Driving while conversing: Cell phones that distract and passengers who react

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\textbf{Abstract}

The research systematically compared the driving performance and conversational patterns of drivers speaking with in-car passengers, hands-free cell phones, and remote passengers who could see the driver’s current driving situation (via a window into a driving simulator). Driving performance suffered during cell phone and remote passenger conversations as compared with in-car passenger conversations and no-conversation controls in terms of their approach speeds, reaction times, and avoidance of road and traffic hazards. Of particular interest was the phenomenon of conversation suppression, the tendency for passengers to slow their rates of conversation as the driver approached a hazard. On some occasions these passengers also offered alerting comments, warning the driver of an approaching hazard. Neither conversation suppression nor alerting comments were present during cell phone conversations. Remote passengers displayed low levels of alerting comments and conversation suppression, but not enough to avoid negative effects on driving performance. The data suggested that conversation modulation was a key factor in maintaining driving performance and that seeing the road and traffic was not sufficient to produce it. A second experiment investigated whether a cell phone modified to emit warning tones could alleviate some of the adverse effects typically associated with cell phone conversations. The modified cell phone produced discourse patterns that were similar to passenger conversations and driving performance nearly as good as that of drivers who were not conversing. This latter finding supported the argument that conversation modulation is a key ingredient in avoiding adverse effects of conversations with drivers, rather than the physical presence of an in-car passenger.

\section{1. Introduction}

A range of studies has shown that the use of cell phones has adverse consequences on a driver’s probability of being involved in a crash. Epidemiological research has shown that as little as 1 h per month of cell phone use while driving increases a driver’s crash risk 400–900\% (McEvoy et al., 2005; Violanti, 1998; Violanti and Marshall, 1996). A widely reported case-crossover study found that the risk attached to cell phone conversations by drivers is comparable to a level of 0.08 blood alcohol concentration, the maximum legal limit in many countries (Redelmeier and Tibshirani, 1997, 2001).

The reasons for the heightened crash risk associated with the use of cell phones have been examined in a number of laboratory and field studies. One of the most consistent findings is that drivers’ use of cell phones increases their reaction times to vehicles braking ahead (Ålm and Nilsson, 1994, 1995; Brookhuis et al., 1991; Lamble et al., 1999; Strayer and Drews, 2004) and responding to stop signs and stop lights (Beede and Kass, 2006; Hancock et al., 2003). A meta-analysis of the research findings in this area (Caird et al., 2008) reported a mean increase in drivers’ reaction times of 0.25\ s (although the authors noted that this value was probably an underestimate of on-road decrements). Other adverse changes in driver behaviour have been reported as well, including: impaired gap judgements (Brown et al., 1969; Cooper and Zheng, 2002); increased traffic violations (Beede and Kass, 2006); failure to maintain appropriate headway distances (Ålm and Nilsson, 1995; Rosenbloom, 2006); higher curve speeds (Charlton, 2004); impaired eye scanning (Harbluk et al., 2007; Maples et al., 2008); reduced checking of rearview mirrors (Brookhuis et al., 1991); striking pedestrians (Kass et al., 2007); impaired vehicle control (Treffner and Barrett, 2004); and poor speed management (Ålm and Nilsson, 1994; Horberry et al., 2006; Rakauskas et al., 2004; Törnros and Bolling, 2005, 2006).

Several mechanisms have been proposed to account for the adverse effects of cell phone conversations on driver performance.
Manipulation of handheld cell phones certainly produces some adverse effects via interference with control actions (Brookhuis et al., 1991). Many of the negative effects associated with cell phone conversations, however, do not appear to be the result of impaired driver control actions. Further, the findings that use of hands-free cell phones may be just as detrimental as handheld (Horrey and Wickens, 2006; Matthews et al., 2003; Patten et al., 2004) suggest that cell phone interference results from cognitive demands of the conversation rather than distraction due to manipulation.

The cognitive demands associated with cell phone conversations have been interpreted as interfering with driving performance in three principal ways: (1) verbal processing of conversation results in withdrawal of attention to visual inputs (Strayer et al., 2003); (2) conversation diverts drivers’ attention away from components of the driving task that require explicit attentional processing (e.g., detection of hazards and decision-making), resulting in longer reaction times (Beede and Kass, 2006; Brookhuis et al., 1991; Brown et al., 1969; Patten et al., 2004); and (3) conversations have the effect of degrading drivers’ situation awareness and as a result, their ability to identify and respond quickly to hazards (Gugerty et al., 2004; Kass et al., 2007).

Of considerable practical interest is whether or not these cognitive demands are unique to cell phone conversations or are an inevitable result of drivers’ concurrent processing of verbal material. For example, a frequently posed response to the finding that both handheld and hands-free cell phones increase drivers’ crash risk is that, if conversations are distracting regardless of phone type, then conversations with in-car passengers must be equally dangerous. This line of argument goes on to maintain that inasmuch as conversations between a driver and passenger cannot reasonably be prohibited, neither should drivers’ use of cell phones. Unfortunately, the research literature on this point has been somewhat ambiguous. Epidemiological data have shown that carrying two or more passengers in the car does increase a driver’s risk of a crash (a twofold increase), albeit not as much as talking on a cell phone (a fourfold increase), but there is the suggestion that this may be primarily an issue for young drivers (McEvoy et al., 2007; Neyens and Boyle, 2007).

Several laboratory experiments examining drivers engaged in concurrent verbal tasks (e.g., word games or general knowledge and arithmetic questions) have failed to find any significant differences between remote and in-car verbal sources (Amado and Ulupinar, 2005; Gugerty et al., 2004; Nunes and Recarte, 2002). In contrast, experiments employing more naturalistic conversations have reported that conversations with passengers are not as cognitively demanding as cell phone conversations and are associated with fewer driver errors and crashes (Drews et al., 2004; Hunton and Rose, 2005).

There are several logical reasons why drivers’ conversations with passengers may not be as cognitively demanding or impair their driving performance to the same degree as conversations over cell phones. Drivers conversing with passengers have access to a range of nonverbal cues (e.g., facial expressions, gestures, and posture) that are not available when conversing over a cell phone (Gugerty et al., 2004; Hunton and Rose, 2005). This additional information can make it easier to parse the speech stream and process the meaning of a speaker’s utterances, as well as provide cues for turn-taking and other pragmatic aspects of discourse. A related finding is that good speech quality (intelligibility and fidelity) is important in reducing the mental workload of drivers (Matthews et al., 2003). Passenger conversations undoubtedly enjoy greater fidelity and intelligibility as compared to any sort of cell phone and thus require less attention and effort by the driver to process the conversation, allowing more attention to remain with the primary driving task.

There is also the suggestion that the form and content of passenger conversations are fundamentally different to conversations over hands-free and handheld cell phones (Haigney and Westerman, 2001; McKnight and McKnight, 1993; Strayer and Johnston, 2001). The logic of this argument is that, because passengers can see what the driver sees, they are able to modulate the timing and complexity of their speech to match the driving conditions. As a result, drivers talking to passengers are less likely to become overloaded in difficult driving conditions and may avoid many of the adverse consequences associated with cell phone conversations (Crundall et al., 2005; Hunton and Rose, 2005). In support of this argument, a study comparing the conversations of drivers with in-car passengers to cell phone conversations found that in-car passengers reduced their rate of speech when approaching particularly demanding or hazardous driving situations, and some stopped talking altogether (Crundall et al., 2005). This demonstration of conversation suppression, which was absent in the cell phone conversations, may help to explain why cell phone conversations are more cognitively demanding than passenger conversations. Although the study did not examine driving performance, the underlying logic was that an in-car passenger’s ability to see the momentary demands of the traffic and road situation led to a modulation of their speech, which in turn, freed the driver to allocate more attention to the driving task.

Other evidence for the advantage of passenger conversations over cell phone conversations can be taken from the finding that the content of conversations with in-car passengers includes more turn-taking, more references to the driving situation, and may actually help maintain driver situation awareness, as compared to cell phone conversations (Drews et al., 2004). Drivers engaged in a cell phone conversation spent less time discussing the surrounding traffic and were more likely to miss important elements of the driving task. Passengers’ conversational involvement in the driving task may even increase the driver’s situation awareness of upcoming hazards, and alleviate the potential adverse effects of driving while conversing (Drews et al., 2004).

The purpose of the present study was to investigate whether, and in what ways, drivers’ conversations with passengers were able to avoid the harmful effects of cell phone conversations on driving performance. The study compared the driving performance and conversational characteristics that occurred when drivers engaged in realistic self-paced conversations with: (1) passengers physically present in the car; (2) cell phone conversors; and (3) remote passengers (who could see the driver’s situation but were not physically present in the car). Of interest was whether the remote passengers’ visual access to the driver’s situation (being able to see the road and traffic) was sufficient to produce the conversation suppression (shorter utterances and more frequent pauses) and references to the immediate driving task reported to occur with in-car passengers. Also of interest was the degree to which these conversational aspects were associated with drivers’ speed management, reaction times to driving hazards, recall of those hazards, and ratings of driving difficulty across the three conversation conditions.

2. Experiment 1

This experiment compared four driving conditions: drivers conversing with in-car passengers; drivers conversing over a hands-free cell phone; drivers conversing with remote passengers (who could see the driving situation) by means of a hands-free cell phone; and a no-conversation Control group. Several aspects of driving performance were measured including drivers’ speeds and deceleration reactions on the approach to hazardous road situations. In addition, the pacing and content of the discourse in the three conversation groups was recorded along with drivers’ rat-
ings of driving difficulty and conversational interference, and the accuracy of their recall of the hazards they encountered.

2.1. Method

2.1.1. Participants

A sample of 119 participants, 56 male and 61 female, were recruited from the local area via notices placed in professional newsletters, university bulletin boards, and newspapers. The participants ranged from 17 to 59 years of age with an average age of 27.65 years (S.D. = 10.55). Participants were required to possess a current New Zealand driver licence and were asked to wear any corrective lenses during the experiment if they were required to do so as a condition of their driver licence. Seven participants did not complete the experiment due to either mechanical failures (5) or participant reports of eyestrain or dizziness (2). The remaining sample of 112 was composed of equal numbers of male (56) and female (56) participants. Of the 64 participants in this sample who were drivers in the experiment (the other 48 served as conversors for the drivers), 87% indicated they owned a cell phone. Of those drivers who owned a cell phone, 78.6% admitted they used it to converse as they drove and 51.8% said they used it weekly or more often. Also of note, 66.1% of the drivers who owned a cell phone said they used their cell phone to send and receive text messages while they drove, 51.8% of them weekly or more often. Also of note, 66.1% of the drivers who owned a cell phone said they used their cell phone to send and receive text messages while they drove, 51.8% of them weekly or more often. The participants received a gift voucher in the amount of $10 in recognition of their participation.

2.1.2. Apparatus

The experimental apparatus was the University of Waikato driving simulator consisting of a complete automobile (BMW 314i) positioned in front of three angled projection surfaces (shown in Fig. 1). The centre projection surface was located 2.42 m in front of the driver’s seat with two peripheral surfaces connected to the central surface at 62° angles. The entire projection surface was angled back away from the driver at 14° (from the bottom to the top of the projection surface) and produced a 175° (horizontal) by 41° (vertical) forward view of the simulated roadway from the driver’s position. The image projected on the central surface measured 2.64 m wide by 2.10 m high (at a resolution of 1280 by 1024 pixels) and each of the two peripheral images measured approximately 2.65 m by 2.00 m (at resolutions of 1024 by 768 pixels). In addition, two colour LCDs with an active area of 12.065 cm by 7.493 cm each at a resolution of 640 by 480 pixels were mounted at the centre rearview mirror and driver’s wing mirror positions to provide views looking behind the driver’s vehicle. The simulated vehicle’s dashboard displayed accurate speed and engine RPM data and vehicle performance was determined by a multi-body vehicle dynamics model configured as an automobile with automatic transmission, 3.1 engine (making 170 kW power), and power steering. The projected images and vehicle model were updated at a minimum rate of 100 frames per second. The steering wheel provided tactile feedback to simulate the forces produced when steering the vehicle. Four speakers located inside the car and a sub-woofer underneath the car presented realistic engine and road noises as appropriate. The simulation software recorded the participant’s speed, lane position, and control actions automatically throughout designated sections of the simulation scenario. A digital video camera was mounted in the rear seat of the simulated vehicle to record the participants’ conversations during the experimental sessions.

2.1.3. Simulation scenario

The simulated road created for this study was a 25.3 km-long section of rural road containing a combination of straight and gentle horizontal and vertical curves. The road geometry was an accurate representation of a rural two-lane state highway in New Zealand and was based on the surveyed three-dimensional road geometry of the highway. The lane widths, road markings, sight distances, and other road engineering characteristics were incorporated in the simulation using road survey data obtained from the road controlling authority and by comparing the simulations to video recordings of the highway taken from the driver’s perspective. Road signs and roadside objects were modelled as 3D objects and placed in the simulations to match the video recordings of the highway. Other traffic was placed in the scenario to depict a representative mixture of cars, light trucks, and heavy trucks at a volume of approximately 8000–10,000 passenger car units per day. Special care was taken to introduce heading traffic at key points in the scenario to control each participant’s progress through a series of driving hazards described below. The speed limits of the simulated road were changed from those present on the actual highway: the first 4.75 km of the simulated road had a posted speed limit of 60 km/h; followed by 19.5 km of road with a 100 km/h speed limit; returning to a 60 km/h speed zone for the final 1.05 km of road. The simulated road was also altered from the actual road to contain five traffic hazards and an overtaking lane, located at approximately 4–5 min intervals as shown in Fig. 2. The first hazard was a busy “T” intersection with several turning vehicles as shown in Fig. 3a. On the approach to the intersection the participant’s vehicle was preceded by two vehicles travelling at 52 km/h. When the participant reached a point 150 m before the intersection, the car immediately ahead began indicating a left turn and then decelerated and moved left into a left turn lane. The other leading car briefly illuminated its brake lights and then proceeded though the intersection which contained a truck signalling a turn across the participant’s path (moving towards the participant’s vehicle at 1 m/s) and a vehicle emerging from the road to the left also preparing to turn across the participant’s path. Approximately 2 km later the participants reached the second hazard, a car pulling out of a curb parking area as the participant approached (see Fig. 3b). When the participant’s vehicle was 60 m away, the parked car began to blink its right indicator light. When the participant was 30 m away the parked vehicle pulled into the participant’s lane, accelerating to 60 km/h. The third hazard was a one-lane bridge located 4.24 km later, in the 100 km/h speed area (see Fig. 3c). A hazard warning sign for the bridge was located 272.5 m in advance of the bridge; with a second warning sign accompanied by a supplementary right of way plate (giving right of way to the participant’s vehicle) located 42.5 m ahead of the bridge entrance (at the beginning of the roadway taper). As the participant’s vehicle approached the bridge a large truck was exiting the bridge and two cars were beginning to cross. A fourth vehicle arriving at the far end of the 48 m bridge...
slowed to a rolling stop (1 m/s) to wait for the participant's vehicle to cross.

An overtaking lane approximately 1 km in length was located 3.15 km after the bridge hazard. Although not specifically designed to constitute a hazard, it was included to present a challenging driving task for the participants. The overtaking lane was preceded by a series of advisory/warning signs located 2 km, 1 km and 400 m before the start of the lane. As the participant's car approached the 1 km advisory sign it encountered a series of leading vehicles; a car travelling 95 km/h which slowed to follow a van travelling 87 km/h, both of them slowing further to follow a tanker truck travelling 78 km/h. At the beginning of the overtaking lane all three leading vehicles stayed in the left (slow) diverge lane. Almost immediately, the car and the van indicated a change to the right (fast) lane and accelerated to 96 km/h. After the van overtook the truck it indicated and moved to the left lane while the car accelerated to 106 km/h and overtook the truck and van (see Fig. 3d). Approximately 250–300 m of the overtaking lane remained at this point and an advisory warning sign indicating the lane merge was located 200 m before the merge taper. If the participant did not overtake the truck or van during the overtaking lane, the car and van indicated a left turn and pulled into a left turn lane at an intersection located 560 m after the overtaking lane.

The fourth hazard location was a road works site preceded by a road works hazard warning sign (240 m prior), a temporary 30 km/h speed restriction sign (60 m prior), and a loose seal (gravel) hazard sign 30 m prior. The road works site itself consisted of a series of road cones located in the centre of the road leading through a 38.5 m stretch of loose seal and an 85 m section of road with no road markings (see Fig. 3e). The road works terminated with a "works end-100 km/h" sign.

The final hazard was located 3.5 km later and was composed of a temporary "slip" hazard warning sign followed by a series of road cones in the centre and along the left of the road leading traffic around a landslip that extended approximately 1.5 m into the participant's lane (100 m after the initial warning sign). The posted speed limit returned to 60 km/h 2.28 km after the final road cone and led to a stop sign indicating the end of the simulation scenario 1.05 km later.
2.1.4. Procedure

At the time of scheduling an appointment for the experiment the participants were randomly assigned to one of four experimental groups. Group 1 was a no-conversation Control group containing 16 participants (eight male and eight female) that completed the simulation scenario individually. Group 2 was a passenger conversation group in which 16 pairs of participants (eight male pairs and eight female pairs) completed the simulation scenario together, one member of each pair driving the simulated car while the other sat in the front passenger seat. Group 3 was a cell phone conversation group that contained 16 pairs of participants (eight male and eight female pairs) in which one person drove the simulated car and the other was seated in an adjoining room conversing with the driver by means of a hands-free cell phone. Another 16 participant pairs (eight male and eight female) were assigned to Group 4, a remote passenger condition in which the conversor was seated in an adjoining room while communicating with the driver over the hands-free cell phone but was able to watch the driver’s progress through the simulation scenario via a large window located just behind the rear (driver’s side) of the simulation vehicle (the remote passengers’ view is shown in Fig. 1). In most cases, the members of each participant pair were acquainted with one another from their workplace, university classes, or membership in professional organisations.

Upon arrival, the participants were given an overview of the activities involved and the time required for the experiment, and were asked to complete an informed consent agreement and a brief questionnaire about their driving background and cell phone use. After completion of the questionnaire each participant was given a short practice session and allowed to drive until they felt comfortable operating the simulator. Participants in Groups 2, 3, and 4 then self-selected which member of the pair would be the driver and which would be the conversor. The pairs were told that they were free to converse about any topics they wished. The conversor in each pair was also provided with a set of conversation cards containing topics that could be used if they had any difficulty finding subjects to discuss (e.g., a list of 10 items they would agree to take to a deserted tropical island for a 2-week stay; a list of 10 songs to put on a mix tape to listen to on a long car trip; etc.)

Drivers were given general instructions about the simulated road (three speed zones, etc.) and asked to drive in the simulator as they would normally drive in their own car. Once the driver and conversor were seated in their positions, a voice check was conducted with the hands-free cell phone for the participants in Groups 3 and 4, the video recorder was switched on, and the simulation scenario was begun. The average time required to complete the simulation scenario was approximately 24 min. Following completion of the simulation scenario the drivers were asked to rate the difficulty of driving the simulated road on a seven-point mental workload/driving difficulty scale ranging from 1 = easy; no difficulty at all to 7 = extremely difficult; unsafe (Charlton, 2004) and recall as many hazards or difficult situations from their drive as possible. Drivers in Groups 2, 3, and 4 were also asked to rate the amount of interference their conversation had on their driving on a seven-point scale (1 = no interference, 7 = complete interference).

2.2. Results

2.2.1. Vehicle speeds

Shown in Fig. 4 are the mean vehicle speeds for the four groups as they approached and passed through each of the five simulated hazard sites. As can be seen in the figure, drivers in the Control (no conversation) and Passenger groups generally reduced their speeds as they approached and drove past each hazard point, whereas the average speeds of drivers in the Cell Phone and Remote Passenger groups decreased only slightly or not at all.

A one-way multivariate analysis of variance (General Linear Models procedure, SPSS, Inc., Chicago IL) comparing the groups’ vehicle speeds at the five hazard points indicated a statistically significant difference between the groups [Wilks’ lambda = 0.470, 0.05].

Fig. 4. Participants’ mean speeds through each of the five hazards in Experiment 1. Error bars show 95% confidence intervals. For clarity, error bars that overlap with other data points have been omitted.
Fig. 5. Participants’ deceleration reactions at Hazards 3–5 in Experiment 1. Error bars show 95% confidence intervals.

Univariate analyses at each hazard site showed significant group differences at Hazard 1 (busy intersection) \( F(3,60) = 5.577, p < 0.01, \eta^2 = 0.218 \), Hazard 3 (one-lane bridge) \( F(3,60) = 4.543, p < 0.01, \eta^2 = 0.328 \), Hazard 4 (road works) \( F(3,60) = 4.924, p < 0.01, \eta^2 = 0.228 \), and Hazard 5 (landslip) \( F(3,60) = 11.026, p < 0.001, \eta^2 = 0.355 \). The mean speeds of the four groups as the parked car pulled away from the curb (Hazard 2) were not significantly different \( F(3,60) = 1.938, p > 0.05, \eta^2 = 0.088 \).

Post hoc pair-wise comparisons of the four groups’ mean speeds at the individual hazard points were made using a Bonferroni correction for experiment-wise error rate (corrected alpha levels of 0.05 reported below refer to actual alpha levels of 0.0083, obtained when 0.05 was divided equally across the six pair-wise comparisons between the four groups). At the busy intersection (Hazard 1) the mean speeds of drivers in the Passenger group were significantly lower than the speeds in the Cell Phone and Remote Passenger groups \( p’ s < 0.05 \) and the Control group was marginally slower than the Cell Phone and Remote Passenger groups \( p < 0.06 \) and \( p < 0.07 \), respectively). There was no significant difference between the Cell Phone and Remote Passenger groups’ mean speeds; nor was there any significant difference in the speeds of the Control and Passenger groups.

Because no significant group difference in speed was obtained at Hazard 2 (car entering traffic), no post hoc comparisons were performed. At the one-lane bridge (Hazard 3) the mean speeds of the Passenger group were significantly lower than the speeds for the Cell Phone and Remote Passenger groups \( p’ s < 0.05 \), but none of the other group differences reached statistical significance. At the road works site (Hazard 4) the Control group’s mean speed was significantly lower than the Cell Phone group \( p < 0.01 \) and the Passenger group’s speed was marginally lower than the Cell Phone group \( p < 0.055 \). None of the other pair-wise comparisons were statistically significant at this site. Finally, at the landslip (Hazard 5) both the Control and Passenger groups displayed significantly lower speeds than the Cell Phone and Remote Passenger groups \( p’ s < 0.01 \).

2.2.2. Reaction time and time-to-collision

Two measures of the participants’ deceleration reactions (accelerator pedal release) were examined at each hazard location: deceleration reaction time (RT) was measured in seconds from a point 250 m prior to each hazard; and deceleration time-to-collision (TTC) was measured in seconds to reach the hazard at the current velocity. During the approach to the busy intersection site (Hazard 1) only 31.3% of the drivers in the Cell
Phone and Remote Passenger groups registered a deceleration response (removed their foot from the accelerator), whereas 56.3% of drivers in the Control group and 68.8% of the Passenger group did so. The relatively low numbers of participants registering a deceleration response in the Cell Phone and Remote Passenger groups at this site made statistical comparison of reaction time differences between the groups impracticable. A one-way multivariate analysis of variance comparing the four groups’ performance on the two deceleration measures across the four remaining hazard sites (hazards 2–5) indicated a significant effect of group [Wilks’ lambda = 0.179, $F_{(3,43)} = 2.737$, $p < 0.01$, $\eta^2_p = 0.437$]. Univariate analyses of the two deceleration measures did not reveal any significant difference between the groups at hazard 2 (parked car entering traffic). There were, however, significant group differences in the drivers’ deceleration reactions as they approached hazards 3–5, and these differences are shown in Fig. 5.

Hazard 3, the one-lane bridge, which displayed some of the largest between-group differences in speed, is shown in the top panels of Fig. 5. The univariate analyses of the two deceleration measures at this location produced a significant effect of group for RT [$F_{(3,43)} = 6.353$, $p < 0.001$, $\eta^2_p = 0.307$] and for TTC [$F_{(3,43)} = 5.30$, $p < 0.01$, $\eta^2_p = 0.270$]. Post hoc pair-wise comparisons revealed that the Control group was significantly different from the Cell Phone and Remote Passenger groups on both deceleration measures [$p's < 0.01$], and the Passenger group was reliably different than the Cell Phone and Remote Passenger groups for deceleration RT [$p < 0.01$], but none of the other group means were significantly different from one another.

Hazard 4, the road works, is shown in the middle panels of Fig. 5. The univariate analyses of the two deceleration measures at this location produced a significant effect of group for TTC only [$F_{(3,40)} = 7.292$, $p < 0.001$, $\eta^2_p = 0.267$], but not for RT [$F_{(3,40)} = 1.560$, $p > 0.05$, $\eta^2_p = 0.072$]. Post hoc group comparisons of the TTC data indicated that the Control group responded further away from the road works than the Cell Phone and Remote Passenger groups [$p's < 0.01$] and the Passenger group decelerated marginally further away than the Cell Phone group [$p < 0.06$].

The bottom panels of Fig. 5 show the participants reactions at Hazard 5 (landslip). Univariate analyses of the two deceleration measures indicated a significant group differences for RT [$F_{(3,52)} = 5.322$, $p < 0.001$, $\eta^2_p = 0.232$], and TTC [$F_{(3,52)} = 4.683$, $p < 0.001$, $\eta^2_p = 0.272$]. Post hoc pair-wise comparisons revealed that the Cell Phone and Passenger groups responded more quickly and further away than the Cell Phone and Remote Passenger groups [$p's < 0.01$], but none of the other groups differed reliably.

Across the three hazard sites shown in the figure, drivers in the control group had the fastest RTs and longest TTCs, releasing the accelerator earlier and further away from the hazards than other drivers. Drivers conversing with passengers were somewhat slower than non-conversing drivers, but still registered deceleration responses considerably earlier and further away than drivers in the Cell Phone and Remote Passenger groups. It should also be noted that the RT and TTC reactions shown in the figure represent only those drivers who registered deceleration responses; a substantial proportion of drivers in the Cell Phone and Remote Passenger groups did not remove their foot from the accelerator pedal on the approach to Hazards 3 and 5 (56.2% of Cell Phone and 31.2% of Remote Passenger drivers at Hazard 3 and 25% of both groups at Hazard 5). All of the drivers in the Control and Passenger groups registered deceleration responses at the three hazards, with the exception of three drivers in the Passenger group (18.7%) who did not release the accelerator on the approach to the one-lane bridge (Hazard 3).

### 2.2.3. Discourse measures

The conversations of the participants in the Passenger, Cell Phone, and Remote Passenger groups were recorded throughout the experiment. The portions of these conversations corresponding to the 15 s prior to, and 5 s after each hazard point were transcribed and three discourse measures were calculated for both the driver and conversor in each participant pair (as described in Brown and Yule, 1983). Two of the measures were intended to assess differences in the form of the discourse, indicative of conversation suppression: the mean utterance length (the total number of words divided by the number of utterances); and the number of pauses longer than 2 s that occurred within clause boundaries. A third discourse measure was intended assess content differences; the number of utterances where the topic was the immediate driving situation (defined as situation awareness utterances or simply SA utterances).

Fig. 6 shows the discourse measures for the three conversation groups combined across the five hazards. As can be seen in the figure, participants in the Cell Phone group had fewer pauses in their discourse (the conversors had none), fewer SA utterances, and the conversors in this group tended to produce the longest utterances. Conversors in the Remote Passenger group did produce some pauses and SA utterances, but not in the amounts displayed by the in-car passengers. A multivariate analysis of variance of the drivers’ and conversors’ discourse measures indicated a significant difference between the three groups [Wilks’ lambda = 0.122, $F_{(12,80)} = 12.446$, $p < 0.001$, $\eta^2_p = 0.651$]. The univariate analyses indicated significant group differences for all of the measures: driver utterance length, $F_{(2,45)} = 4.663$, $p < 0.05$, $\eta^2_p = 0.172$; conversor utterance length, $F_{(2,45)} = 14.617$, $p < 0.001$, $\eta^2_p = 0.394$; number of driver pauses, $F_{(2,45)} = 10.070$, $p < 0.001$, $\eta^2_p = 0.309$; number of conversor pauses, $F_{(2,45)} = 60.317$, $p < 0.001$, $\eta^2_p = 0.728$; percent of driver SA utterances, $F_{(2,45)} = 25.599$, $p < 0.001$, $\eta^2_p = 0.522$; and percent of conversor SA utterances, $F_{(2,45)} = 25.320$, $p < 0.001$, $\eta^2_p = 0.529$.

Post hoc pair-wise comparisons of the mean discourse measures for the three groups indicated that the conversors in the Passenger and Cell Phone groups were significantly different for all three discourse measures ($p's < 0.001$). Conversors in the Passenger group were also significantly different from the Remote Passenger group in their number of pauses and percent SA utterances ($p < 0.001$ and $p < 0.05$, respectively). The conversors in the Cell Phone and Remote Passenger groups were significantly different for all three discourse measures ($p's < 0.01$). The post hoc comparisons also indicated that the drivers in the three groups produced significantly different percentages of SA utterances ($p < 0.05$); the number of pauses made by drivers in the Cell Phone group were significantly different to those in the Passenger and Remote Passenger groups ($p's < 0.01$); and drivers’ utterance length in the Passenger group was significantly different for to the Remote Passenger group ($p < 0.05$) and approached significance when compared to the Cell Phone group ($p < 0.064$). (Bonferroni-corrected alphas of 0.05 corresponded to actual alpha levels of 0.0167 when adjusted for the pair-wise comparisons between the three groups.)

### 2.2.4. Difficulty ratings, hazard recall, and crashes

Comparison of the participants’ ratings of driving difficulty and interference produced by the conversations are shown in Fig. 7. There was wide variation in the driving difficulty ratings and no significant group differences were obtained from the statistical analysis. There was, however, a significant difference in the ratings of conversation interference [$F_{(2,45)} = 3.394$, $p < 0.01$, $\eta^2_p = 0.211$], with post hoc comparisons indicating that the Cell Phone group
reported considerably more interference than the Passenger group \(p < 0.01\).

As shown in the bottom panels of Fig. 7, there were also group differences in the number of hazards correctly recalled and in the number of crashes that occurred at the five hazard sites. A one-way analysis of variance indicated that the difference in hazard recall was significant \(F_{(3,60)} = 3.817, p < 0.05, \eta^2_p = 0.160\) with drivers in the Control group recalling highest percentage of hazards (76.25%) and drivers in the Cell Phone recalling the lowest (46.25%) (post hoc \(p < 0.05\)). The most memorable hazard for the participants was the landslip (recalled by 84.38% of all participants), perhaps indicative of a recency effect inasmuch as this was the last hazard to appear. The total number of crashes is also shown in Fig. 7, the bulk of them occurring at Hazard 3, the one-lane bridge (61.9% of the crashes) and Hazard 2, the parked car entering traffic (33.3%). Most of the crashes at these two sites occurred when drivers sideswiped the bridge rails or another vehicle (but in these cases often did not result in an appreciable loss of forward velocity). As can be seen in the figure, the Cell Phone and Remote Passenger groups recorded the highest numbers of crashes (11 drivers in each group, or 68.8%), while only three drivers in the Passenger group (18.8%) and one driver the Control group (6.3%) had crashes. In order to evaluate the group differences in crash rate a chi-squared analysis was calculated for the proportion of drivers having one, two, or no crashes across the five hazard sites. This analysis indicated a significant difference between the four groups [chi-square = 27.042, d.f. = 6, \(p < 0.001\)].

### 2.2.5. Overtaking

A final point of interest was the participants’ driving performance at the overtaking lane. There were no significant group differences in the drivers’ speeds measured at four points along the overtaking lane. There were, however, differences in the number of vehicles overtaken by the participants. In the overtaking scenario the maximum number of vehicles that could be overtaken was three, however the optimal number that could be safely overtaken (without excessive speed or crossing into oncoming traffic) was two vehicles. Fig. 8 shows the proportion of drivers in each group successfully overtaking one, two, three, or no vehicles. The Control group had the highest proportion of drivers overtaking two vehicles (58.8%) whereas 50% of the drivers in the Cell Phone group did not overtake any of the vehicles. A chi-squared analysis of the proportion of drivers overtaking one, two, three or no vehicles indicated a marginally significant group difference [chi-square = 16.119, d.f. = 9, \(p < 0.064\)].

### 2.3. Discussion

The findings clearly indicated that driving while conversing over a cell phone is appreciably different to driving while talking to an in-car passenger or driving without any conversation. Drivers talking on a cell phone often failed to take any action to reduce their speed as they approached the hazards, resulting in the highest crash rates obtained. Many of these drivers also failed to manage the overtaking scenario by increasing their speeds when appropriate. Drivers who were not conversing (Control group) were the safest by most measures. These drivers displayed cautious speeds, rapid deceleration reactions to hazards, good speed management leading to safe overtaking, the fewest crashes, and good recall of the hazards after the drive. Similarly, drivers talking to in-car passengers were more likely to anticipate hazards and reduce their speeds, performing nearly as well as the no-conversation Control group. Drivers talking to Remote Passengers were similar to those in the Cell Phone group; if they reacted to the hazards it was later and to a lesser degree than exhibited by drivers in the Control and Passenger groups.

The differences in the discourse measures give some insight into why these groups may have performed so differently. Conversation suppression, as measured by the number of conversor pauses that occurred within clause boundaries, occurred to a much greater degree in the Passenger group as compared to the Cell Phone and Remote Passenger groups. Topic shifts to the hazards (SA utterances) also occurred to a greater degree in the Passenger group, potentially improving the drivers’ awareness of the hazards. In this context it is interesting that although the remote passengers did engage in some discussion of the hazards, and did display some conversational suppression, the driving performance...
of this group was not appreciably better than the Cell Phone group. Apparently the ability to see the road and traffic was not sufficient to produce the level of conversation modulation associated with safe driving and resulted driving performance only slightly better than drivers talking to conversors who were blind to their situation.

It is possible, however, that the better driving performance enjoyed by drivers in the Passenger group, as compared to the Remote Passenger group, might have been the result of other factors related to the conversors’ physical presence in the car. For example, the superior acoustic quality and access to nonverbal cues associated in-car conversations might have provided better speech intelligibility and reduced the cognitive demands of these conversations relative to cell phone conversations (Gugerty et al., 2004; Matthews et al., 2003). Alternatively, a social phenomenon such as a driver’s concern about the welfare of their passenger may have produced more conservative driving practices. The next experiment addressed these possibilities by attempting to produce passenger-like conversation modulation (pauses and topic shifts) over a modified cell phone. If a cell phone modification can be shown to produce safe and acceptable driving performance, the acoustic and social advantages of in-car passenger conversations might reasonably be discounted in favour of the conversation modulation explanation.

3. Experiment 2

Regardless of the wealth of information available about the risks associated with driving while conversing on a cell phone, many drivers continue to engage in the practise and resist restrictions on their use (McCarrt and Geary, 2004; Rajalin et al., 2005). The findings of the previous experiment indicate that conversations per se are not inherently a problem for drivers; conversation rates that are inflexible and incompatible with momentary traffic demands are a problem however. Passenger conversations that contain pauses during difficult driving situations, and offer comments alerting drivers to the presence of hazards, enable quite satisfactory levels of driver performance.

A reasonable question to ask is whether there are any technological modifications to cell phones that could introduce some of the same features of passenger discourse into a cell phone conversation? One study addressed this proposition by creating a simulated cell phone that presented three short beeps followed by a suspension of the conversation (Wood and Hurwitz, 2005). The researchers reported that the modified cell phone counteracted some of the negative effects typically associated with cell phone conversations, decreasing drivers’ workload ratings and their reaction times to vehicles decelerating ahead of them. Similarly, other researchers have reported that auditory warnings regarding road and traffic conditions can be successful at re-directing distracted drivers’ attention back to the driving task (Donmez et al., 2006, 2007).

The present experiment explored a modification similar to those described above, in the form of a cell phone that provided alerting tones as a driver approached a hazard location. The purpose of this trial was to investigate whether the introduction of alerting beeps would produce conversation modulation, similar to that seen in passenger conversations, and whether these ‘artificial’ pauses and topic shifts would result in similar driving performance. There were three possibilities predicted for the alerting cell phone design: (1) driving performance would not change relative to the cell phone groups of the previous experiment, indicating that speech intelligibility or social factors are important components of safe driving with in-car passengers; (2) the alerting beeps would add another source of distraction and workload making driving performance...
worse than the previous experiment; or (3) the alerting cell phone would produce conversation modulation and improved driving performance, artificially replicating the role of an in-car passenger.

3.1. Method

3.1.1. Participants
A sample of 40 participants, 14 male and 26 female, were recruited from a third-year university course in applied cognitive psychology. The participants ranged from 19 to 40 years of age with an average age of 23.5 years (S.D. = 5.54). Participants were required to possess a current New Zealand driver's licence and asked to wear any corrective lenses during the experiment if they were required to do so as a condition of their driver's licence. Two participant pairs did not complete the experiment due to eyestrain or dizziness leaving a final sample of 38 (18 participant pairs) that was composed of 13 male and 23 female participants. In this sample all of the drivers indicated they owned a cell phone and of those, 55.6% admitted they conversed on it while they drove, with 22.3% using it weekly or more often. In comparison, 77.8% of the drivers said they used their cell phone to send and receive text messages while they drove, with 61.1% of the drivers using it weekly or more often.

3.1.2. Apparatus
The University of Waikato driving simulator hardware, software, and video recording equipment described in the previous experiment was used unchanged.

3.1.3. Simulation scenario
The 25.3 km simulated road created for the previous study was again used for the present experiment. The simulation scenario was changed such that the software produced a series of beeps at each of the five hazard sites that was clearly audible over the cell phone by both the driver and conversor. As the driver reached a point 300 m away from the hazard a single beep 100 ms in length was sounded. At 200 m from the hazard three beeps were sounded at 400 ms intervals. At 100 m and 50 m from the hazard a series of five beeps (at 250 ms intervals) was sounded.

3.1.4. Procedure
At the time of scheduling an appointment for the experiment the participants self-selected into pairs. All of the pairs experienced the same experimental condition, the alerting cell phone. As in the cell phone conversation group from the previous experiment, one member of each pair drove the simulated car and the other was seated in an adjoining room conversing with the driver by means of a hands-free cell phone. The participants were given the same overview of activities as in the previous experiment and asked to complete an informed consent agreement and a brief questionnaire about their driving background and cell phone use. As with the previous experiment, each participant was given a short practice session and then each pair self-selected which person of the pair would be the driver. The pairs were told that they were free to converse about any topics they chose to and the conversor in each pair was provided with the conversation cards used in the previous experiment. Following completion of the simulation scenario the drivers were asked to rate the driving difficulty of the simulated road, recall as many hazards or difficult situations from their drive as possible, and to rate the amount of interference their conversation had on their driving.

3.2. Results

Fig. 9 shows the participants' speeds at each of the five hazard locations. The speeds from the previous experiment have been included alongside for comparison. As can be seen, the Alerting Cell Phone condition was associated with the lowest speeds at every hazard, even lower than the no-conversation control condition in some cases. A multivariate analysis of variance indicated a significant difference between the groups across the five hazards [Wilks' lambda = 0.409, $F_{(20,243)} = 3.766$, $p < 0.001$, $\eta^2_p = 0.201$] and univariate group differences were significant for each hazard except Hazard 2: $F_{(4,77)} = 5.218$, $p < 0.001$, $\eta^2_p = 0.213$ for Hazard
Fig. 10. Participants’ deceleration reactions for the Alerting Cell Phone condition (Experiment 2) compared to the results of Experiment 1 at Hazards 3–5. Error bars show 95% confidence intervals.

1; \(F_{(4,77)} = 2.337, p < 0.063, \eta^2_p = 0.108\) for Hazard 2; \(F_{(4,77)} = 9.412, p < 0.001, \eta^2_p = 0.328\) for Hazard 3; \(F_{(4,77)} = 5.680, p < 0.001, \eta^2_p = 0.228\) for Hazard 4; and \(F_{(4,77)} = 10.174, p < 0.001, \eta^2_p = 0.346\) for Hazard 5]. Pair-wise comparisons were Bonferroni-corrected such that the reported alphas of 0.05 were equivalent to an actual 0.01 alpha required for the five pair-wise comparisons of the Alerting Cell Phone group to each of the four groups from Experiment 1. The pair-wise comparisons indicated that the Alerting Cell Phone condition produced significantly lower speeds than the Cell Phone group at each hazard location \([p<0.05]\). The Alerting Cell Phone condition also produced significantly lower speeds than the Remote Passenger condition at Hazards 1, 3, and 5 \([p<0.01]\), and marginally lower speeds at Hazard 4 \([p<0.065]\). No significant differences between the Alerting Cell Phone group and the Control and Passenger groups were obtained except at Hazard 3, the one-lane bridge, where the Alerting Cell Phone group was lower than the Control group \((p=0.05)\) and the Passenger group \((p<0.67)\).

All of the Alerting Cell Phone drivers registered a deceleration response at Hazards 1, 2, 4, and 5, and all but one driver at Hazard 3. \(\text{Fig. 10}\) shows the deceleration measures at Hazards 3–5 for the present experiment compared to the groups from the previous experiment. As can be seen in the figure, the alerting cell phone was associated with RT and TTC values equivalent to, or better than the no-conversation Control group. A multivariate analysis of variance comparing all five groups’ deceleration measures (the Alerting Cell Phone group and the four groups from the previous experiment) at Hazards 3–5 indicated a significant group difference \([\text{Wilks’ lambda} = 0.224, F_{(24,183)} = 4.070, p < 0.001, \eta^2_p = 0.312]\]. Pair-wise comparisons of the Alerting Cell Phone group to the four groups from Experiment 1 confirmed that the drivers in the Alerting Cell Phone condition responded earlier (RT) and further away (TTC) than the drivers in the Cell Phone and Remote Passenger conditions at all three hazards \([p<0.05]\), but did not differ from the Control or Passenger conditions at any location except Hazard 5 (landslide) where the Alerting Cell Phone group was better than the Passenger group on both RT and TTC \([p<0.01]\).

\(\text{Fig. 11}\) shows the discourse measures for the Alerting Cell Phone group compared to the results of Experiment 1. Multivariate analy-
sics of the discourse measures from all five groups indicated a significant group effect [Wilks’ lambda = 0.166, $F_{(18,162)} = 7.955$, $p < 0.001$, $\hat{\eta}_p^2 = 0.450$]. Pair-wise comparisons (Bonferroni-corrected 0.05 alpha corresponded to actual alpha of 0.0167) of the Alerting Cell Phone group to the three conversation groups from Experiment 1 indicated that the conversors in the Alerting Cell Phone group produced significantly more pauses than the Cell Phone and Remote Passenger groups ($p’s < 0.01$) as well as a shorter utterance lengths and lower percent SA utterances than the Cell Phone group ($p < 0.001$). There were no observed significant differences between the conversors in the Alerting Cell Phone and Passenger groups. Drivers in the Alerting Cell Phone group produced significantly more pauses than drivers in any of the other groups ($p’s < 0.001$) and a greater percent of SA utterances than drivers in the Cell Phone group ($p < 0.001$).

The mean driving difficulty rating for drivers in the Alerting Cell Phone condition was 2.89, and their ratings of driving interference produced by their conversations was 4.22. Post hoc pair-wise comparisons of both sets of ratings did not produce any significant differences when compared to the four groups from Experiment 1. Four of the 18 Alerting Cell Phone drivers had crashes in Experiment 2, but all but one of them at the one-lane bridge (the other was at the landslip). This was more than the single crash that occurred in the 16 no-conversation participants in Experiment 1, but fewer than the six crashes experienced by drivers conversing with a passenger and far fewer than the 18 crashes in the Cell Phone group. A chi-squared analysis comparing the Alerting Cell Phone and Cell Phone groups’ proportion of drivers having one, two, or no crashes at the five hazard sites indicated a significant group difference [chi-square = 11.879, d.f. = 2, $p < 0.01$]. Finally, at the end of the experimental session the Alerting Cell Phone group correctly recalled 74.44% of the hazards, which was equivalent to the Control group in Experiment 1 (76.25%) but significantly better than the 46.25% correctly recalled by the Cell Phone group [univariate group effect: $F_{(4,77)} = 4.249$, $p < 0.01$, $\hat{\eta}_p^2 = 0.181$, post hoc $p < 0.01$].

3.3. Discussion

The alerting cell phone was associated with driving performance as good as that of the no-conversation controls from the previous experiment. The drivers’ deceleration responses were faster and further away than those of the Cell Phone group. The discourse produced during the cell phone alerts contained significantly more pauses and SA utterances than the Cell Phone group, at a level equivalent that produced by in-car passengers. Given the explicit alerting function of the cell phone beeps, it was perhaps not surprising to find that this condition produced the highest hazard recall accuracy as well. The low number of crashes observed in this experiment suggests that the alerting cell phone was at least as effective as passengers at helping drivers prepare for, and respond to, road hazards. Finally, the findings suggested that conversation modulation was an important contributor to the safe driving seen with drivers’ conversations with passengers, rather than aspects related to their physical proximity to the driver.

4. General discussion

Driving while talking on a cell phone is different from driving while talking to a passenger. Drivers conversing on cell phones are less likely to initiate a deceleration response as they approach a hazard. When cell phone drivers do decelerate, they decelerate later and closer to the hazard, and they are more likely to crash. In the present study, many of these cell phone drivers failed to prepare for hazards, often did not react when they had close calls or minor collisions, and they had no recollection of the hazard afterwards; one can infer that these drivers never detected the hazards unless they had a significant collision.

The practical implication of these findings is clear; the idea that drivers’ use of cell phones need not be restricted simply because of the impracticality of restricting equally hazardous conversations with passengers is not a viable argument. Drivers’ cell phone and passenger conversations are different and have different effects on driving performance. The findings suggest that it is the different form and content of the discourse in these two cases that is responsible for their safety differences. Passengers were more likely to pause (conversation suppression) and/or say something about the current driving situation (SA utterances) as compared to cell phone conversors. Remote passengers, who could see the road and traffic, displayed significantly lower levels of this conversation modulation with the result that their driving partners displayed nearly the same level of disruption as drivers conversing with a conversor who was blind to the drivers’ situation. Two aspects of this finding are important to consider: (1) seeing the drivers’ situation can result in some conversation modulation, even when conversors are not present...
in the car; (2) the level of conversation modulation produced by remote conversors may not be enough to avoid the negative effects associated with drivers conversing on hands-free cell phones. The results of the second experiment showed that conversation modulation could occur even when conversors are not able to see the driver’s situation, and that having the conversor present in the car is not required to produce safe driving.

An argument can be made that cell phone conversations are more distracting than other in-car activities because they are continuous and externally paced. In contrast, operation of radios and CD changers can be stopped and started, and drivers can actively manage their level of distraction, similar to the way passengers manage their distracting influence by pausing. Drivers cannot, however, manage their cell phone conversations in the same way. Participants in a conversation have an expectation of continuous discourse, with no interruptions, that places cognitive demands on drivers that other distractions do not (McKnight and McKnight, 1993).

The finding that the alerting cell phone simulation was able to produce a level of conversation modulation similar to that found with passengers promises an appealing technological approach to a vexing problem associated with public resistance to restrictions on the use of cell phones in cars. The underlying concept is that radio frequency “tags” could be placed on hazard warning signs, or GPS-capable cell phones could be programmed with maps containing the locations of known road hazards. In either case, the cell phone would emit a series of warning beeps as a driver conversing on a cell phone approached a hazard. The feasibility of these solutions, however, would require considerably more investigation in order to judge their ultimate usefulness. Additional research could also productively explore and compare the self-paced and externally paced aspects of other in-car distractions.

The artificiality of laboratory procedures generally, and simulations specifically, must be taken into account when generalising the results from experimental studies to real-life situations. In the present case, the unfamiliar car and visual resolution may have contributed to poorer performance than we would obtain in an actual car on the highway. Although the hazards included in the simulation scenario were all plausible, their concentration in a short section of road was unlikely. Certainly the number of crashes observed in the present experiments would be extremely disappointing and tragic were they to occur in real life. This does, however, speak to one advantage of simulation, the possibility of even a low rate of crashes would make replication of this sort of experiment on the highway unethical and impractical. Further there is an emerging consensus that relative validity (i.e., the equal generalisability of the conditions being compared in a simulated environment) may be more important than absolute validity (e.g., the veridical correspondence between driver speeds and reaction times obtained in simulation and on real roads) (Godley et al., 2002; Törnros, 1998). The number of laboratories using simulation has increased dramatically in recent years, perhaps reflecting this understanding (Bella, 2008). In the specific case of research into driving and cell phone use, a recent meta-analysis failed to detect any significant differences in on-road and simulator research (Caird et al., 2008).

Some of the other experimental protocols employed in the present study should also be considered when evaluating the findings. The experiments allowed the participant pairs to self-select the participant who would be the driver and who would be the conversor (just as drivers and passengers self-select their roles in everyday situations). It can be argued that this procedure departs from true random assignment of participants to conditions, but the fact that the pairs were randomly assigned to the four experimental conditions ensured that no systematic between-group bias contributed to the observed differences. Second, the conversations between the drivers and conversors were self-paced and unstructured. This too differed from many of the previous investigations of cell phones’ effects on driving (Haigney and Westerman, 2001). In order to examine differences in conversation modulation, however, the conversation had to be free to vary (i.e., not be controlled). In the present experiment both of these protocols (self-selection of driver and conversor roles and self-paced conversations) were included to promote the ecological validity of the experimental design.

At the outset of this research we posed the question of whether driving while conversing with passengers was safer than conversing over a cell phone; and, if so, was it because of passengers’ conversation suppression and their ability to alert drivers to hazards ahead? The present research has shown that passenger conversations are indeed safer than cell phone conversations, and that what passengers do not say to drivers may be at least as important as what they do say.

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