

In-Car Cell Phone Use: Mitigating Risk by Signaling Remote Callers

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ABSTRACT

Research has linked in-car cell phone use with automobile accidents. We explore a signaling method that could mitigate that risk. We show in a first experiment how remote cell phone callers were induced to speak less during critical driving periods, and, in a second experiment, how driving performance in a simulator improved when callers reduced conversation levels during critical driving periods.

Keywords

Context-aware computing, cell phones, driving, distraction, attention, cognitive load.

INTRODUCTION

Redelmeier and Tibshirani [1] reported that cellular telephone conversations were associated with a four-fold increase in the likelihood of an accident, and that the increased risk was comparable to the risk of driving a vehicle while legally intoxicated. Strayer and Johnson [2] demonstrated in two experiments that cell phone conversation draws the driver's attention away from driving, causing increased risk. Peripheral interference from holding the phone, listening to music or speech, or repeating word lists into the phone did not cause increased risk.

People sometimes ask why cell phone conversation is risky, in that conversation with passengers in the car does not seem to cause accidents. We believe passengers moderate their speech based on their observation of current driving conditions. For example, most people would stop talking to a driver who is passing a truck on a two-lane mountain road after dark. We investigated the possibility of achieving similar results if a remote cell phone caller were made aware of critical driving periods, as a passenger would be.

EXPERIMENTS

We designed two experiments to test our idea that a context-aware cell phone could change callers' and drivers' behavior and performance. Experiment 1 tested whether remote cell-phone callers would slow or stop their conversation with a driver when signaled. Experiment 2 tested whether a driver's performance while speaking on a cell phone would be improved by slowing or stopping the remote callers' conversation.

Experiment 1

Participants ($n = 24$) were asked to role-play a person seeking to rent an apartment. Each participant made successive cell phone calls to three "landlords," played by the experimenter. Participants were provided a list of questions to ask the landlord about each apartment (e.g., how many bedrooms the apartment had). At a pre-specified point in each call, the landlord would unexpectedly pause for 10 seconds. Each call was assigned to 1 of 5 conditions.

In the control condition, participants heard nothing during the 10-second pause (except their own speech, if any). In the experimental conditions, the participant heard 1 of 4 signals—beeping, squealing brakes, police-type siren, or a synthesized voice message, "The person you have called is busy. Please hold." Participants could talk over the signal. For each call, we logged the number of sentences and words spoken by the participant during the 10-second pause.

Results

Typically, participants in the control condition kept talking when there was silence on the line. Signaling the remote cell phone caller reduced the caller's words and conversation significantly ($p < .01$). The long signal, in particular, reduced conversation as compared with the control condition (see Figure 1). These results suggest that a context-aware cell phone could use a signal successfully to reduce the volume of conversation by the caller. We conducted the next study to see whether a caller's reduced conversation would improve the driver's performance.



Figure 1. Effect of signaling on phone conversation.

Experiment 2

For experiment 2, we constructed a driving simulator (see www.cs.cmu.edu/~mpschnei/sim/) using Alice, a virtual-reality authoring environment (see www.alice.org). Users navigate a vehicle through a test track using the arrow keys on the keyboard. Before beginning the experiment, participants ($n = 20$) practiced using the driving simulator until they said they felt comfortable. Participants then completed one circuit of the track on the driving simulator under each of three conditions. The order of the experimental conditions was counter-balanced.

In the control condition, participants simply completed one circuit of the track. In each of two experimental conditions, participants were asked to play the role of a landlord driving a car and answering questions of an apartment seeker (played by an experimenter) over a cell phone. To simulate a hands-free cell phone, the participant talked over a speakerphone. In the continuous call condition, the apartment seeker kept talking with the participant during the entire circuit of the track. In the paused call condition, the apartment seeker stopped speaking during the most difficult section of the track. In each condition, a trace was generated showing each point where the participant drove off the test track (see Figure 2). The number of these accidents was the dependent measure.

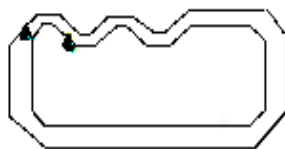


Figure 2: User trace showing a run with 2 accidents.

Results

The accident traces in the driving simulator were correlated with time to complete the circuit, $r = .49$, supporting the validity of the accident measure.

The analysis examined the differences in accidents across the three driving conditions: control (no phone call), continuous phone call, and paused phone call. Figure 3 shows that comparatively few accidents were logged in the control condition ($\bar{X} = 3.8$). Over 50% more accidents were logged when participants conversed by phone for the entire circuit of the track ($\bar{X} = 6.7$). However, accidents dropped to no-call control levels when the pause was

inserted in the conversation during the difficult driving period ($\bar{X} = 3.7$). With driver skill controlled in the statistical tests, the differences across conditions are statistically significant ($p < .01$). The contrast between the calls with and without the pause was highly significant too ($p < .01$).

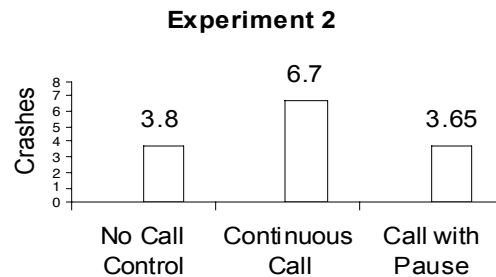


Figure 3: Effect of phone calls on driving.

GENERAL DISCUSSION AND CONCLUSIONS

Our data replicate earlier results that cell phone conversation is a significant driving hazard. We have taken an additional step by testing a potential method for reducing this hazard. We have shown that by signaling a remote caller during a phone call, it is possible to induce the caller to talk less. Furthermore, we have shown that when a caller's conversation is reduced, the driver's performance improves. In our tests with a simulator, accident rates while talking were reduced to the same level as driving with no phone call.

We posit that judiciously interrupting cell phone conversations based on an estimate of driving risk could reduce the overall accident risk of cell phones and driving. One can imagine a cell phone capable of receiving of real-time localized traffic data that could implement this signaling system. Our results suggest this would decrease the risk of in-car cell phone use. However, it is an open question as to whether overall accident rates would decrease, since an inflated sense of security might encourage drivers to use their cell phones longer or more often. Given the ever-increasing penetration of cell phones into modern life, further investigation into the feasibility and merits of such a system is warranted.

REFERENCES

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