Does phone interface type influence the distracting effects of text messaging in tunnels?

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Abstract

There is clear evidence that text messaging while driving is distracting and can significantly increase the risk of being involved in a collision. However, very little is known about how the type of phone interface might moderate the distracting effects of text messaging. In addition, compared to highway driving, driving in tunnels introduces additional issues such as monotony, fatigue, and more severe consequences of crashing, all of which may serve to exacerbate the effects of distracting activities on driving performance and safety. This study assessed the effect of using a touch screen keyboard versus numeric keypad phone to send and receive text messages on simulated driving performance and eye glance behaviour in a tunnel environment. Twenty-four drivers aged 25 to 55 years (M=33.4, SD=9.9) drove a 14km route in the MUARC advanced driving simulator. During the drives, participants read and sent text messages using their own mobile phones. Half of the participants used a phone with a numeric keypad, while the other half used phones with a touch screen keyboard interface. Results revealed that, regardless of phone interface type, reading and sending text messages while driving in a tunnel significantly impairs driving performance, eye glance behaviour, and subjective workload measures. There was also evidence that phone interface might moderate the impact of text messaging on some aspects of driver behaviour; although, contrary to expectation, numerical keypad phones appeared to have a more deleterious effect on driver behaviour than touch screen keyboard phones. It was concluded that the relatively larger, higher resolution screens and more familiar keyboard layout of touch screen phones may offset their lack of tactile feedback.

Introduction

A growing body of research has found that text messaging while driving is distracting and can significantly increase the risk of being involved in a collision (Olson, Hanowski Hickman & Bocanegra, 2009). Despite these dangers, the prevalence of texting while driving is high. In the Australian state of Victoria, sending and receiving text messages while driving is common, particularly among the young driver population (Young & Lenné, 2010, Young Rudin-Brown & Lenné, 2010). In an online survey, Young and Lenné (2010) found that 88% of young drivers (18 to 25 years) who use a handheld phone while driving reported reading text messages, while 77% admitted to sending text messages. Texting while driving is also common in other countries. Lansdown (2012) found that 41% of drivers in the UK report sending text messages while driving and 62% read text messages. The prevalence of text messaging was even higher in a sample of 91 US college students, with 91% reporting that they have text messaged while driving (Harrison, 2011).

Research suggests that text messaging may be more distracting than conversing on a phone because of the high visual-manual demands it places on drivers (Reed & Robbins, 2008, Drews Yazdani Godfrey Cooper & Strayer, 2009, Hosking Young & Regan, 2009, Owens McLaughlin & Sudweeks, 2011, Alosco Spitznagel Fischer Miller Pillai Hughes & Gunstad, 2012). Previous research has found that reading and particularly sending text messages negatively affects drivers' lateral and longitudinal (following distance) control, slows reaction time, and leads to more frequent and longer glances away from the roadway (Drews et al., 2009, Hosking et al., 2009, Owens et al., 2011).

To date, studies examining text messaging while driving have been conducted in simulated open-air environments, such as urban roads, freeways, or test tracks. No studies have examined the impact of texting in a tunnel environment, where the consequences of crashes can be far more severe than in open-air surroundings, primarily due to the risk of fire and asphyxiation (Carvel & Marlair, 2011). Research has shown that driving performance in tunnels differs from freeway driving in a range of ways. Due to the enclosed environment and the resulting change in the optic flow of information used to guide vehicle position and speed, tunnel driving increases the effort required to maintain lateral control of the vehicle, increases visual fixation to the road center and increases driver workload (Shimojo Takagi & Onuma, 1995, Chatziastros Wallis & Bülthoff, 1999, Manser & Hancock, 2007, Kircher & Ahlstrom, 2012). It is possible that the high visual demand of text messaging combined with the altered visual conditions of the tunnel environment may work to exacerbate the effects of texting on driving performance.

Another factor that might moderate the effects of text messaging on driver behaviour is the type of phone interface used. The popularity of touch screen phones has increased massively in the past few years with the advent of the 'smartphone'. Touch screens offer a range of advantages such as direct and intuitive (pointing) input, but their use in vehicles has raised alarm because they can place significant visual demand on the driver due to the absence of tactile feedback (Pitts Burnett Williams & Wellings, 2010). A lack of tactile cues can lead to greater visual demand and a higher number of glances to the interface to guide the user's fingers and to confirm selections (e.g., Allen McFarlin & Green, 2008, Harrison & Hudson, 2009). Under static (no driving) conditions, Allen et al. (2008) examined text entry performance on touch screen versus keypad phones. When entering text, users made a greater number of errors on the touch screen compared to the keypad phone, which the researchers concluded was due to the lack of tactile cues on the touch screen keypad. Under simulated driving conditions, Reimer et al. (2012) found that dialling phone numbers on a touch screen phone resulted in longer completion times and less time looking at the forward roadway compared to a flip-phone with tactile buttons. Given the increased visual demands of touch screen interfaces, it is possible that the use of touch technology may exacerbate the already high levels of distraction associated with text messaging while driving.

The current study examined the impact of using a touch screen keyboard versus numeric keypad phone to send and receive text messages on simulated driving performance and eye glance behaviour in tunnels. It was hypothesised that, compared to driving alone, text messaging would be associated with more variable lateral control, slower and more variable vehicle speeds, greater eyes-off-road time, and increased subjective workload. It was also expected that, compared to reading a text message, reading and writing a text message would result in greater degradations in driving performance and higher subjective workload. Finally, it was predicted that, compared to numeric keypad phones, reading and writing text messages on a touch screen keyboard phone would exacerbate the expected impairments in driving, visual performance and workload due to their lack of tactile cues.

Method

Experimental Design

The study used a two-way (2 x 3) mixed design with phone type (touch screen keyboard vs. numeric keypad) as a between-subjects factor and task (Baseline, Texting—read only, and Texting—read and write) as a repeated-measures factor. Both primary (driving) and secondary (texting) task variables were examined. To assess drivers' performance on the text-messaging tasks, the speed of text-messaging and any errors made served as dependent variables. To assess driver performance, vehicle speed and speed variability, standard deviation of lane position (SDLP), the percent of drivers' total gaze time to the road centre (during text-messaging conditions), frequency and duration of glances to the phone, and ratings of subjective workload were examined. Secondary task presentation was counterbalanced across participants.

Participants

Twenty-four licensed drivers (12 male; 12 female) aged 25 to 55 years ($M = 33.4$, $SD = 9.9$) participated in the study. All participants held a valid driver's license for at least three years ($M = 14.8$, $SD = 10.4$), and had normal or corrected-to-normal visual acuity. All participants were regular users of text messaging, spending an average of 1.6 hours ($SD = 1.7$) text messaging per week. A large proportion (87.5%) of participants reported reading text messages while driving, while 45.8% reported sending text messages while driving. Participant age, driving experience, kms travelled each week and mobile phone use in and outside the vehicle did not vary significantly across the two phone type users (all $p > .05$). Participants were recruited through advertisements at Monash University. Ethics approval for the study was granted by the Monash University Human Research Ethics Committee. Participants were offered $30 (AUD) for their time and expenses.

Materials

Driving simulator task

Driving performance was evaluated using the MUARC advanced driving simulator, a high fidelity, motion-based simulator consisting of a 2009 GM Holden VE Commodore sedan mounted on a three degrees-of-freedom motion base platform, and a curved projection screen providing a 180° horizontal, and 40° vertical field-of-view. Forward vision was produced by three image generators using seamless blended projection onto a cylindrical screen, while rear vision was provided by a separate projection screen at the rear of the vehicle. Simulated, speed-adjusted engine and road / tyre noise was present in all scenarios. An experimenter controlled all driving simulations remotely from a control room.

Each of the three test drives comprised a 7 km tunnel segment (see Figure 1). A 7 km freeway segment was also included in the scenario, but the data for this segment are not reported here. Differences in the effects of text messaging across the freeway and tunnel environments are the subject of a paper by Rudin-Brown et al. (2013).

The tunnel was designed according to a section of the blueprints of the Stockholm Bypass tunnel and adapted for right-hand drive traffic. It contained three lanes of travel in the same direction and the speed limit was 80km/h throughout. The roadway had an average 3% downhill slope for most of the drive. Ambient traffic (approximately 3-4 vehicles per km) travelling in the same direction was present during each test drive, but not within the participant's lane. Pilot testing confirmed that there were no features of the environment that would be interpreted as novel or unusual for Australian drivers.

Each drive also included two overhead traffic signs: the first sign indicated the approach of an exit in 500 m, and the second was located directly preceding the exit. These signs were included in the scenarios as the 'read only' text-messaging task instructed participants to take a specific exit. Each drive took approximately 10 minutes to complete.

During each drive, drivers' visual scanning behaviour was captured using the faceLAB™ 4.0 eye tracking system (Seeing Machines, 2007). This system uses an unobtrusive stereo camera system and infrared illumination to track pupil and head movement in three dimensions at a rate of 60Hz, with a static accuracy of gaze direction measurement within +/- 5° rotational error (Classic configuration). Camera images and recordings were linked to a user-operated computer interface, allowing for post-drive analysis of glance location and duration. Eye movement data was reduced using the faceLAB software.

Figure 1 Simulated tunnel environment

Mobile phone task

Participants used their own personal mobile phone for the text-messaging task to ensure that they were familiar with the functionality of the phone and the text messaging features. Half of the participants used a mobile phone with a numerical keypad and half used a phone with a touch screen interface with a virtual QWERTY keyboard. The tactile numeric keypad interface was selected to compare against touch screen keyboard interfaces as, at the time of the study, numeric keypad phones made up 73% of all mobile phones sold worldwide (TomiAhonen Consulting, 2010) and, thus, represented the tactile phone interface used by the majority of drivers.

In the ‘read only’ condition, participants received two text messages in the tunnel segment, which they were required to read aloud. The first message read: “Heavy traffic - Long delays expected. Take Sydney Harbour exit in 5 kilometres”. The second message received was the same, but specified that the exit was in 1 kilometre. Failure to take the exit was noted. In the ‘read and write’ text condition, participants received one text message while in the tunnel. They either read “What day comes after Tuesday?” or “What is the capital of Victoria?”. Participants were required to answer by means of composing a text message after having first read the message out loud. Participants could use the predictive text function of the telephone if they reported being regular users of this feature. In total, six (of 12) numeric keypad users and eight (of 12) touch screen keyboard users chose to use the predictive text function during the experiment. Errors in spelling and responses were recorded.

Procedure

Participants attended a single study session at the MUARC Advanced Driving Simulator. Participants first signed a consent form and completed a demographic and driving history questionnaire. Participants were informed that the purpose of the study was “to study the effects of performing distracting tasks on driving behaviour”. Participants then completed a 10 minute familiarisation drive. Participants were instructed to practice accelerating and braking gently and to practice driving at a consistent speed of 80 km/h. After the familiarisation drive, the simulator was configured for the first of three test drives: a baseline (no texting) drive, a drive where they read text messages, and a driver where they read and sent text messages. Participants were instructed to drive in the left-hand (outside) lane, and to maintain a consistent speed of 80 km/h throughout the drive, with the experimenter providing verbal reminders if participants were observed to deviate more than 5-10 km/h from that speed. Participants were also directed to drive in the left-hand lane at all times and to not change lanes or interact with the traffic in adjoining lanes.

At the end of each drive, participants completed a modified version of the NASA Raw Task Load Index (NASA-RTLX) (Hart & Staveland, 1988), which assessed, using a rating scale from 0 to 20, subjective ratings of workload for the task of driving alone (baseline condition) or when performing the text messaging tasks. Each experimental session took approximately 1.5 hours, with all testing conducted on weekdays during business hours.

Statistical Analyses

Only data from the tunnel segment of the drive have been analysed and reported here. Prior to any analysis, data were checked for violations of statistical assumptions, missing data points and outliers, which were excluded from the analysis. In all cases, a two-tailed α-level of .05 was used to determine statistical significance.

Where data were normally distributed, a series of two-way (2 x 3) analysis of variance (ANOVAs) with phone type (numeric keypad vs. touch screen keyboard) and phone task (baseline, ‘read only’, and ‘read / write’) as factors were carried out. Effect sizes are reported as Eta squared (η^2). Where data were not normally distributed, Generalised Estimating Equations (GEE) and non-parametric testing were conducted. GEE models were fitted to examine the frequency and duration of glances to the phone. GEE is applicable to factorial repeated-measures designs and provides greater power with smaller sample sizes as well as parameter estimates. Text task completion time across phone type was examined separately for the read only and the read and write tasks (because their durations differed) using a Mann-Whitney U test. All analyses were conducted using SPSS Statistics 20.0.

Results

Driving Performance

To compare the secondary task (text messaging) conditions, driving performance data collected in the baseline condition were compared to data collected during segments where drivers were reading and reading and writing text messages.

Mean speed

A 2-way mixed ANOVA revealed a significant interaction between phone type and phone task for mean speed ($F(2,44) = 3.56$, $p = .037$, $\eta^2 = .08$). Paired comparisons conducted for each phone type did not reach statistical significance, but suggest that the interaction is being driven by the difference in mean speed across phone types being larger when reading and writing texts than when reading alone. Figure 2 indicates that when drivers were *reading and writing* text messages, mean speed was higher than it was when only reading texts or when not text messaging (baseline) for both phone types; however, the increase in mean speed was greater for those drivers using a numeric keypad phone. Mean speed decreased from baseline when only reading text messages on both phone types, but the decrease was more pronounced for numeric keypad phones.

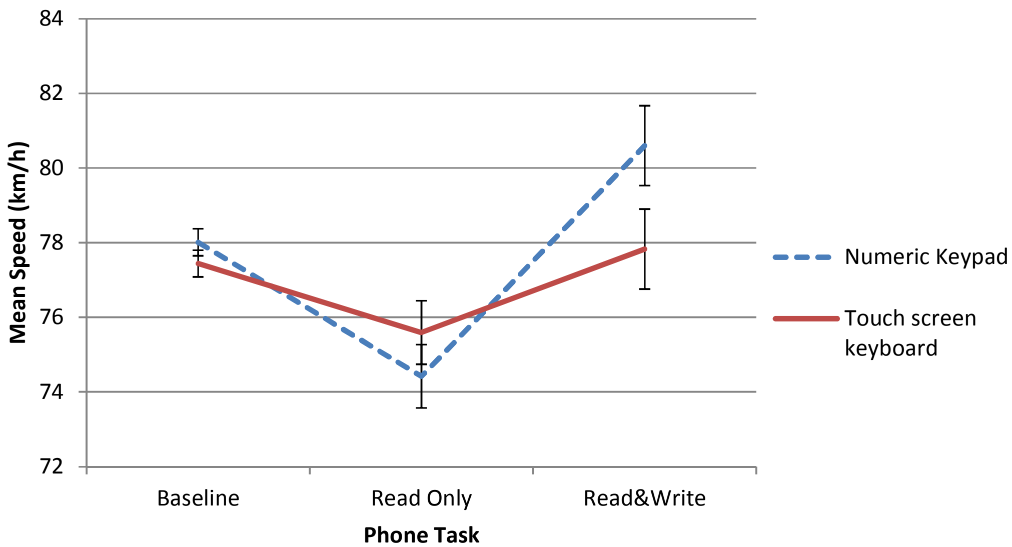

Figure 2 **Effect of phone type and task type on mean speed (error bars represent standard error of the mean)**

Standard deviation of speed

A 2-way mixed ANOVA examined if standard deviation of speed differed significantly across phone type and task condition. Results revealed no significant interaction between phone type and phone task (p = .546), nor a significant main effect of phone type (p = .779). There was, however, a significant main effect of phone task ($F(2,44) = 11.23$, $p < .001$, $\eta^2 = .33$), whereby the standard deviation of speed was higher when drivers were reading texts (p<.001) and when they were reading and writing texts (p=.03) compared to when not text messaging (Figure 3). There was also a trend for the standard deviation of speed to be higher when reading text messages than when reading and writing texts (p=.06).

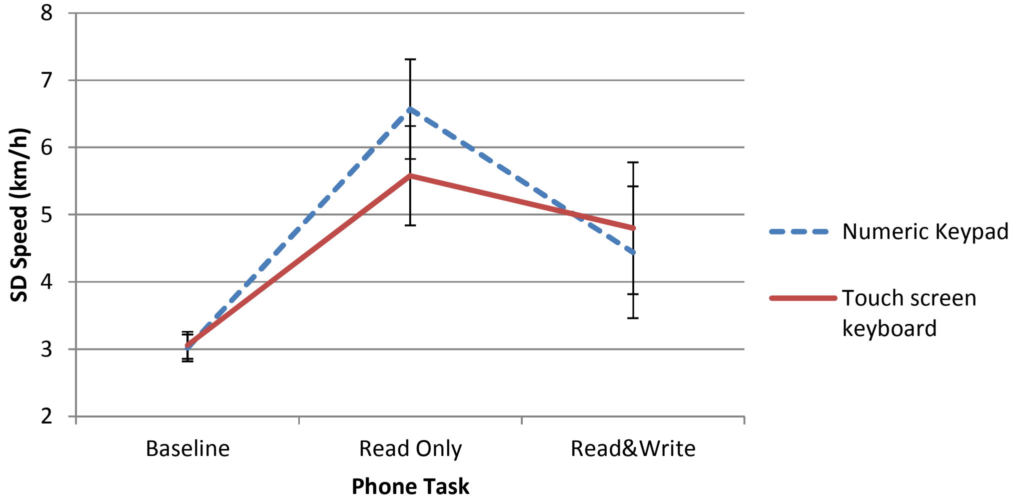

Figure 3 **Effect of phone type and task type on standard deviation of speed (error bars represent standard error of the mean)**

Standard deviation of lateral position

A 2-way mixed ANOVA revealed a significant main effect of phone task on SDLP (F(2,44) = 11.52, p < .001, η^2 = .34), where drivers deviated in their lane significantly more when reading and writing texts compared to when reading only (p=.001) or when not text messaging (p=.002) (Figure 4). There was no significant interaction between phone type and phone task (p = .589), nor a significant main effect of phone type (p = .264).

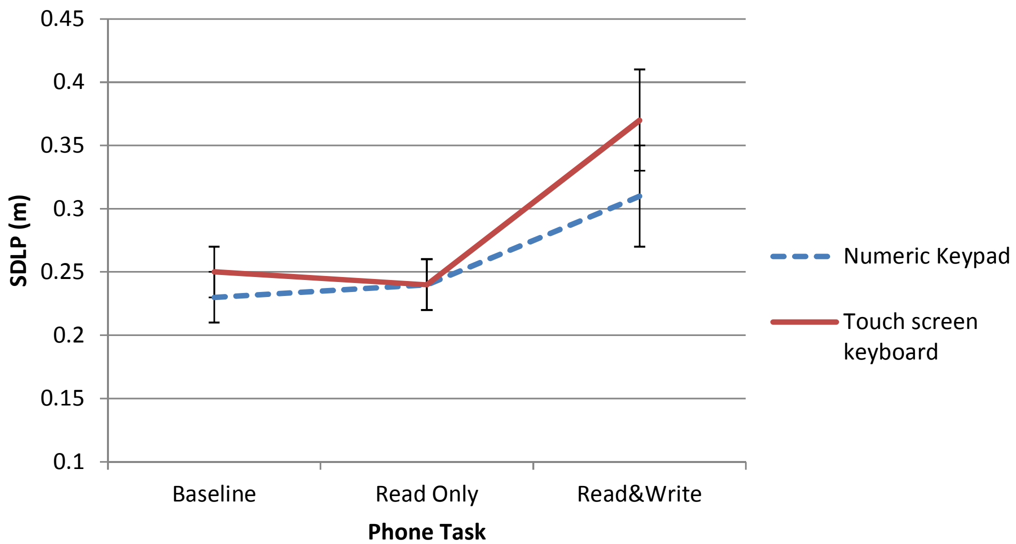

Figure 4 **Effect of phone type and task type on standard deviation of lane position (error bars represent standard error of the mean)**

Eye Glance Behaviour

Three measures of eye glance behaviour were examined: the percentage of total time that a driver's gaze was directed towards the centre of the roadway (when performing the text messaging tasks compared to baseline driving), frequency of glances to the phone during the text messaging tasks, and mean duration of glances to the phone during the messaging tasks.

Percent Road Centre

Percent Road Centre was calculated as the percentage of all gaze fixations within an 8-degree radius of the driver's most frequent gaze location. A 2-way mixed ANOVA revealed a significant main effect for phone task ($F(2,44) = 5.08$, $p = .01$, $\eta^2 = .18$). Compared to baseline, drivers looked at the road centre for a smaller percentage of time when reading text messages (p=.029) and when reading and writing text messages (p=.014) (Figure 5). There was no significant difference between the reading only and reading and writing conditions in the percentage of time looking at the road centre (p=.508). There was also no significant interaction between phone type and phone task (p = .525), nor a significant main effect of phone type (p = .886).

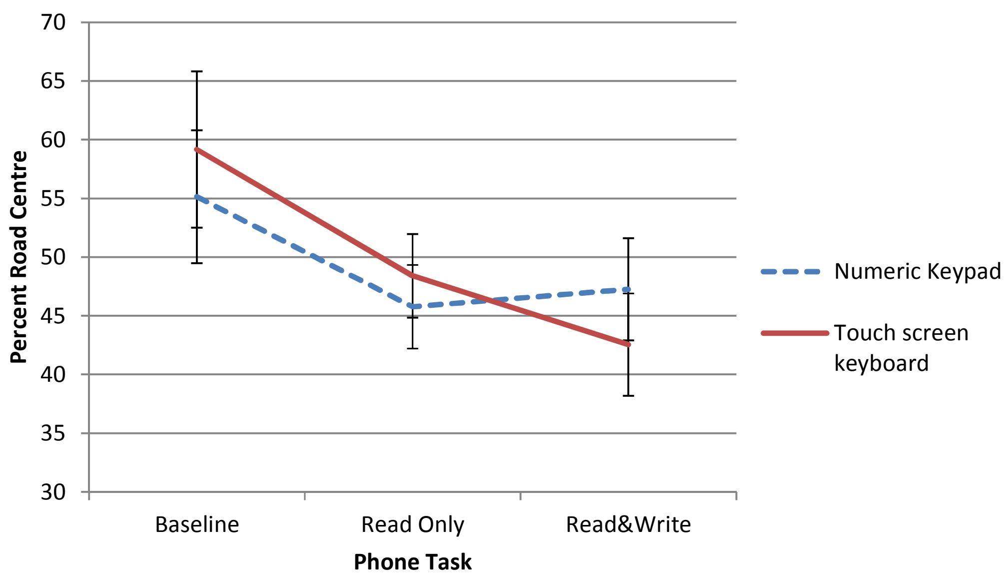

Figure 5 **Percentage of time spent looking at road centre as a function of phone type and text task (error bars represent standard error of the mean)**

Frequency and duration of glances

Two GEE models were fitted to determine if the frequency and duration of glances to the phone during the texting tasks differed according to phone type and task condition (reading only vs. reading and writing). The GEE model to examine the frequency of glances to the phone was specified with a Poisson error distribution and a log link function and the correlation matrix was specified as unstructured. As the time taken to complete the reading and writing tasks differed, the log of task completion time was included in the GEE model as an off-set variable. Glance frequency is defined as the number of glances to the phone during the task where each glance is separated by at least one glance to a different area away from the phone. The GEE model examining the mean duration of glances to the phone was specified with a normal error distribution, an identity link function and the correlation matrix was specified as unstructured.

The frequency and mean duration of glances to the phone during the reading and writing tasks are displayed in Table 1. With respect to the frequency of glances to the phone during the texting tasks, there was a significant interaction between phone task and phone type (p=.041). Drivers using numeric keypad phones took a greater number of glances to the phone during both texting tasks than drivers using a touch screen keyboard phone. However, the difference in glance frequency between numeric keypad and touch screen keyboard phones was greater when reading and writing texts than when reading alone. The duration of glances to the phone did not differ significantly across phone type or text task (p=.283).

Table 1 Mean (SD) frequency and duration of glances to the phone during the read only and read and write text tasks as a function of phone type

	Glance Frequency	**Mean Duration of glances (s)**
Read Text		
Numeric Keypad	15.09 (8.70)	1.36 (0.42)
Touch Screen Keyboard	11.91 (5.80)	1.52 (0.72)
Read & Write Text		
Numeric Keypad	21.91 (18.32)	1.62 (1.23)
Touch Screen Keyboard	11.00 (8.46)	2.61 (2.01)

Secondary Task Completion Time

Two Mann-Whitney U tests were conducted to examine if the time taken to complete the reading only and reading and writing text tasks differed across keypad and touchscreen phones. As the duration of the reading and reading and writing tasks differed, each task was examined separately (Table 2). No significant differences in task completion time were found across the two phone types for both the reading texts (p=.389) and reading and writing text tasks (p=.204).

Table 2 Mean (SD) task completion time for the read only and read and write text tasks as a function of phone type

	Read text	Read & Write text
Numeric Keypad	19.7 (10.8)	46.4 (27.9)
Touch Screen Keyboard	20.8 (7.9)	38.3 (23.6)

Subjective Workload

At the end of each drive, participants completed the NASA-RTLX (Hart & Staveland, 1988), which assessed subjective ratings of workload for the driving task alone (baseline) and combined with the text messaging tasks.

A 2-way mixed ANOVA was conducted to examine whether subjective workload differed across phone type and phone task. There was no significant interaction, nor a main effect of phone type. However there was a significant effect of phone task on overall workload rating, $F(2,44) = 35.84$, $p < .001$, $\eta^2 = .62$, with participants rating their workload as significantly greater when reading texts (p<.001) and when reading and writing (p<.001) compared to baseline. Further, subjective workload was rated as significantly greater when reading and writing texts compared when reading only (p=.001) (Figure 6).

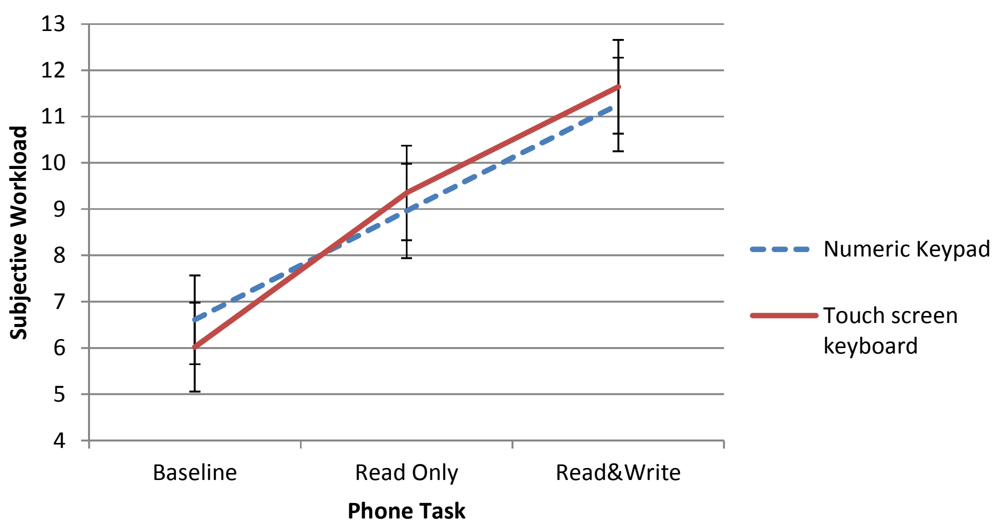

Figure 6 Subjective workload as a function of phone type and text task (error bars represent standard error of the mean)

Discussion

This study examined the potentially moderating effects of phone interface - touch screen keyboard vs. numeric keypad - of sending and receiving text messages on simulated driving performance and eye glance behaviour. The results demonstrate that, regardless of interface type, reading and writing text messages while driving in a tunnel environment impairs a number of aspects of driving. As predicted, when reading and writing text messages, drivers displayed changes in mean speed, increases in speed variability and increases in lateral position variability. They also spent a smaller amount of time looking at the road ahead, and rated their subjective workload as higher.

It was predicted that text messaging would result in degraded driving performance and increased subjective workload, and that *reading and writing* text messages would result in greater driving performance decrements than only reading text messages. These predictions were partially supported. Compared to baseline, *reading* text messages led to a reduction in vehicle speed. In contrast, however, mean speed increased when drivers were *reading and writing* text messages compared to baseline and reading only. This increase may reflect that drivers' speed monitoring capacity was compromised to a greater extent during more challenging phone tasks. The higher relative demands of the reading and writing task (which was associated with significantly higher workload scores than reading alone) may have resulted in drivers monitoring vehicle speed less effectively. Given the downward gradient of the road for the majority of the tunnel, this decrease in speed monitoring would explain the increased speeds observed. The standard deviation of speed data also supports this explanation. Speed variability increased from baseline when *reading* texts as predicted, but decreased when *reading and writing* texts, suggesting that while drivers were able to adjust their speed when reading alone, this was not the case when reading was combined with writing texts. It appears that, given the downhill gradient of the tunnel, reduced attention to speed monitoring while reading and writing texts resulted in increased mean speed and a reduction in speed variability.

Relative to baseline, reading and writing text messages while driving also led to decrements in lateral control. The standard deviation of lane position was significantly higher when reading and writing text messages compared to when only reading texts, and both texting conditions had higher lateral variability than baseline (no texting). The increased lateral deviation observed, particularly during the more demanding reading and writing task, may result from drivers' overcorrecting unintentional lateral drift from the lane centre brought about by the reduced proportion of time spent looking at the forward roadway while texting. These findings support previous research that found that lane keeping ability is degraded by the visual-manual demands of text messaging and, in particular, the increased demands associated with sending text messages (Drews Yazdani et al., 2009, Hosking Young et al., 2009, Owens McLaughlin et al., 2011).

The visual scanning results highlight the high visual demand placed on drivers by text messaging. When reading text messages, the amount of time drivers spent looking at the centre roadway decreased by 18% from baseline. When reading and writing texts, drivers spent 21% less time looking at the road centre. Our results are in line with other research, which has found that drivers look away from the roadway significantly more when text messaging (Hosking Young et al., 2009), particularly when writing messages

(Owens, McLaughlin et al., 2011). There was some evidence that drivers may have been regulating their interaction with the phone to minimise distraction, with the eye glance measures showing that drivers took a large number of short (< 1.5 sec) glances to the phone during the texting tasks. Green (1999) found that drivers are typically unwilling to exceed around 1.5 sec eyes-off-road time. However, it is important to note that there was large variability in visual scanning across participants, particularly for the reading and writing task, suggesting that some drivers are more adept at regulating their secondary task interactions.

In contrast to what was predicted, drivers took a greater number of glances to numeric keypad phones than touch screen keyboard phones while text messaging and this was particularly pronounced when reading and writing texts. No significant differences were found across the text message tasks or phone types in terms of the duration of glances made to the phone once the total duration of each task was accounted for. Hosking et al (2009) also found that the duration of glances to the car interior were similar for reading and sending text messages. It is interesting to note, however, that while not significantly different between the phone types, the mean glance duration for reading and writing text messages on a touch screen keyboard phone was high and above the 2-second single glance duration threshold associated with increased crash risk (Klauer Dingus Neale Sudweeks & Ramsey, 2006). This result appeared to be driven by only a small number of drivers with high single glance durations.

It was initially predicted that, compared to numeric keypad phones, reading and writing text messages on a touch screen keyboard phone would exacerbate the expected impairments in driving and visual performance due to the lack of tactile cues provided by this interface. Contrary to expectations, few differences were observed between the two phone types and, of the differences that were found, the numeric keypad phones appeared to have a more deleterious effect on driver behaviour. Phone type was found to have a moderating effect on mean speed, with drivers using a numeric keypad phone travelling at a higher speed that those using a touch screen keyboard phone while writing text messages. According to the theory posed above that higher mean speed reflects impaired speed monitoring when distracted, the numeric keypad phones appeared to have a more detrimental effect than the touch screen keyboard phones on speed control. Phone type also moderated the frequency of glances made to the phone while text messaging, with drivers taking a greater number of glances to numeric keypad phones compared to touch screen keyboard phones. This finding may be due to the numeric keypad phones having relatively smaller screens than touch screen keyboard phones which may result in drivers having to take more glances to read and confirm the content of the message.

The subjective ratings of driver workload are in-line with the driving and eye glance findings. The fact that few differences in driving and eye glance measures were observed between the two phone types is supported by the subjective workload data, with drivers rating the workload of both phones similarly across the three task conditions. A stepwise increase in subjective workload across the three texting conditions (baseline, read only', and read and write) was found, which confirms the driving and eye glance findings that text messaging places significant demand on drivers and that reading and writing combined is generally more demanding than reading alone. An interesting avenue for further research would be to break down what aspects of driver workload are affected by the different texting tasks. In particular, it would be interesting to establish if the increased workload of writing texts is due the physical demands of typing, the increased visual attention required, or to some more general cognitive interference.

There are several explanations for the lack of differences found across phone types. First, drivers in this study used their own phones and were familiar with using them for text messaging. It is possible that drivers' familiarity and adeptness at using their own phone may have served to attenuate any differences between the two interface types. Second, it may be that the QWERTY keyboard used on the touch screen phones is more familiar and easier to use for writing texts than the numeric keypad and this might offset the lack of tactile cues provided by the touch screen interface. Finally, it is possible that the larger and higher resolution screens on touch screen keyboard phones may also offset the lack of tactile cues they provide.

Conclusions

The increasing popularity of touch-based smartphones motivates the need to examine how the touch interface, with its lack of tactile cues, might moderate the impact of text messaging on driver performance. This study found that reading and, in particular, reading and writing text messages in a simulated tunnel environment decreased the amount of time that drivers spent looking at the centre roadway, degraded their speed monitoring and increased their lane position variability and subjective workload. The enclosed tunnel environment, with its increased consequences of fire and restricted evacuation options, makes the observed decrements associated with text messaging all the more concerning. As such, drivers should be actively encouraged not to engage in text messaging in any environment and particularly when in tunnels.

The study also found that, while the observed performance degradations were largely similar across numeric keypad and touch screen keyboard phones, phone interface may moderate the impact of text messaging on some aspects of driver behaviour. Indeed, contrary to expectation, it was found that users of numerical keypad phones showed greater degradation in speed monitoring and looked at the phone more often than those drivers using touch screen keyboard phones. It may be that their relatively larger, higher resolution screens and more familiar QWERTY keyboard layout may offset the lack of tactile feedback provided by touch screen-based smartphones.

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