The Relationship Between Cellular Phone Use, Performance, and Reaction Time Among College Students: Implications for Cellular Phone Use While Driving

Adam Szyfman, Gregory Wanner, and Leslie Spencer

Abstract

Two studies were performed to determine the relationship between cellular phone use and either reaction time or performance among college students. In the first study 60 undergraduates completed a computerized reaction time test. Mean reaction times were significantly higher when participants were talking on a cellular phone, either handheld or on a headset, than when they were not. In the second study 40 undergraduates steered a remote-controlled car through an obstacle course. Performance scores were significantly poorer for participants when they were talking on a cellular phone than when they were not. A majority of participants reported using cellular phones while driving, yet believed this was a dangerous practice. We recommend incorporation of education about cellular phone use and driving in health/safety curriculums for high school and college students.

The safety of using a cellular phone while driving is a significant public health concern, and a growing body of research is validating this concern. More than 63 million Americans have cellular phones in their vehicles, and 23% report using them daily (Moore & Moore, 2001). Redelmeir and Tibshirani (1997) retrospectively studied 699 drivers who were involved in motor vehicle accidents and also owned cellular phones. They concluded that a driver's risk of being involved in a motor vehicle collision was four times greater if she or he had been using a cellular phone during or immediately prior to the collision. This study also showed no significant safety advantage of using a hands-free headset device over the handheld cellular phone; both produced similar risks. A second study comparing drivers who had been in car accidents to those who had not revealed that cellular phone users were four times as likely to be among those who had car accidents (Violanti & Marshall, 1996). In another study, drivers in a simulated driving experience were twice as likely to miss a traffic signal when they were using a cellular phone (Strayer, 2001). McKnight and McKnight (1991) concluded that all forms of cellular phone use led to increases in response time and distraction, and that the distracting effect was two-to-three times greater in drivers over 50 years old. They also adjusted for prior experience with cellular phones and driving and found no relation between experience and distraction levels; thus, more experience driving and talking on a cellular phone did not make one safer while doing both simultaneously.

One reason for the limited research on cellular phone use and driving is the difficulty in using a rigorous study design while maintaining the safety of participants. In a review of the research methodology in this area, Haigney and Westerman (2000) recognized the ethical and liability concerns of intentionally placing a driver in a situation designed to cause driving errors. For this reason the body of research in this area has

Adam Szyfman and Gregory Wanner are students at Rowan University in Glassboro, NJ. Leslie Spencer, PhD, CHES, is an associate professor in the Department of Health and Exercise Science at Rowan University, 201 Mullica Hill Road, Glassboro, NJ 08028; E-mail: spencer@rowan.edu.

Adam Szyfman and Gregory Wanner completed this study for their undergraduate thesis in the Rowan University Honors Concentration.

been largely cross-sectional. Haigney and Westerman (2000) recommended the use of simulated testing situations in a controlled environment as an appropriate alternative to having participants drive motor vehicles in these studies.

The purpose of the present research was to explore the relationship between the use of a cellular phone and either reaction time or performance on a motor skills test in a college student population. We also explored differences in reaction time when students used a hands-free cellular phone as compared with use of a handheld phone. This study expands on previous research in two important ways. First, it focuses specifically on young adult drivers, a population not previously studied. Second, it uses a quasi-experimental design within a controlled environment, unlike most previous research, which has been cross-sectional in design.

METHODS

We performed two separate studies, both of which are reported here. In the first study, reaction time for a computerized test was the dependent variable; in the second study, accuracy in navigating a remote-controlled car through an obstacle course was the dependent variable.

Study 1

We conducted a computerized test in which participants responded to a series of visual and auditory signals by right-clicking the mouse. The reaction time tests utilized a computer program designed to measure reaction time to 0.0001 seconds (*Activity*, 2001). The test is offered through ExploreScience, a web site for educators and students. The site is promoted as a professional resource for educators; however, specific reliability data for this test were not available. Participants sat before a blank computer screen with their dominant hand positioned over the mouse. As visual (i.e., a red square) and auditory (i.e., a bell ringing) cues were given, the participant was instructed to click the mouse as quickly as possible. Each participant completed the test three times, once under each of the following conditions:

(1) No cellular phone: The computer test was taken one time without using a cellular phone or having any conversational distraction.

(2) Handheld cellular phone: Participants took the computer test one time while using the handheld cellular phone. Over the phone, participants were asked a predetermined list of 12 questions typical of conversation while taking the test. Questions included items such as "What did you eat for breakfast this morning?", "Where do you live?", and "What did you do last weekend?".

(3) Headset cellular phone: Participants took the computer test one time while using a cellular phone with an attached hands-free headset. Over the phone, participants were asked a second predetermined list of 12 questions typical of conversation.

Participants were randomly assigned the order of conditions under which they would take the test to minimize the effect of improved reaction times as they became more familiar with it (treatment effect). Prior to taking the test, participants were instructed how to use the computer program and asked to complete a pretest survey of their demographic data and habits and attitudes related to cellular phone use while driving. Survey data were matched to test results. Data were analyzed using SPSS (version 10.0).

Results

Sixty undergraduate students (31 men, 29 women) ranging from age 17 to 24 volunteered to participate in this study. Participants were recruited by the researchers in the student union building where the test was administered.

The mean reaction time of all participants for the no cellular phone condition was 0.3562 seconds for visual cues and 0.3364 seconds for auditory cues. When a handheld cellular phone was used, the mean reaction time was 0.5460 seconds for visual cues and 0.5661 seconds for auditory cues. These reaction times showed an increase of 53% for visual cues, and 68.3% for auditory cues when compared with the no distraction condition. The mean reaction time for the headset cellular phone condition was 0.4647 seconds for visual cues and 0.4976 seconds for auditory cues. These reaction times showed an increase of 31% for visual cues and 48% for auditory cues when compared with the no distraction condition.

A general linear model procedure was used to compare the means of the three conditions. Reaction times increased significantly and in a positive linear direction for both auditory cues (F=23.9, df=3, 57, p=.000) and visual cues (F=19.4, df=3, 57, p=.000) from no cellular phone with the lowest means to handheld cellular phone use with the highest means. When men and women were compared for the three conditions, significant differences were found, with women having higher reaction times to visual cues (F=3.5, df=3, 57, p=.037), but not to the auditory cues.

Although we recognize the limitations in applying these data to driving a motor vehicle, we used the computerized test program (*Activity*, 2001) to calculate potential outcomes as if these same increases in reaction time were to occur while the subjects were driving. At a speed of 65 miles per hour (mph) the average reaction distance (i.e., distance traveled before the driver is physically able to react to an obstacle or stimulus) of the participants in this study was approximately 33.01 feet, the average reaction distance for a driver using a cellular phone with a headset was approximately 45.87 feet, and the average reaction distance for a driver using a handheld cellular phone was approximately 53.01 feet.

Sixty-eight percent (n=41) of the participants owned a cellular phone. Seventy-two percent (n=43) had used a cellular phone while driving, and 42% (n=25) used the phone at least weekly while operating a vehicle. Eighty-five percent (n=51) believed that the use of a cellular phone while driving was dangerous, and 63% supported laws restricting their use by drivers.

Study 2

We conducted a test in which participants steered a remote-controlled car set at a constant speed through an obstacle course. The outcome variable was the number of obstacles they hit and/or boundaries they crossed, with a higher number indicating poorer performance. Participants twice performed the task of driving the car; once with the cellular phone and once without. We randomly assigned participants to the order of conditions (with and without a cellular phone) to control for the treatment effect. While taking the test under the no cellular phone condition, participants had no distractions. With the cellular phone condition, participants were asked a predetermined list of questions over the phone while they completed the task. (Note: the questions used in study 1 also were used here.) All tests were administered using an identical obstacle course and the same set of questions in the cellular phone use condition. After each test was completed, the course was reconstructed to preset specifications to ensure consistency in the challenge of the course. As in study 1, participants completed a survey of demographic data, as well as their habits and attitudes toward the use of cellular phones while driving.

Results

Forty undergraduate students, ranging from age 18 to 23, volunteered to complete this study. Twenty-eight participants were men and 12 were women. Participants were recruited by the researchers in the lobby of a residence hall to complete the trial in a nearby lounge.

The mean score (i.e., number of obstacles hit or boundaries crossed) under the no cellular phone condition was 4.53, whereas during the cellular phone use condition, the mean score was 5.15. There was a significant increase of .62 points (12%) in the score between the two conditions. A *t*-test confirmed that reaction times were significantly poorer when participants were using a cell phone (t=8.3, p=.000).

We also examined the relationship between gender and test performance. Under the no cellular phone condition, the mean score for men was 3.5, whereas women scored 6.92 on average. The same relationship can be seen under the cellular phone use condition; men scored a mean of 3.96 and women scored a mean of 7.92. *T*-tests were performed comparing men and women, confirming that women had poorer reaction times both using the cell phone (t=-2.9, p=.01) and not (t=-2.8, p=.01).

Of the 40 participants, 55% (n=22) owned cellular phones and 75% (n=30) reported using a cellular phone while driving a motor vehicle. Twenty-eight percent (n=11) of the participants reported using cellular phones daily while driving. Forty-eight percent (n=19) of the participants felt distracted while driving and using a cellular phone, and 90% (n=36) of the participants believed that driving while using a cellular phone is dangerous.

DISCUSSION

These studies demonstrated a clear and consistent pattern of slower reaction times and poorer performance while using a cellular phone among young adult men and women. In study 1 the increase in reaction time was greater for the auditory cues than for the visual cues. We suggest that this may be due to the use of hearing as a primary tool in conducting a conversation over the cellular phone. In study 2, women had significantly poorer performance than the men both with and without the cellular phone condition. A plausible reason for this is that the men may have had more previous experience using a remote controlled car than did women. In both studies a majority of the participants reported using cellular phones while driving, yet also believed that this was a dangerous practice.

This study had two important limitations; therefore, the results should be interpreted cautiously. First, we were unable to test students while they drove a motor vehicle and cannot be certain of the degree to which our results apply to driving. Second, the sample sizes were small, and students self-selected to participate. Those who chose to participate may have been significantly different from the rest of the student body in their outcomes.

The implications of this data for the use of a cellular phone while driving a motor vehicle are important. Although we could not conduct a study in which participants were driving cars, we believe that our studies measured basic skills that are transferable to the experience of driving a car. Drivers must be able to respond quickly to visual and auditory signals, and they must have good eye/hand coordination, both of which were measured in our studies. Health educators at the high school and college level should be aware of the threat to personal and public safety posed by cellular phone use while driving and address the practice with students through the health/safety curriculum and other educational channels in their institutions. The methods used in our studies were inexpensive, safe, brief, and interesting for the participants. Educators may find it useful to replicate these activities with their students to reinforce their learning.

REFERENCES

Activity: Sight vs. Sound Reflexes. (2001). Retrieved Jan-Feb 2002 from www.explorescience.com/often often activities/activity_page.cfm?activityID=38.

Haigney, D. & Westerman, S. J. (2000). Mobile cellular phone use and driving: A critical review of research methodology. *Ergonomics*, *44*, 132–144.

McKnight, J. & McKnight, A. S. (1991). *The effect of cellular phone use upon driver attention.* Retrieved April 2001 from www.aafts.org.

Moore, L. R. & Moore, G. S. (2001). The impact of cell phones on driver safety. *Professional Safety*, *46*, 30–33.

Redelmeier, D. A. & Tibshirani, R.J. (1997). Association between cellular-telephone calls and motor vehicle collisions. *New England Journal of Medicine*, *336*, 453–458.

Strayer, D. L. (2001). Driven to distraction: Dual-task studies of simulated driving and conversing on a cellular telephone. *Psychological Science*, *12*, 462–467.

Violante, J. M. & Marshall, J. R. (1996). Cellular phones and traffic accidents: An epidemiological approach. *Accident Analysis & Prevention*, *28*, 265–270.