and the next scene will come up shortly.

Do you have any questions so far?

The next thing you will see will be a complete driving scene with both questions following it.

Do you have any questions?

Throughout the experiment we are going to be recording where your eyes are looking on the screen. We will do this by using an eye tracker. It works by reflecting an infrared beam off of your eye. You won't be able to see or feel it. The eye tracker works best when your eyes are closer to the computer monitor, so I will have you move up a little bit. It is also important that you try to minimize your eye movements while you are sitting here. So, if it helps you, you can stabilize yourself by putting your arms on the table. Before we get started, we do need to calibrate the eye tracker. There are going to be several yellow dots that come up on the screen, all you need to do is look in the center of each dot. Ready?

(Calibration Check)

Any final questions? You can press the button when you are ready to begin**.**

Appendix B

1. How many years of driving experience do you have?
2. Do you own a mobile (cell) phone?
3. How frequently do you talk on your phone while driving?
4. Do you feel that your driving performance is degraded when talking on a mobile phone while driving?
5. Do you feel that others' driving performance is degraded when talking on a mobile phone while driving?
6. Do you think that there should be legislation limiting mobile phone use while driving?
7. (for those in the mobile condition) Do you think you would have performed this task better had you not been using the language learning c.d.?
8. (for those in the non-mobile condition) Do you think that you would have performed this task more poorly had you been talking on a mobile phone?

Appendix C

1. How do you say 'English' as in a sentence?
2. How do you say 'do you understand'?
3. What does 'ē – Á' mean?
4. How do you say 'Japanese' as in the language?
5. How do you say 'I understand Japanese'?
6. How do you say 'a little'?