INFLUENCE OF MOBILE PHONE USE WHILE DRIVING
— The Experience in Taiwan —

T. Hugh WOO, Ph.D., P.E.
Associate Professor
Dept. of Transportation
National Chiao Tung University
Hsinchu, Taiwan

Jawkuan LIN, Ph.D., P.E.
Associate Professor
Dept. of Urban Planning
Feng Chia University
Taichung, Taiwan

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Many recent investigations and reports revealed that mobile phone use while driving may seriously affect traffic safety. The increase rate of mobile phone ownership in Taiwan was the first among Asian countries for year 2000, with about 4 sets per 5 persons. A study was initiated by the Ministry of Transportation and Communications to examine and investigate the influence of mobile phone use while driving in order to determine the legislation needs. Data were collected in four areas: driving reaction test using a simulator, accident reports, questionnaires to drivers involving an accident, and a general public opinion survey.

It was found from the driving simulator test that the reaction time for drivers using mobile phones is significantly longer. Age and gender were also found to affect the reaction time. For a four-month period in three selected cities, 3,075 accident reports were examined to reveal that either involved driver carried a mobile phone in 676 cases, and either involved driver was using it in 133 cases. Unsurprisingly, drivers who do not own mobile phones are more inclined to support the ban of using mobile phones while driving. Although the majority of the general public is aware of the adverse effects of using a mobile phone while driving, only 44.2 percent of the responders support a legislative ban.

Based on the conclusions of this study, the Legislative Yuan of Taiwan passed a law to ban the use of handheld mobile phones while driving in January 2, 2001. For a compulsory three-month campaign, the regulation will be in force from September 1, with a violation fine of NT$3,000 (approximate to US$90) for drivers and NT$1,000 for motorcyclists.

Key Words: Driving simulation, Mobile phone, Traffic safety, Reaction time

1. INTRODUCTION

To drive safely, a driver needs to pay attention to the driving task. Even a momentary distraction can lead to a crash. The distraction can be caused by anything that draws the driver's attention away from the road. Based on a 1996 National Highway Traffic Safety Administration study, the agency estimates that driver distraction in all of its various forms probably contributes to between 20 and 30 percent of all crashes. Exact statistics may never be known due to the difficulty of determining driver actions prior to a crash[1].

One of the most popular innovations in automotive travel in the past decade has nothing to do with the automobile itself, the people who drive them, or the roads over which they operate. Rather, it is the ability to carry on telephone conversations while driving. What CB radios were to the '70s, mobile phones were to the '80s. From early 1984, when the first complete systems became operational, the number of mobile phone users has grown dramatically. While mobile phones are really elements of communication rather than transportation, their potential impact on the latter is sizable. There is little doubt that using a mobile phone while driving can distract the driver from the task of driving safely. This potential problem will have an increasing impact on road safety as more mobile communications devices appear in vehicles in traffic. As of the end of year 2000, the ownership of mobile phones has reached 802 sets per 1,000 persons in Taiwan. A major concern is that a distracted driver may not notice or compensate for other driver's unsafe behaviors on the road, increasing the risk of a crash. Indeed, previous research and statistics from around the world have shown that drivers who use mobile phones while driving have impaired driving performance.

1.1 Mobile phone and safety

An early study by Brown, Tichner and Simmonds[2] found that use of the telephone while driving had little effect upon routine driving skills, but did impair the perception of gaps in traffic. A study by Stein, Parseghian and Allen[3] investigated lanekeeping and found significant degradation when placing phone calls during straight driving or on curves. Brookhuis, De Vries, and De Waard[4] found that placing mobile telephone calls reduced mirror checks in light traffic, slowed responses to headway changes, and increased the variance of steering wheel movements. Concern over mobile phone use in cars is growing. Violanti and Marshall[5] indicated that talking

more than 50 minutes per month on cellular phones in a vehicle was associated with a 5.59-fold increased risk in a traffic accident. In the United States, eleven states now ask patrol officers to determine if phones were factors in traffic accidents. Since 1995, 37 states have considered curbs on mobile phones in moving vehicles. So far only minor restrictions have been adopted by California, Florida and Massachusetts. The number of traffic accidents caused by drivers using mobile phones during the 12 months after the Road Traffic Law was revised in November 1999 to ban mobile phone use while driving fell 52.3 percent from the previous 12 months to 1,351 in Japan, according to a National Police Agency survey[6].

1.2 Age-related effects

The attentional processes that must be shared when placing, receiving, or carrying on telephone conversations while driving are known to be vulnerable to age-related effects. The ability to share attention, as between the phone and the road, has demonstrated a relationship to age in studies by Craik[7], Parkison, Lindholm and Urell[8], Temple[9], and Ranney and Pulling[10]. The studies by Kahneman[11], and Mihal and Barrett[12] also found declines in selective attention to be associated with over-representation in accidents. The study by Stein, Parseghian and Allen[3] indicated that older drivers showed greater performance degradation than younger drivers when placing phone calls whilst driving. McKnight and McKnight[13] concluded that significant age differences of nonresponse appeared when drivers were exposed to various distractions. Alm and Nilsson[14,15] have found that the difference in reaction time caused by mobile phone use for elderly subjects was significantly longer than that for younger subjects.

1.3 Purpose of the study

The purpose of the study described in this paper was to assess the effect of telephone use on the driver's ability to meet the perceptual and cognitive demands of the highway traffic environment. Specifically, it attempted to answer the following research questions:

1. What effect does placing calls have upon perceptually mediated responses to traffic situations?
2. How do these effects vary across highway traffic situations?
3. How do any of these effects vary with gender or age?
4. How do the general public recognize the issue?
5. What is the seriousness of this issue in selected cities?

2. METHODS AND DESIGNS

The independent variable under study was distraction. In this discussion, the term "distraction" refers to a diversion of attention from driving produced by some situations. The situation of primary concern is, of course, use of a mobile telephone. The mobile phone itself involves minimum distraction. The only time a driver is distracted by the apparatus is during the act of placing and/or receiving a call. There is evidence that when people focus their attention upon one stimulus, they may fail to perceive another stimulus separated from the first but by a few degrees of visual angle. To assess the effect of placing a call upon driver attention, subjects were required to dial a number given to them by the test staff and start a conversation. To gauge the effect of various acts in distracting attention, we need to be able to compare them with a condition that offers no distraction, that is, simply driving the car.

Because of the ethics of testing drivers in actual traffic on public roads, the study was conducted on an established driving simulator, which was made up of a screen, a driver's seat, a steering wheel, an accelerator pedal, a braking pedal, and a computer. In the study, participants 'drove' the simulator along a simulated road with a handheld mobile phone in hand and holding a conversation with one of the test staff. The test was repeated once again without either holding a mobile phone or a conversation. The performance of concern in the present study was the driver's perception of those elements of the traffic environment that require the driver to do something. Of primary concerns are those situations in which the driver must do something to prevent an accident. Participants were instructed what situations they should expect and the reaction they should take is to apply the brake. The greater the distraction from a mobile phone, the longer it would take for a response to be initiated. The response measure employed was the reaction time that took the driver to properly respond, which was recorded by a computer. The effect of the distraction upon the driver's perceptual and cognitive functioning would be assessed by studying how quickly people respond to various traffic situations. Five different traffic situations randomly appeared on the screen, namely signal change, obstacles falling in front, pedestrian intrusion from roadside, vehicle cut-in from an adjacent lane, and abrupt braking of a leading vehicle. A total sample of 390 participated in the experiment. Subjects for the study were recruited at populated locations, such as a park and a museum, in

Table 1 Average reaction time and standard deviation in response to various traffic situations

Traffic situations	Using mobile phones		No distraction		Difference
	Average time	S.D.	Average time	S.D.	
Signal change	1.13413	0.54920	0.79677	0.29650	0.33736
Obstacle falling	1.69328	0.91416	1.06023	0.34829	0.63305
Pedestrian intrusion	1.13551	0.45322	0.85469	0.27248	0.28082
Vehicle cut-in	1.40727	0.58016	1.02063	0.32906	0.38664
Abrupt braking	1.40097	0.82519	0.90103	0.28299	0.49994

Taichung city.

To further investigate the role of mobile phone use in car crashes, three cities were selected to append to their accident reports two extra items, which indicated whether the involved drivers carried or used a mobile phone when the accident happened. For a period of 4 months, 3,075 accident records were collected.

In order to probe the potential involvement of mobile phones in actual crashes, 1,000 questionnaires were sent to drivers who had been recorded as involved in an accident before. Questions include responders' mobile phone use while driving, and their perception to its effects and safety. The same questionnaires were used to interview the general public. A total sample of 500 was interviewed.

3. ANALYSIS AND RESULTS

The analysis involved comparing either mobile phone use or not in responding to various traffic situations. As some participants did not successfully complete all five traffic situations, the process of data reduction was carried out. Results for 350 out of the 390 participants were identified valid and analyzed, and consisted of 230 males and 120 females. The overall level of distraction by the mobile phone use while driving was highly significant for all five traffic situations as shown in Table 1. Results indicated that mobile phone use increased the length of time needed in response to various traffic situations by 0.28 seconds for pedestrian intrusions ($t = 10.84$; $df = 698$; $p < 0.01$) to 0.63 seconds for obstacle falling ($t = 12.11$; $df = 698$; $p < 0.01$). Figure 1 presents the mean reaction time for both scenarios under five traffic situations.

In general, females take more time to respond to various traffic situations when mobile phones were not in use. The only exception under the situation is that a vehicle from the adjacent lane cuts in, where male drivers took 0.03 seconds more than female drivers did. When it comes to which gender tended to be distracted more by mobile phone use, the results showed that females consistently increased more reaction time than males did for all traffic situations. Nevertheless, only the situation of an obstacle falling evidenced marginal significance ($t = 1.515$; $df = 348$; $p < 0.07$) with females showing more distraction. However, it should be noted that whether it is due to a difference in physical function or in driving experience among male/female was not tested. Figure 2 and Figure 3 show the reaction time by gender for both scenarios.

It is evident from Figure 4 that the older the driver, the longer the reaction time ($F = 30.21$; $df = 4, 16$; $p < 0.01$). Although mobile phone use had an overall effect to increase reaction time, turning to the difference among various age groups, we see that what the results seem to say is that the older drivers were very cautious to any roadside

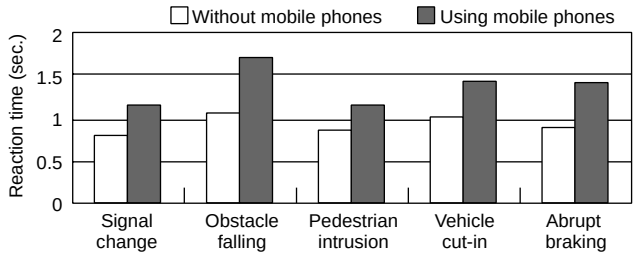

Fig. 1 Effects of mobile phone use on reaction time

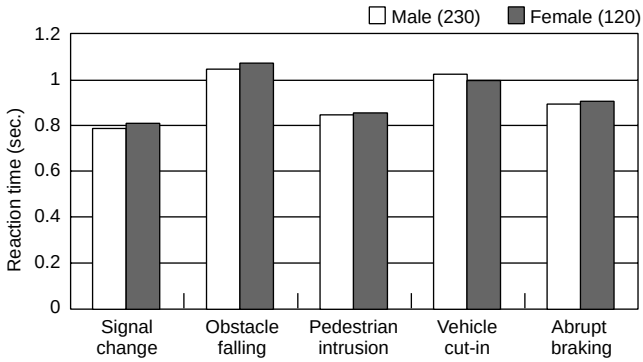

Fig. 2 Normal reaction time by gender

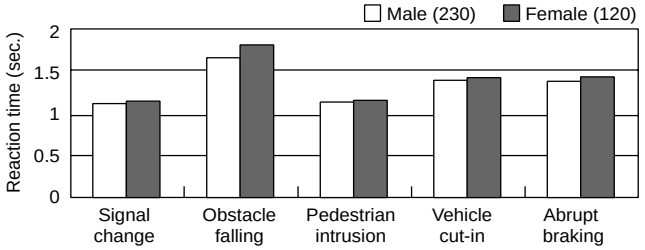

Fig. 3 Reaction time using mobile phones by gender

pedestrians, who might intrude anytime. The age differences are significant for mobile phone use ($F = 17.93$; $df = 4, 16$; $p < 0.01$). Figure 5 displays the results.

3,075 accident records were collected during the study period from the three cities selected, namely, Taichung, Changhua, and Hsinchu. Table 2 shows that 4.3 percent of accidents involved drivers using a mobile phone (133/3,075), and among drivers who carried a mobile phone and were involved in an accident, nearly 20 percent were using their mobile phones when the accidents occurred. A NHTSA survey, completed in January 2001, found that 54 percent of motor vehicle drivers in the United States usually have a mobile phone in their vehicles or carry mobile phones when they drive. Almost 80 percent of these drivers leave their mobile phone turned on while driving, and 73 percent report having talked on the phones while driving[1].

The return rate of questionnaires from those involved in crash was unexpectedly low. As a result, only 56 were received. Among the respondents, 29 owned a mobile phone, and 4 of them reported experiencing accidents caused by mobile phone use. 50 percent of the respondents supported a legislative ban of using mobile phones while driving.

For the 500 interviewed general public, 76.8 percent recognized that mobile phone use while driving had significant adverse effects on safety. However, only 44.2 percent supported a legislative ban, with another 19.4 percent expressing their indifference.

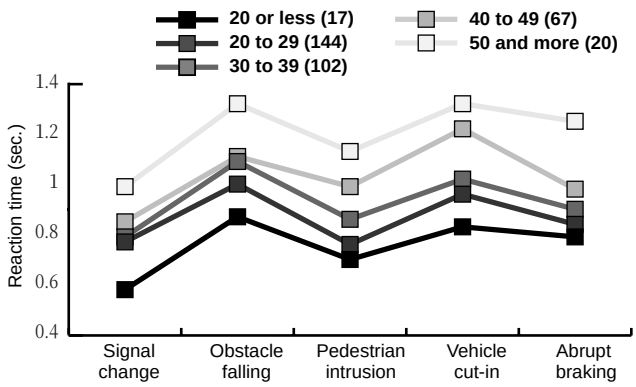

Fig. 4 Normal reaction time by age

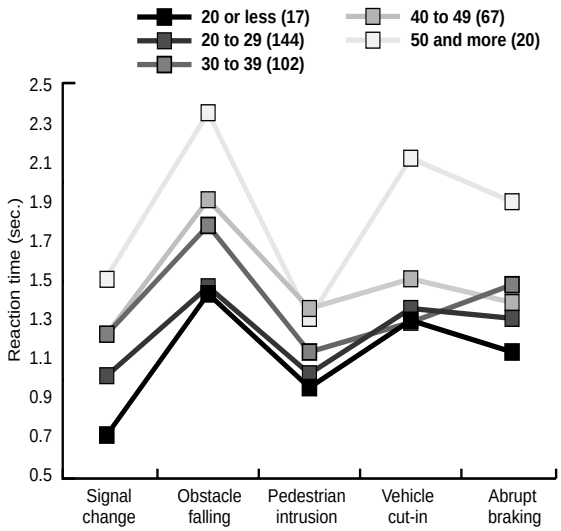

Fig. 5 Reaction time using mobile phones by age

Table 2 Accidents caused by using a mobile phone in three cities

Cities	Taichung	Changhua	Hsinchu	Total
Total accidents	2,149	163	763	3,075
Carrying a mobile phone	216	17	443	676
Using a mobile phone	40	0	93	133
Possible cause rate	18.5%	—	21%	19.7%

4. CONCLUSIONS

4.1 Conclusions

From the results of the study that has been described in this paper, the following conclusions may be offered.

1. The study showed that drivers were less responsive when they were having a conversation over a handheld mobile phone.
2. Female drivers were more adversely affected by mobile phone use than male drivers when faced with obstacles falling in front.
3. Older drivers were more adversely affected by mobile phone use than younger drivers.
4. Selected accident records revealed that 20 percent of mobile phone carrying crashes were caused by the use of mobile phones.

5. The majority of the public in Taiwan recognized the adverse effects of mobile phone use upon driving safety, whereas less than half supported a legislative ban.

4.2 Discussion

Every new technology introduced into a society causes problems, or perhaps it is better to say that it has effects that inflict change on our everyday relationships and create friction. It takes time to adapt and develop the appropriate ethics to go with them. The mobile phone is no exception and, since so many people are using them now, they are a major source of concern. One of the strongest points used by legislators in pushing through laws against mobile phones is that the phone is a different kind of distraction. It is more demanding. Distractions such as navigation systems, the radio, passengers chatting, can be managed by the driver. The mobile phone, on the other hand, can ring at any time, and there may be a sense of importance or urgency in a phone call that drastically disturbs the driver's ability to attend to matters in traffic. The greatest overall deficit in ability to respond to highway traffic situations while distracted was experienced by older subjects. Among older drivers, whose attention-sharing abilities might already be in decline, any use of the mobile phone during attention-demanding situations seems potentially hazardous.

Taiwan police statistics showed that during the eight months ending in March 2001, 2,407 traffic mishaps were caused by the use of mobile phones by drivers. Nine deaths and 354 injuries were involved with handheld mobile phones, while five deaths and 89 injuries were caused by handsfree phones[16]. It is clear that the effect of mobile phone use upon operation of automobiles is not confined to the direct interference involved in attempting to handle phone equipment and is therefore not a concern that will disappear with widespread adoption of handsfree system. While a growing list of countries are passing legislation against mobile phone use while driving, and particularly against handheld phones, the Legislative Yuan of Taiwan passed a law in January 2, 2001 to ban the use of handheld mobile phones while driving. For a compulsory three-month campaign, the regulation will be in force from September 1, with a violation fine of NT$3,000 (approximate to US$90) for drivers and NT$1,000 for motorcyclists. For safety purposes, the public needs to be informed about the possible problems that can occur when using a mobile phone on the road and the best ways to use their phone to reduce the risk of an accident.

Telematics suppliers claim that they already have the capability of loading up a vehicle with sensors that gauge everything from wheel speed to weather and traffic conditions. If the vehicle senses heavy traffic and bad weather, it can be programmed to block access to mobile phone calls or Internet use. But there is still a question about how an independent-minded public would react to such internal policing. Legislation and enforcement may be given a second thought.

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