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The Effects of Text Messaging on Young Drivers

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Objective: This study investigated the effects of using a cell phone to retrieve and send text messages on the driving performance of young novice drivers. **Background:** Young drivers are particularly susceptible to driver distraction and have an increased risk of distraction-related crashes. Distractions from in-vehicle devices, particularly, those that require manual input, are known to cause decrements in driving performance. **Method:** Twenty young novice drivers used a cell phone to retrieve and send text messages while driving a simulator. **Results:** The amount of time that drivers spent not looking at the road when text messaging was up to ~400% greater than that recorded in baseline (no-text-messaging) conditions. Furthermore, drivers' variability in lane position increased up to ~50%, and missed lane changes increased 140%. There was also an increase of up to ~150% in drivers' variability in following distances to lead vehicles. **Conclusion:** Previous research has shown that the risk of crashing while dialing a handheld device, such as when text messaging and driving, is more than double that of conversing on a cell phone. The present study has identified the detrimental effects of text messaging on driving performance that may underlie such increased crash risk. **Application:** More effective road safety measures are needed to prevent and mitigate the adverse effects on driving performance of using cell phones to retrieve and send text messages.

INTRODUCTION

Driver distraction is a significant road safety issue with up to one quarter of crashes estimated to be a result of drivers' engaging in distracting activities (e.g., Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006; Stutts et al., 2005; Wang, Knipling, & Goodman, 1996). Distraction has negative effects on a range of interrelated performance dimensions, including visual processing of the road environment, motor control and response, and higher-order (cognitive) processing (e.g., Lee & Strayer, 2004; McPhee, Scialfa, Dennis, Ho, & Caird, 2004; Strayer & Drews, 2004; Strayer, Drews, & Crouch, 2006; Strayer, Drews, & Johnston, 2003). Devices that have been either designed or adapted for use while driving, such as e-mail, MP3 players, and navigation systems, have been shown to pose threats to driving safety that are at least as great as those caused by talking on a cell phone

(e.g., Chisholm, Caird, & Lockhart, 2008; Jamson, Westerman, Hockey, & Carsten, 2004; Lee, Caven, Haake, & Brown, 2001; Tsimhoni, Smith, & Green, 2004).

The willingness of young drivers to engage in text messaging should be of particular concern to road safety authorities. Recent surveys have found that up to 58% of young drivers have used text messaging on their cell phone while driving (Telstra, 2004), and the proportion of younger drivers who text message while driving is significantly larger (31%) than that of more experienced drivers (McEvoy, Stevenson, & Woodward, 2006). Such findings are consistent with research showing that young drivers (a) are more likely than experienced drivers to engage in distracting activities while driving (e.g., Gras et al., 2007; Lam, 2002; Poysti, Rajalin, & Summala, 2005), (b) are not well calibrated to the effects of distraction on their driving performance (Horrey, Lesch, & Garabet, 2008), and

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(c) have an increased risk of distraction-related crashes (e.g., Lam, 2002; Neyens & Boyle, 2007). One of the reasons that young drivers are particularly vulnerable to distraction is that they allocate most of their attentional resources to the skills necessary for operating a vehicle (which may take years to fully develop and become automatic), leaving fewer resources for engaging in secondary tasks (e.g., Shinar, Meir, & Ben-Shoham, 1998).

Driver distraction has been defined as the "diversion of attention away from activities critical for safe driving toward a competing activity" (Lee, Young, & Regan, 2008). The extent to which engaging in secondary tasks results in degradation of driving performance depends on several factors, including the demands of the driving task, the demands of the secondary task, and the manner in which resources are allocated between the two tasks (e.g., Horrey & Wickens, 2004; Lee, Regan, & Young, 2008; Wickens, 2002, 2008). A decomposition of text messaging while driving would suggest that it involves competition for visual, manual, and cognitive resources. Indeed, the extent of competition for drivers' resources when text messaging and driving may be greater than that when conversing on a cell-phone and driving because the continuous visual and manual demands of text messaging would appear to be more in conflict with the driving task (however, see Atchley & Dressel, 2004, for findings on the effects of conversation on drivers' field of view).

It has been claimed that text messaging while driving could be even more distracting than talking on a cell phone while driving (Lee, 2007). However, there is surprisingly little empirical data on the effects of text messaging on driving behavior. A simulator study for the Swedish National Road and Transport Research Centre (Kircher et al., 2004) found that when drivers were retrieving a text message, their braking reaction times were significantly slower than in baseline conditions but only in response to one of four simulated hazards (a turning motorcycle). There were no effects of text messaging on mean speeds. However, Kircher et al. (2004) noted that their study had some methodological limitations, including a small sample size and the use of experienced drivers who may have had sufficient attentional capacity and driving skill to engage in

the dual task without observable decrements in their driving performance. It should also be noted that Kircher et al. investigated only the effects of retrieving text messages rather than those of both retrieving and sending text messages.

There is evidence that manual input while driving leads to degraded driving performance, and these decrements have been found to be greater than those that occur when conversing on a cell phone or using voice-activated devices. For example, comparisons between the effects of talking on a handheld cell phone while driving and of dialing a phone number while driving have found that the latter resulted in greater deviation in drivers' lateral position, larger reaction times to peripheral stimuli, and a greater number of missed traffic signals (Brookhuis, de Vries, & de Waard, 1991; Tornros & Bolling, 2005). Tsimhoni et al. (2004) found that when drivers entered addresses into a navigation system using a keyboard, their lateral control, including lane position variation and number of lane departures, was significantly worse than when addresses were entered using a voice-activated interface. Results from a naturalistic driving study have shown that dialing handheld devices while driving increases the risk of a crash by 2.8 times and that this increased crash risk is significantly greater than that of conversing on a cell phone while driving (Klauer et al., 2006).

One possible explanation for why manual input while driving elicits negative driving behaviors may be related to the overt attentional demands of button pressing. Increases in the amount of time that drivers spend looking away from the road to interface with an in-vehicle device can lead to degraded driving performance, such as increased steering wheel deviations (e.g., Dukic, Hanson, & Falkmer, 2006), increases in the frequency of lane excursions and undetected hazards (Haigney & Westerman, 2001), and negative effects on drivers' speed and lane position (Hildreth, Beusmans, Boer, & Royden, 2000). Klauer et al. (2006) have shown that off-road glances of duration longer than 2-s more than doubles the risk of a crash.

In summary, the negative effects of manual input while driving are consistent with driver distraction as a process of diverting attention away from the critical perceptual, cognitive, and response skills necessary for safe driving

toward a secondary task. On this basis, it would be expected that the effects of text messaging on driving performance would vary as a function of the attentional demands of driving, the attentional demands of retrieving and sending text messages, and the timing and distribution of drivers' attention between text messaging and driving.

Given the particular vulnerability to distraction of young drivers with less than 6 months of driving experience (Lee, 2007) and the prevalence of text messaging while driving within this group, the following experiment aimed to test the effects of text messaging on driving performance with a sample of young novice drivers. It was predicted that text messaging while driving would result in significantly more time spent looking away from the road and that the attentional demands of text messaging would result in increased and more variable following distances to lead vehicles, increased variations in lane position, and reduced capacity to respond appropriately to road users, traffic lights, and signs.

METHOD

Participants

Taking part in the study were 20 undergraduate students (12 male and 8 female) from Monash University between 18 and 21 years of age who were paid \$20. Participants had less than 6 months of driving experience on a probationary license ($M = 3.8$ months, $SD = 1.7$) and drove an average of 6 hr per week. All participants had prior experience with text messaging on Nokia cell phones and were experienced with using predictive text messaging (i.e., generating words by pressing the beginning letters). Of the 20 participants, 9 reported reading text messages while driving an average of four times per week, and 6 reported sending text messages an average of six times per week. None of the remaining participants reported reading or sending text messages while driving.

Apparatus

The experiment was carried out in the Advanced Driving Simulator located at the Monash University Accident Research Centre. Scenarios were generated by a Silicon Graphics Onyx computer and projected by four BarcoGraphics 808 High Performance Graphic Projectors onto a

display screen that subtended a visual angle of 180° horizontally and 40° vertically. The scenarios were displayed with a refresh rate of 30 Hz and a resolution of 1,280 × 768 pixels (front center panel) and 640 × 480 pixels (front side panels). An audio system produced accurate localized sound, such as engine and road noises and sound from other vehicles. Drivers viewed the scenarios while seated in a 2003 General Motors Holden VX Calais sedan that was positioned on a low-fidelity motion platform. Participants' head and eye movements were recorded using faceLab™ (Version 4.1). A Nokia 6210 cell phone was used for text messaging.

Driving Simulation

The driving simulation consisted of an 8-km section of mainly straight dual-lane road in an urban environment. Traffic signs indicated a variable speed limit of 50 km/h to 80km/h. The simulation was interspersed with eight test events that were under computer control: (a) A red traffic light was triggered in a 60-km/h speed zone when the driver was 81.7 m from a signalized intersection; (b) each of three car-following tasks consisted of a lead car that merged into the driver's lane 50.0 m in front of the driver and traveled at the signed speed limit; (c) each of two lane-changing tasks, modified versions of the standard Lane Change Test (Mattes, 2003), consisted of a 3,100m section of a straight three-lane road with 12 lane change signs placed on the side of the road approximately 230 m apart; (d) a pedestrian walked from behind a parked car on a collision path with the driver's vehicle (triggered in a 60-km/h speed zone when the driver was 80 m from the pedestrian); and (e) an oncoming car in an 80-km/h speed zone turned right at a signalized traffic intersection in front of the path of the driver's vehicle (triggered when the driver was 84 m from the intersection). Two sets of parked cars that did not have a pedestrian stepping out from behind them and two cars that gave way at a signalized intersection were included in the scenarios to reduce the likelihood that participants could predict the occurrence of the hazard events.

Procedure and Experimental Design

Participants first completed a predrive questionnaire that asked for information regarding driving experience and demographics. They

then completed a 5-min practice drive followed by two experimental drives. Participants were instructed to drive as normally as possible according to Australian road rules and to adhere to the signed speed limit. They were asked to change into the signed lane as soon as they could read a sign in the lane-changing task and to maintain a 2-s gap between their vehicle and the lead vehicle in the car-following task.

Participants were given training (with practice) on how to retrieve and send text messages on the cell phone using predictive text. After participants had demonstrated that they could operate the text message functions, they were seated in the simulator vehicle and began the experimental drives. The eight text messages were preloaded on the cell phone and consisted of simple questions that required single-word replies (e.g., "What day is it?" or "What month is it?").

A computer-generated beep signaled to participants that one of the text messages had been received and that they were to immediately retrieve the message and read its contents. Fifteen seconds after retrieving the text message, a computer-generated digital voice message, "Reply now," signaled that participants were to immediately begin sending a text message reply. Participants held the phone in a comfortable position below the level of the top of the dashboard (to prevent the phone from occluding the eye-tracking cameras) and placed it in the center console when not in use. It should be noted that after participants began retrieving or sending text messages, there were no restrictions on how they distributed their attention between text messaging and driving.

Each of the two experimental drives contained the same set of eight test events described earlier. In Drive 1, four of the test events were timed to correspond with participants' instructions to retrieve and send text messages (i.e., treatment events), and the remaining four test events were completed without text messaging (i.e., control events). In Drive 2, the events that served as control events in Drive 1 were timed to correspond with participants' instructions to retrieve and send text messages, and those that served as treatment events in Drive 1 served as control events.

Computer prompts to retrieve and send text messages in the lane change tasks occurred 16 m after the sixth sign and 23 m after the seventh sign, respectively, in Drive 1, and 108 m before and 145 m after the first sign, respectively, in Drive 2. During the car-following tasks, the computer prompt to retrieve and send text messages occurred 161 m before, and 339 m after, respectively, the lead vehicle merged into the lane in front of the driver. For the discrete hazard tasks, initiation of the computer prompts to retrieve messages occurred simultaneously with the triggers for the pedestrian, traffic light change, or car turn. Half the participants first completed Drive 1 and then Drive 2, and the remaining half of the participants completed the drives in the opposite order. The design of the study was a two-factor mixed factorial design with one repeated-measures factor, distraction (two levels; text-messaging condition and no-text-messaging condition), and one independent-measures factor, drive order (two levels; Drive 1 first and Drive 2 first).

RESULTS

For the continuous driving measures (in-vehicle glances, time headway, lane position, and speed), driving performance data were recorded at 30 Hz for 15-s periods that began when (a) drivers were given a computer-generated signal to begin retrieving or sending text messages in the treatment conditions and (b) the corresponding time-periods in the baseline (no text-messaging) conditions. For each test event, there was a 15-s window between each of the retrieving and sending periods and the corresponding control period. Therefore, for each event, there was a combined data window of 30 s for each of the text-messaging and no-text-messaging (control) periods. There were some individual differences in the amount of time taken to retrieve and send text messages; retrieving a message was always completed within the 15-s time interval, and sending a message always took longer than the 15-s interval.

Because the driving conditions were different for the retrieving and sending periods, driving performance during these periods could not be directly compared. Therefore, separate mixed-model two-way ANOVAs on the

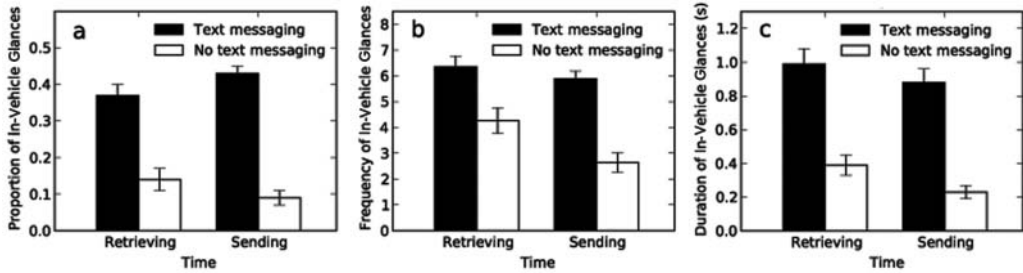


Figure 1. Mean duration of in-vehicle glances (in seconds) (a), mean frequency of in-vehicle glances (b), and mean proportion of in-vehicle glances (c) for the text-messaging and no-text-messaging conditions during the retrieving and sending periods, collapsed across all driving events. Error bars represent standard error of the mean.

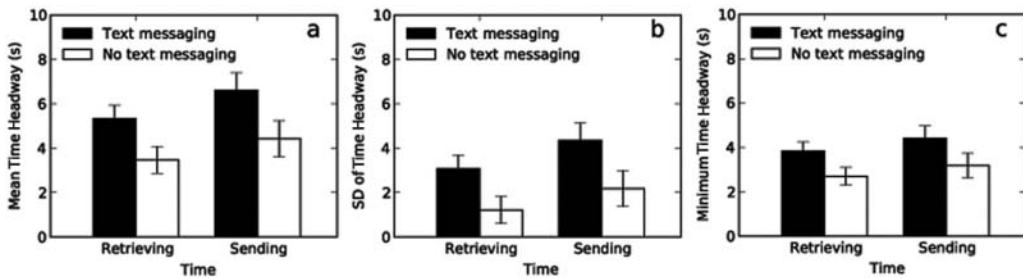


Figure 2. Mean time headway (a), standard deviation of time headway (b), and minimum time headway (c) for retrieving and sending periods of car-following event as a function of text-messaging and no-text-messaging conditions (in seconds). Error bars represent standard error of the mean.

distraction and drive-order factors were carried out for the retrieving and sending periods, with alpha set to .05. Except where reported, none of the analyses found a significant main effect of drive order, nor were there any significant interactions between drive order and distraction.

Eye Movement Analyses

As can be seen in Figure 1a, participants spent a significantly greater proportion of time looking inside the vehicle (in-vehicle glances) when text messaging during both the retrieving, $F(1, 18) = 114.87, p < .001, \eta^2 = .865$, and sending, $F(1, 18) = 219.54, p < .001, \eta^2 = .924$, periods. Figures 1b and 1c show that there were (a) more in-vehicle glances when retrieving, $F(1, 18) = 23.08, p < .001, \eta^2 = .562$, and sending text messages, $F(1, 18) = 71.22, p < .001, \eta^2 = .798$, and (b) longer in-vehicle glances when retrieving, $F(1, 18) = 46.00,$

$p < .001, \eta^2 = .719$, and sending text messages, $F(1, 18) = 71.07, p < .001, \eta^2 = .798$.

Car-Following Event

After treating the first car-following event as practice (because of an interaction effect of drive order), an analysis of the effects of retrieving text messages during the second car-following event found significant increases in drivers' mean time headway, $F(1, 18) = 9.40, p < .01, \eta^2 = .343$ (Figure 2a), and drivers' average time headway variability within a time window, $F(1, 18) = 9.40, p < .01, \eta^2 = .343$ (Figure 2b). There was no significant effect of retrieving text messages on drivers' minimum time headways. An analysis of the effects of sending text messages found significant increases in mean time headways, $F(1, 18) = 9.63, p < .01, \eta^2 = .349$ (Figure 2a); time headway variability, $F(1, 18) = 9.63, p < .01, \eta^2 = .349$ (Figure 2b);

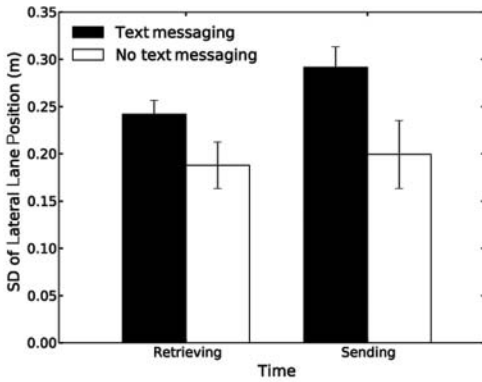


Figure 3. Mean standard deviation (SD) of lateral lane position (in meters) in the car-following event as a function of text messaging and no-text-messaging conditions in sending periods only. Error bars represent standard error of the mean.

and minimum time headways, $F(1, 18) = 6.22$, $p < .05$, $\eta^2 = .257$ (Figure 2c). Driving performance in the third car-following task could not be analyzed because of missing data.

Figure 3 shows that drivers also significantly increased the variability in their lane position when sending and retrieving text messages during the car-following task. Separate ANOVAs revealed that although the increase in lane position variability when sending text messages was significant, $F(1, 18) = 4.83$, $p < .05$, $\eta^2 = .212$, the increase in lane position variability that occurred when retrieving text messages did not reach statistical significance, $F(1, 18) = 3.70$, $p = .07$.

Lane-Changing Event

A chi-square test of independence found no relationship between drive order and text messaging on missed lane changes. An additional chi-square goodness-of-fit analysis of the number of missed lane changes accumulated across both the retrieving and the sending periods found that drivers missed significantly more lane change signs when text messaging (24 missed lane changes) compared with when not text messaging (10 missed lane changes), $\chi^2(1, n = 20) = 5.76$, $p < .05$. A subanalysis of the lane change data found that 80% of drivers who missed the lane change signs in the text-messaging conditions failed to change lanes and 20% changed into an incorrect lane. There were no significant

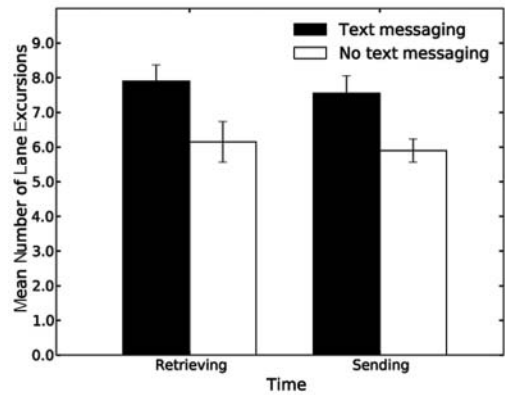


Figure 4. Mean number of lane excursions for retrieving and sending periods across all events (excluding the lane-changing event) as a function of text-messaging and no-text-messaging conditions. Error bars represent standard error of the mean.

effects of text messaging during the lane-changing event on drivers' mean speeds or on the variability in their speed within each time window.

Lane Excursions

The average number of times that any part of the driver's vehicle entered another lane was calculated for each driver across all events except for the lane-changing task. Separate ANOVAs were carried out on the mean number of lane excursions for the sending and retrieving periods using the distraction and drive order factors described earlier. As can be seen in Figure 4, the mean number of lane excursions was significantly greater when both retrieving, $F(1, 18) = 7.47$, $p < .05$, $\eta^2 = .282$, and sending text messages, $F(1, 18) = 10.94$, $p < .01$, $\eta^2 = .365$.

Hazard Events

Hazard response data were analyzed separately using mixed-model two-way ANOVAs (with the same distraction and drive order factors described earlier) on drivers' responses to each hazard when drivers were retrieving text messages. The analyses of responses to each of the three hazards (traffic light, pedestrian, and right-turning car) failed to find any significant effects of text messaging on drivers' braking reaction times, spot speeds on approach to the hazards, and the minimum distance of the driver to the hazards.

TABLE 1: Summary of Mean Differences (With Percentage Increases) Between Text-Messaging and Baseline (No Text-Messaging) Conditions for Each Driving Performance Measure

Event	Dependent Variable	Measure	Retrieving	Sending
All events	In-vehicle glances	Proportion	0.23 (164)	0.34 (378)
		Frequency	2.09 (49)	3.25 (123)
		Duration ¹	0.60 (154)	0.65 (282)
Car-following task	Lane excursions	Frequency	1.75 (28)	1.65 (28)
	Time headway ^a	Mean	1.86 (54)	2.17 (49)
		Variability	1.86 (152)	2.16 (99)
		Minimum	NS	1.22 (38)
		Variability	NS	0.09 (45)
Lane-changing task	Lane position ^b	Frequency	14 (140)	
	Missed lanes ^c	Mean	NS	NS
	Speed	Variability	NS	NS
Hazards	Braking time ^c	Mean		NS
	Approach speed ^c	Mean		NS
	Distance (min) ^c	Mean		NS

Note. Positive numbers indicate a significant increase in the dependent variable. NS = no significant effect on the dependent variable. Numbers in parentheses show the percentage increase in the dependent variable.
^aIn seconds.
^bIn meters.
^cMeasured within the retrieving and sending periods.

TABLE 2: Correlations Between the Proportion of Time Drivers Spent Looking Inside the Vehicle While Retrieving and Sending Text Messages and Their Time Headway and Lane Position Variance During the Car-Following Task

		Time Headway			Lane Position
		Mean	Minimum	Variance	Variance
Proportion of in-vehicle glances	Retrieving	.41**	.34*	.41**	.37*
	Sending	.47**	.36*	.47**	.39*

* Correlation is significant at the .05 level (two-tailed test). ** Correlation is significant at the .01 level (two-tailed test).

Table 1 shows the average increases (with percentage increases in parentheses) for each of the driving-performance measures that were significantly affected when drivers were retrieving and sending text messages relative to the baseline (no text-messaging) conditions. In summary, Table 1 shows that the frequency, duration, and proportion of in-vehicle glances all increased significantly when retrieving and sending text messages. In addition, the mean, minimum, and average variance of the time headway in the car-following task increased significantly, with the exception of time headway variance when drivers were retrieving

text messages. The overall frequency of lane excursions and the number of lane changes missed, and the variance in drivers' lane position when sending text messages, also increased significantly. Pearson's correlations were carried out to test the link between the amount of time drivers spent visually distracted by text messaging and their driving performance. As can be seen in Table 2, there were significant positive correlations between the proportion of in-vehicle glances and drivers' mean time headway, minimum time headway, time headway variance, and lane position variance.

DISCUSSION

The aim of this study was to investigate the effects of text messaging on a handheld cell phone on the driving performance of young drivers. It was expected that a range of driving-control measures would be adversely affected by text messaging because of the competing attentional demands of retrieving and sending text messages and those of driving a vehicle. The results found that text messaging while driving affected drivers' visual scanning of the road, their ability to maintain time headway and lane position, and their ability to follow lane change signs.

An analysis of the visual demands of text messaging while driving showed that the duration of off-road glances were more than half a second longer than in baseline (no-text-messaging) conditions. Drivers also looked inside the vehicle up to twice more often when distracted by text messaging and spent up to approximately 400% more of their driving time not looking at the road. These findings highlight the overt visual-attentional demands of text messaging while driving. The associated decrements in driving performance that were found in this study support previous claims that the time spent with one's eyes off the road is a major contributing factor for poor driving performance and increased crash risk (e.g., see Lansdown, 2001; Wierwille & Tijerina, 1998).

Relative to baseline conditions, retrieving and sending text messages while driving also led to decrements in driving control, as evidenced by an increased number of lane excursions and increased variation in lateral lane position. Drivers had approximately 50% more variation in their lane position (i.e., they swerved more) and made 28% more lane excursions when retrieving and sending text messages. The decreases in driving control that occurred as a function of text messaging supports previous research that has shown that lateral position is particularly affected by visual-manual tasks, such as dialing a cell phone or entering destination details into a route navigation system (Green, Hoekstra, & Williams, 1993; Reed & Green, 1999). The number of incorrect lane changes in the lane-changing task also increased when drivers were text messaging. This finding supports a number of other studies that have found that drivers are

more likely to miss traffic signs, or not process the information provided on the sign, when distracted (Strayer & Johnston, 2001).

The results also show that when drivers were text messaging, the variability of their time headway in the car-following task at least doubled. The average time headway, and the minimum time headway when retrieving text messages, also increased by up to 50%. These findings are consistent with previous suggestions that drivers increase their following distance when using a cell phone or an in-car e-mail system as compensation for being distracted by increasing their safety margin to the vehicle ahead (Jamson et al., 2004; Strayer et al., 2003; Strayer & Drews, 2004). That is, when the variability in time headway increased, drivers appear to increase their average distance to the lead vehicle to ensure that the closest gaps to the lead car that occurred at the limits of such variability remained safe.

Surprisingly, there were two driving measures in this study that did not show an effect of text messaging. The absence of an effect on driving speeds was in contrast to several on-road and simulator studies that have found that drivers tend to decrease their mean speed when distracted in an attempt to reduce workload and moderate their exposure to risk (Alm & Nilsson, 1994; Donmez, Boyle, & Lee, 2006; Haigney, Taylor, & Westerman, 2000; Horberry, Anderson, Regan, Triggs, & Brown, 2007; Rakauskas, Gugerty, & Ward, 2004). It is possible that the absence of an effect of text messaging on drivers' speeds was attributable to (a) the instructions given to participants to drive as closely as possible to the signed speed limit, which resulted in more attentional resources allocated to speed maintenance (see Horrey & Wickens, 2004) and/or (b) drivers' monitoring their speed while looking at their cell phone by processing optic flow information available to the peripheral visual system (cf. Horrey, Wickens, & Consalus, 2006). It should be noted, however, that a recent meta-analysis of the effects of cell phones on driver performance (Caird, Willness, Steel, & Scialfa, 2008) found little evidence of speed compensation.

The failure to detect significant effects of text messaging on drivers' ability to detect and respond to hazards was also in contrast to

previous studies that have consistently shown that cell phone conversations negatively affect reaction times to unexpected events (Caird et al., 2008; Horrey & Wickens, 2006). It would seem likely that the visual distraction associated with text messaging would have decremental effects on hazard detection, and several factors can be identified as potential contributors to the null effect found in this study.

Although the simulation attempted to maximize each hazard by timing it to occur while drivers were engaged in text messaging, it is quite possible that participants were expecting a hazard early on approach when the road environment became more complex (cf. Lansdown, 2001). The hazards may not have been entirely unexpected, given that they occurred on four occasions during each drive, and this may have led to an overestimation of the likelihood of a hazard; the likelihood was considerably greater than what occurs in real-world driving. A possible outcome of this overexpectancy may have been that the experiment lacked sufficient power to detect reaction time effects. It is also possible that drivers were able to retrieve and send text messages while simultaneously looking at the road (i.e., without looking at the keypad). However, this seems unlikely, given the significant increases in the amount of time drivers spent looking inside the vehicle during the text-messaging conditions.

The experience that some of the participants had with text messaging and driving may also have influenced their hazard responses (cf. Chisholm et al., 2008; Shinar, Tractinsky, & Compton, 2005), and some of the negative effects of text messaging found in this study may not occur with more experienced drivers. However, a recent study suggests that practice and experience are unlikely to attenuate the negative effects that occur when drivers engage with a cell phone while driving (Cooper & Strayer, 2008). Further research that takes into account these factors is necessary before any definitive conclusions can be made about the effects of text messaging on hazard responding.

CONCLUSION

Previous research has shown that the risk of crashing while dialing a handheld device, such

as when text messaging and driving, is more than double that of conversing on a cell phone. The present study has identified some of the factors that may underlie such an increased crash risk. Text messaging increased the amount of time that drivers spent looking inside the vehicle and decreased their ability to maintain a constant lane position, carry out a car-following task, and respond correctly to lane change signs. Given the relatively high prevalence of text messaging while driving, in particular among young drivers, it is recommended that appropriate countermeasures be developed and implemented (e.g., see Donmez et al., 2006; Regan, 2006) to prevent and mitigate the adverse effects of cell phone use on driving performance and safety.

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