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

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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.

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.

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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 posited 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-