

TEXTING WHILE DRIVING: EVALUATION OF GLANCE DISTRIBUTIONS FOR FREQUENT/INFREQUENT TEXTERS AND KEYPAD/TOUCHPAD TEXTERS

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Summary: The threat that cell-phones pose to driving has been a well researched topic. There are fewer studies of the threat that texting creates for drivers, but the risks are obvious and the few existing studies confirm this. What is not obvious is whether frequent texters will expose themselves to the same risks as infrequent texters. This is important to know because many texters, especially teens who text frequently, may consider themselves immune to the dangers of texting while driving. As such, a comparison of frequent and infrequent texters was undertaken on a driving simulator. It is also not immediately clear what effects the different types of interfaces have on driving performance while text messaging. The interfaces under evaluation included keypad or “qwerty” phones (e.g., Blackberries) and touchpad phones (iPhone). It was found that the frequent and infrequent texters were equally likely to glance at least once for more than 2s inside the vehicle while sending a text message. It was also found that touchpad texters had a larger number of glances above the 2s threshold than keypad users, though this difference was not significant. The implications of this for future public policy are discussed.

INTRODUCTION

Driver distraction has increasingly become a critically important safety issue, receiving emphasis at the highest levels of government (Conway, 2009, referring to Ray LaHood, US Secretary Of Transportation) and throughout the research community (Lee, 2007). With the advancements in technology, the potential number of distractions to which drivers are exposed is numerous. High-technology, in-cab control and display systems (along with new nomadic devices) introduce secondary tasks which may compete with the primary task of driving. This competition potentially leads to increases in driver workload. Unfortunately, the manufacturers of these devices have often failed to evaluate the possible impact these devices could have on the average human driver. Without an assessment of how distracted the various devices can make the driver, the safety of the devices remains unknown (Hanowski, Kantowitz & Tijerina, 1996). This assessment has been largely left to the research community.

Mobile phones are increasingly multi-function devices allowing a broad range of communication activities. Indeed, whether verbal communication is still clearly their primary function, especially amongst young users, is not certain [over 7 billion text messages are sent each day throughout the world (The GSM Association, 2007)]. Despite text messaging being so popular, the study of its effects on drivers' performance has only recently become of interest. This relative absence of research is of concern as a significant number of drivers admit to text messaging whilst driving (The RAC Foundation, 2008; McEvoy, Stevenson & Woodward, 2006; Reed & Robbins, 2008).

Moreover, although text messaging bans are being implemented in more and more states, the effect of these bans is questionable. An Insurance Institute for Highway Safety study even showed an actual increase in crashes in states with bans (as cited by Charette, 2010, in IEEE Spectrum, 2010). The question is why this might be the case. There are many different answers. We will explore two possible answers.

But first, let's consider the evidence that texting while driving is a frequent activity. In 2010, the Pew Research Center conducted a project that concluded that adults (27%) were just as likely as teens (26%) to have text messaged while driving. Forty-nine percent of adults and 48% of teens said that they have been passengers in a car when the driver was sending or reading text messages on their cell phone. The Pew research Center also determined that over 47% of all text messaging adults admitted having sent or read a text message while driving. This compares to one in three text messaging teens who said they had "texted while driving", in a September 2009 survey (Madden & Rainie, 2010).

Next, consider the research on texting and driving. Although the research on cell phone use and driving is extensive, there has been much less research on texting and driving. Four studies stand out. First, Monash University Accident Research Center (MUARC) conducted a study on a driving simulator to evaluate the effects of text messaging on the driving performance of young novice drivers (Hosking, Young & Regan, 2006). MUARC hypothesized that there would be a decrease in mean speed and increased variability in speed. They also predicted increased lane excursions and poor lane positioning. They found that the proportion of time drivers spent glancing away from the forward roadway in the text messaging condition (40%) was consistently higher than for their control condition (10%). The authors found no significant differences between the text messaging and non-text messaging conditions on mean speed and mean standard deviations of speed. Lane positioning and lane excursion analyses revealed no significant differences either.

Second, Drews et al. (2009) also conducted a study on a driving simulator. They found that (a) drivers were more likely to crash while text messaging, (b) were more likely to respond to the onset of lead vehicle brake lights, and (c) were less able to control their vehicle in both the forward and lateral position. Drews et al. concluded that the type of attentional demand has an impact on the severity of distracted driving. They hypothesized that texting while driving requires task switching coupled with extended durations of time spent looking away from the forward roadway and poses a higher crash risk than other tasks like talking on a cell phone that requires task switching too.

Third, Reed and Robbins (2008) conducted a simulator study in which the hypothesis that they tested was that the performance of drivers would be worse while entering a text message than while reading a text message. The results of this study demonstrated impairment by concurrent text messaging tasks. The study found that drivers tended to reduce their speed in text messaging conditions. The authors also suggest the possibility that the drivers were aware of the impairment whilst engaged in text messaging tasks and hence chose to reduce their speeds in order to mitigate accident risk.

Finally, a recent naturalistic study conducted by the Virginia Tech Transportation Institute (Sherri, 2009) determined that truck drivers were 23 times more likely to be in a crash while texting than were these same drivers while not texting. This research also showed that among the various in-vehicle tasks in which the drivers were engaged, the drivers' eyes were off the road for longer periods of time while texting than they were for any other in-vehicle task.

We want to explore in this study two explanations for why it is that bans on texting may not have the effect that they were intended to have. For lack of a better term, we will refer to the first explanation as the Lake Wobegon effect. In brief, many individuals text frequently – so frequently that they may think that they are of “above average” ability and therefore the texting laws are irrelevant to them so they do not need to obey them. As more and more drivers acquire texting capabilities, especially with predictive texting (Drews et al., 2009), the sheer number of experienced texters will increase. Thus, we want to determine whether individuals who text frequently are indeed less likely to crash than individuals who text less frequently. If not, then an increase in the number of individuals who consider themselves skilled at texting and persist in doing such while driving could explain the increase in crashes. Second, we want to determine whether the method of entry, keypad (“qwerty”) or touchpad, has an effect on the likelihood of crashing. There is a sense among teens that touchpad phones like iPhones are less risky than the conventional keypad phones like the Blackberry. The Blackberry uses a more conventional keypad that mimics the PC keyboards to a certain extent. These keyboard entry systems are called the “QWERTY” systems. QWERTY is derived sequentially from the first six keys (from left to right) on the far left portion of a standard keyboard just below the number keys. The QWERTY layout was designed to prevent people from typing too quickly and jamming various keys on early typewriters as they moved to strike the paper. If iPhones are more dangerous than keypad phones, then as they become relatively more common, they too may lead to an increase in crashes.

We will use several surrogate measures of crashes, comparing frequent and infrequent texters on these surrogate measures. To begin, we will measure the percentage of glances greater than 2s inside the vehicle while drivers are texting. Several authors have shown that especially long glances inside the vehicle are associated with an increased risk of crashing. For example, Horrey and Wickens (2007) showed that 80% of the crashes in a driving simulator were associated with the 20% of glances inside the vehicle longer than 1.8s. And a naturalistic study completed at the Virginia Tech Transportation Institute (2006) showed that glances inside the vehicle for longer than 2s during the 5s preceding a crash or near crash and the 1s after the crash were associated with an increase of 2 – 3 times in the crash rate. We will also measure the percentage of texting tasks with at least one glance greater than 2s inside the vehicle.

METHOD

Participants were asked to send text messages while navigating the vehicle through a virtual world. The timing of sending messages was experimenter-paced to exercise control over experiment. The participants' eyes were tracked throughout the drives.

Participants

The participants were aged 18 and 19. All participants were regular users of iPhones or Blackberries. A participant is said to be a regular user of a cell phone interface if he/she uses that particular cell phone for dialing, text messaging and internet access on a day to day basis. This was done in order to ensure that the participant was familiar with the interface. The participants were recruited from the University of Massachusetts Amherst and the town of Amherst itself. Sixty percent of the participants were female. Subjects received \$25 for their participation.

The study had 18 participants. Ten of the participants usually used a Blackberry while texting and eight usually used an iPhone while texting. Frequent texters were defined as drivers who text at least 20-25 times per day. Infrequent texters were defined as drivers who text 1-5 times per day. Five of the frequent texters used a Blackberry, and four used an iPhone. Similarly, five of the infrequent texters used a Blackberry; the other four used an iPhone.

Driving Simulator

The fixed-base driving simulator included a full size Saturn sedan in which all vehicle controls were fully operative. The visual world was displayed on three screens – allowing 150° of vision in the horizontal direction and 30° in the vertical direction. Images were displayed with a refresh rate of 60 Hz and a resolution of 1400 by 1050.

Eye Tracker

A portable eye tracker system (ASL Mobile Eye) was used to monitor eye movements of the driver. The eye tracker sampled the position of the eye at 30 Hz. The visual range was 50° in the horizontal direction and 40° in the vertical direction. The system's accuracy was 0.5° of visual angle.

Scenarios and Texting

The virtual environment through which the participants drove was a single environment inclusive of urban and rural sections. The environment was populated with parked vehicles in the city section and there was randomly occurring traffic in all sections. The participants were asked to send three text messages at the start of various scenarios embedded within the drive. Each participant was asked to send the same text and numeric strings. The strings that the participants were asked to send as messages while driving include: "The quick brown fox jumps over a lazy dog", "6173204589", "Few black taxis drive up major roads on quiet hazy nights". Please note that the text strings were pangrams.

Experimental Procedure

The participants were first asked to sign an Informed Consent form. They were next asked to message a couple of strings to measure their texting speeds. Every participant received the same two strings ("6875490123", and "Pack my box with five dozen liquor jugs") in the same order. The time it took them to complete these messages was recorded. The participants were then

provided with a practice drive that had a few hazard anticipation scenarios. This drive was intended to familiarize the participants with the new world of simulated driving. The participants were then fitted with an eye tracker that was used to collect eye movement data. Following this, the participants were asked to drive a multiple-scenario (the experimental drive had six scenarios), single drive once while performing text messaging secondary tasks. Participants performed text messaging tasks on 3 out of 6 scenarios counterbalanced across participants.

Hypotheses

We hypothesize that the frequent texters are as likely as infrequent texters to glance inside the vehicle for longer than any given threshold. The touchpad users were expected to be more likely to take glances inside the vehicle longer than almost all the threshold values.

Dependent Variables

As noted above, prior research confirms that glances away from the forward roadway that exceed 2s are a causal feature of most crashes. To reflect this causal feature, we used *glance duration* as a dependent variable. Glance duration refers to the length of time that a continuous sequence of eye fixations is confined to a specific area, in our case the area inside the vehicle. Glance durations were measured by calculating the interval of time between the moment the participant glances inside the vehicle until the moment that the participant glances back at the forward roadway.

RESULTS AND DISCUSSION

Below we discuss the major differences between the frequent and infrequent texters and the major differences between the users of a Blackberry and an iPhone. Threshold values between .5s and 8s were chosen.

Texting Speeds

The average texting speeds were 12.22s for infrequent texters and 9.60s for frequent texters. These differences were significant, $t(16) = 2.124$, $p < .05$. This indicates that the self-reported measure of texting frequency is reflected in performance.

Percentage of Glances Greater than Threshold

The probability of a glance greater than each threshold between .5s and 8.0s was smaller for the frequent texters than it was for the infrequent texters (Figure 1). Although the hypothesis that the frequent texters are as likely to glance inside the vehicle for longer than any given threshold [especially 2s (Horrey & Wickens, 2007)] could not be rejected, the trend is clear: frequent texters are slightly less likely than infrequent texters to take a glance longer than each of the various thresholds inside the vehicle. Perhaps a larger sample would have shown these differences to be significant.

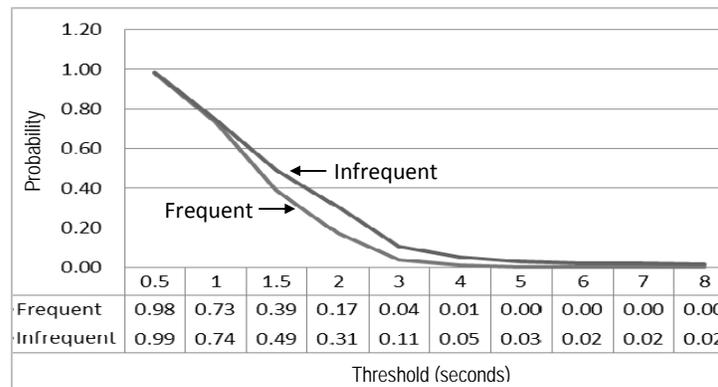


Figure 1. Probability of glances greater than thresholds for frequent/infrequent texters

Percentage of Scenarios Greater than Threshold

We also looked at the probability that an individual glanced at least once inside the vehicle while completing a texting task for each of the thresholds. None of the differences were significant at any of the thresholds. At the critical 2s threshold, the glance probabilities of the frequent and infrequent texters were nearly indistinguishable, 0.78 and 0.81, respectively (Figure 2).

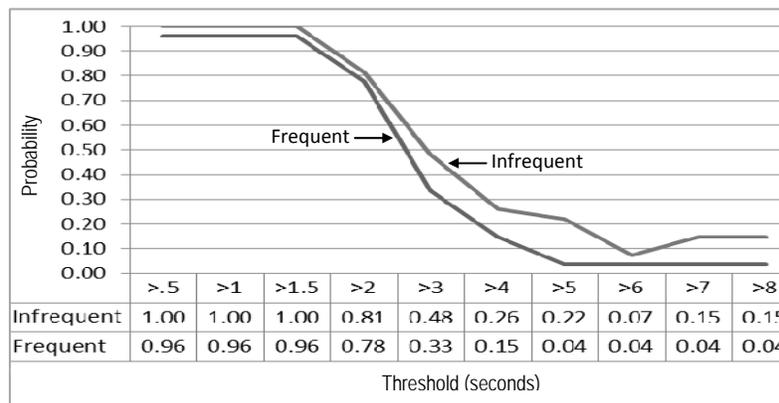


Figure 2. Probability of scenarios greater than thresholds for frequent/infrequent texters

Comparison between Blackberry and iPhone Cellular Interfaces

Finally, a comparison was made between the Blackberry and iPhone users of the probability of making a glance inside the vehicle greater than various threshold values. Although the touchpad users were more likely to take glances inside the vehicle longer than almost all the threshold values, in the most critical region (2s), one could not reject the hypothesis that the iPhone users differed from the Blackberry users, $t = -1.91, p = .07$. Nor could one reject this hypothesis at any of the other threshold values.

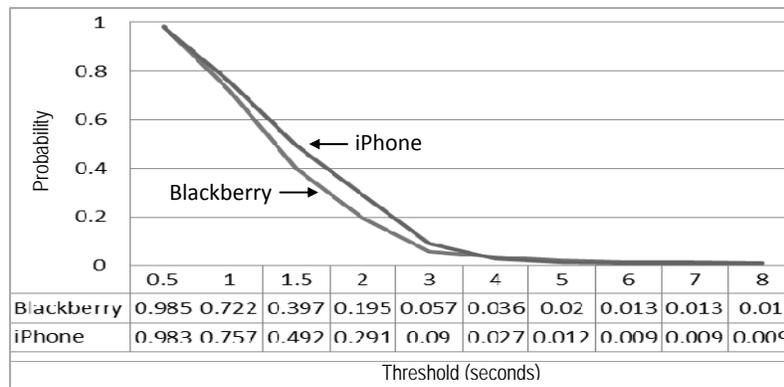


Figure 3. Probability of glances greater than thresholds for Blackberry and iPhone users

CONCLUSIONS

Texting is known to be dangerous, leading many states to introduce bans on texting. Paradoxically, in three of the four states in an early study, crashes related to texting have actually increased (as cited by Charette, 2010, in *IEEE Spectrum*, 2010). One can ask why this is the case. One reason may be that as drivers become more experienced with texting they believe that they can ignore the laws. In order for it to be the case that the total number of texting related crashes increase as bans are put in place, it would need additionally to be true that frequent texters are no safer than infrequent texters. We have shown that this is indeed the case. In fact, if frequent texters send messages while they are driving as frequently as they do in general, they are almost five times more likely to be involved in a crash because of their increased exposure.

A second reason that texting crashes may be increasing, despite the ban, is that the distribution of keypad and touchpad devices is leaning ever more towards touchpad devices. In order for this to be the case, it would have to be true that drivers were less safe using touchpad devices. Although for almost all thresholds, it was true that touchpad users were more likely to look inside the vehicle for a length of time longer than the threshold value, in no case was the difference between touchpad and keypad users statistically significant. Clearly more research is needed.

If texting bans are not working as intended, one can ask whether there is anything that might work. Recent research suggests that training individuals to keep their glances to less than two seconds inside the vehicle can produce safer drivers both on the driving simulator (Divekar et al., 2010) and in the field (Pradhan et al., 2010). Perhaps such training alternatives should be pursued in addition to text messaging bans.

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