

Using Mobile Phone While Driving: a Simulator Study of A Dual-Task Condition

Mostafa Pouya Kian, PhD Student

Occupational Health Department, Tarbiat Modares University, Tehran, Iran

Hassan Asilian Mahabadi*, PhD

Occupational Health Department, Tarbiat Modares University, Tehran, Iran

Seyedeh Monavar Yazdi, PhD

Psychology Department, Alzahra University, Tehran, Iran

Ebrahim Hajizadeh, PhD

Biostatistics Department, Tarbiat Modares University, Tehran, Iran

Ali Nahvi, PhD

Mechatronics Group, K.N. Toosi University of Technology, Tehran, Iran

Objectives: Most studies have performed to identify the affective variables in using mobile phone by drivers based on interview and questionnaire. In this study call answering rate while driving was investigated in a sample of male postgraduate students of a university in Tehran by a driving simulator.

Method: Six driving scenario designed differing in risk of driving. Answer rate to mobile phone calls during observation of driving scenarios were recorded.

Results: Logistic regression models revealed that participants perceived two-way roads and high speeds more risky than one-way roads and low speeds. Also, results indicated that decision to answer to calls while driving is ruled by personality trait than difficulty of driving scenario or age.

Conclusion: drivers in all ages and experiences and different driving scenarios may decide to start answering mobile phone while driving. Traffic safety campaigns against using mobile phones on roads should be focused on personality trait of drivers.

Keywords: Driving, Dual-task, Mobile phone, Sensation seeking, Simulator

Introduction

Levels of ownership and use of mobile phones has risen exponentially over the past decade in all parts of the world. Driver distraction is recognized as being one of the central causes of road traffic incidents and mobile phones are tangible devices (among many other electronic devices) that can distract the driver through changes in workload (1). Using mobile phones can cause drivers to take their eyes off the road, their hands off the steering wheel, and their minds off the road and the surrounding situation. It is this type of distraction – known as cognitive distraction – which appears to have the most important impact on driving behaviors (2).

Researches on the effects of using mobile phone on driving performances have received significant attention during the past decade. Epidemiological studies show that there is a clear relationship between using mobile phone and traffic incidents. Violanti and Marshall (1996) conducted one of the first investigations in this field of study. They

examined the association of mobile phone use in motor vehicles and traffic accident risk using an epidemiological case-control design and logistic regression techniques. Results indicated that talking more than 50 minutes per month on mobile phones in a vehicle was associated with a 5.59-fold increased risk rate in a traffic accident (3). In another study, Violanti (1998) showed an approximate nine-fold increased risk for a fatality given the use of mobile phone (4). Newer surveys in Australia (5), Canada (6), New Zealand (7, 8) and Norway (9) show that there is a dose-response relationship between the frequency of mobile phone use and crash risks. In Iran, Ghorbanali (2011) investigated the prevalence of mobile phone and seat belt use in driving in college students aged 18-24 years in Kerman. He concluded that unbelted or using mobile phone participants were more involved in accidents in the last three years. This study also revealed that 19% of male and 4.2% of female drivers considered using mobile phone in driving not hazardous.

*All correspondences to: asilia_h@modares.ac.ir

A large number of behavioral studies have now shown that performing another cognitive task while driving an actual or virtual car (driving simulator) substantially degrades driving performance (10). Experimental studies using driving simulators have provided some evidences for this subject. These studies address driving performances like brake reaction time, eye field of view and mental workload. Haigney *et al.* showed that the use of a hand-held mobile phone (when compared to a hands-free system) was associated with poorer driving performance (11). Other authors reported same results about decrement of driving performances in drivers who use mobile phone while driving (12-19).

Talking on mobile phone is banned or restricted in many countries around the world. But surveys show that mobile phone has constrained itself into the cars. Observational surveys indicate drivers commonly use mobile phones and that such use is increasing. Drivers report they usually use hand-held phones (20). A survey by the National Highway Traffic Safety Administration (NHTSA) reveals that almost 9% of all vehicles in the United States are driven by drivers that use some type of phone (hand-held or hands free) (21).

Authors have attributed using mobile phone while driving to many reasons. Age, gender, driving experience, risk perception, attitudes, norms and some other psychological and socio-cultural factors have been mentioned as reasons that rules driver behaviors about mobile phone. Most of studies have performed to identify the affective variables in using mobile phone by drivers based on interview and questionnaire. In this study call answering rate while driving is investigated in a sample of male postgraduate students of a university in Tehran by a driving simulator. We examined the effect of age, driving experience, sensation seeking and educational level in answering rate of participants to mobile phone calls in observational driving scenarios. We wanted to test our hypothesis about the research objectives: answer to mobile phone call while driving is influenced by individual factors.

Materials and Methods

Participants

Forty-two male postgraduate students of Tarbiat Modares University participated in experiments. Being in 23 to 35 years of old and at least 3 years of driving experience were the main inclusion criteria. Also, Participants must be in good mental health

condition and do not have the habit of computer car racing games. All participants were reimbursed for their participation in the study.

Equipments

Pride CI 302 Semi driving simulator located in virtual laboratory of Mechanical Engineering Faculty in K.N.Toosi University of Technology is used in this study. The platform of Simulator was static and scenarios projected on a screen located in 2 meters in front of simulator. Driving simulator used in this study is shown in figure 1.



Fig. 1. Driving simulator Pride 302 CI Semi

Suburban One-way and two-way roads were selected and designed as virtual driving environment. One-way road space and two-way road space are displayed in figures 2 and 3. Scenarios designed and created using 3DVIA Vritools® software. Six observation scenarios differing in the degree of difficulty were designed. Type of road (one-way or two-way) and car moving speed were different in each scenario.

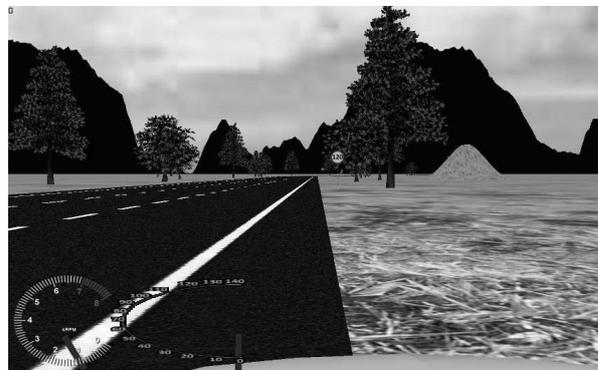


Fig. 2. One-way road scenarios environment

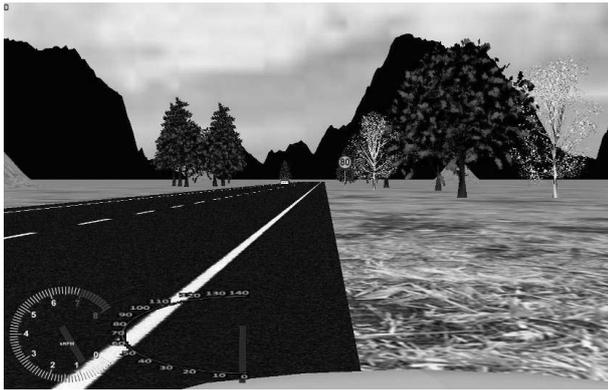


Fig. 3. Two-way road scenarios environment

In three scenarios, the simulator car was moving in a one-way road in three different speeds (20 km/h, 50 km/h and 80 km/h) and in three other scenarios the simulator car was moving in a two-way road and in the same speeds as in one-way roads. In the start of each scenario the simulator car was moving with a constant speed (20 km/h, 50 km/h and 80 km/h). Mobile phone ringtone was played four times in each scenario and participant's answer (accept call or reject call) is recorded. NOKIA® standard ringtone is used in experiments. Also, a button was installed on dashboard to use as mobile phone call answer button.

Experiment methods

Participants were provided information about the tests. Then they sat at the simulator wheel and observed the six scenarios. Scenarios were played in random order and each scenario was played once. Participants were blind about speed of the moving car. While the scenario started to play and after the mobile phone rang, they were asked to answer this question that if they were the driver of the simulator car, do they feel safe to drive and answer the mobile phone call under observed circumstances simultaneously (speed, distance and road type)? Mobile phone ringtone was played twice and participants were free to answer the call with pushing or not pushing the button on dashboard as their decision. Ringtone was turned off if the participant did not decide to answer the call.

Decisions of participants were recorded in each scenario. At the end of tests participants were filled a Persian version of Zuckerman's Sensation Seeking Scale questionnaire.

Results

Participant's characteristics

Mean and standard deviation (SD) of age and

driving experience of forty-two male participants were 26.2 (3.03) and 5.9 (2.6) years, respectively. Mean of sensation seeking score was 22.7 with 5.1 of standard deviation. 78.6% of participants were Master of Arts and Master of Science students and 21.4% were Ph.D. students.

Call answering rate while driving

Participant's decisions to answer or not the mobile phone call were recorded in 6 scenarios differing in road type and speed. The Percentage of answering to mobile phone calls in speeds and roads is shown in figure 4.

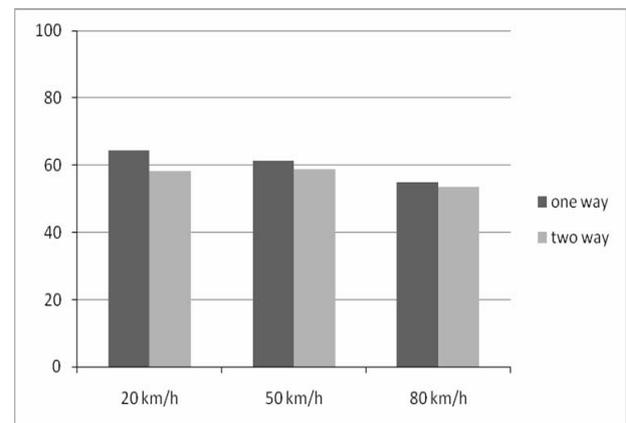


Fig. 4. Percent of answering to mobile phone call in speeds and roads

As shown in figure 4 answering percentage in one way roads were slightly higher than two-way roads. Also, answering percentage in low speeds was higher than high speeds. Answering percentage was decreased as car speed increased. 61.3%, 60.1% and 54.2% of participants decided to answer mobile phone calls in 20 km/h, 50 km/h and 80 km/h, respectively.

Answering percentages reveal that driving with 20 km/h in one-way road is perceived as easiest driving scenario and driving with 80 km/h in two-way road is perceived as most difficult driving scenario by participants. As expected participants perceived two-way roads as more risky than one-way roads. Thus, answering rate in two-way scenarios is lower than one-way scenarios in all speeds.

Prediction of answer to mobile phone call

Logistic regression analysis in 95% of confidence interval (table 1) showed that sensation seeking can predict participant's willingness to answer the mobile phone call while driving. The effect of type of scenario on answering phone calls was not statistically significant. Also, the effect of age in

participant's decisions was not significant. It seems that driving experience and education level could be predictors of answering call while driving because their p value (0.067 and 0.082) is very close to 0.05. Wald statistic was significant for sensation seeking score in $p < 0.05$ ($B = 0.029$, $p = 0.024$). As the driving experience increased tendency to answer mobile phone calls while driving increased (Exp

(B) = 1.052) and as the educational level increased, tendency to answer calls decreased (Exp (B) = 0.662). Findings showed that there was a direct and straight relationship between sensation seeking score with tendency to answer to call while driving. Probability of answer to mobile phone call is 1.03 times greater with one unite increase in sensation seeking score.

Table 1. Logistic regression of predictive varibale of answering to call while driving

Predictor	B	p	Exp (B)	95% C.I. for EXP(B)	
				Lower	Upper
Scenario (2 way 20 km/h=1)		.350			
2 way 50 km/h	.025	.911	1.025	.662	1.578
2 way 80 km/h	-.196	.376	.822	.533	1.269
1 way 20 km/h	.255	.260	1.290	.828	2.009
1 way 50 km/h	.126	.575	1.134	.731	1.759
1 way 80 km/h	-.147	.506	.863	.559	1.333
Sensation Seeking Score	.029	.024	1.030	1.004	1.056
Driving experience	.051	.067	1.052	.997	1.111
Education Level	-.412	.082	.662	.416	1.054
Age	-.004	.909	.996	.933	1.064
Constant	-.432	.642	.649		

Logistic regression analysis revealed that type of scenario and age cannot predict driver's decisions about mobile phone calls. Instead, sensation seeking, driving experience and education level can predict the behavior.

Discussion

The purpose of this study was to investigate the impact of driving difficulty on driver's decisions to answer mobile phone call while driving in an experimental setting. We found that driving scenarios designed in this study cannot predict driver's behavior toward mobile phone. Though answering rate was lower in two-way roads and high speeds than one-way roads and low speeds, but these differences were not statistically significant. It means that chance of answering mobile phone call doesn't change by changing driving scenario.

Driving risk in one-way and two-way roads is different. So, we expected to have a significant difference in answering frequency in one-way and two-way roads. This finding can be attributable to this reason that drivers perceive their driving skills and capabilities regardless of type of road they drive on. This means that drivers suppose their capabilities are consistent with driving safe in all kind of roads. Therefore it can be concluded that car moving direction (cars in the same direction or in the opposite direction) doesn't have considerable effect on driver's perceived risk.

Another prominent finding of this study is that personality traits have major role in defining driver's behavior. As expected, divers who are more thrilled like to put themselves in risky situations. This finding is in line with findings of two other research works (22, 23). In this point of view, logistic regression analysis showed that, overall, sensation seeking significantly accounted for driver's willingness to answer mobile phone calls above and beyond variables like age and different type of driving scenario.

Driving experience and education level showed nearly significant effect on answering rates. In our study it has been shown that experienced drivers are more probable to use mobile phone while driving (8) and less experienced drivers tend to not do so (24). More driving experience results in more self-confidence. Therefore, experienced drivers perceived risks lower than inexperienced individuals and tend to do concurrent tasks while driving. On the other hand, answering probability between Ph.D. students was lower than M.Sc. and M.A. students. This can be attributed to more wise attitudes of Ph.D. students toward driving safety. The effect of educational level on using mobile phone while driving should be investigated in a wide-range sample of drivers including young and old undergraduate drivers and young and old postgraduate drivers. So, our findings about the effect of educational level should be used carefully.

Limitations of study

There were two main limitations. First, study was performed on young (23-35 years old) male drivers. There was not possibility for participation of female students in study. Study on a good sample of male and female participants can lead to more rigorous results. The effects of some important variables are not considered in the study for time and design limitations. For example, driving styles and strategies are different in urban and suburban roads. Urban roads are not studied in this research. Traffic density on road was steady and was not changed in scenarios. This variable is an important factor that can change driver's decision on answering mobile phone while driving. Importance of call and person on the line is another important factor that strongly affects driver's intentions in answering calls while driving.

The second limitation of this study refers to the experimental design. There are some variables that have prominent impact on answering intentions of drivers. Traffic density and importance of call are two variables that are not considered in our study because of time and budget restrictions.

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Conclusion

Many studies have used questionnaires and interviews as data gathering tools for investigating the reasons underlying driver's decision to use mobile phone while driving. But, these methodologies have their substantial weaknesses. Simulator studies have shown their benefits in indentifying driver's behavior in past decades. Therefore, we used this methodology to study of driver's decision making mechanisms in different scenarios differing in risk. According to our findings, we concluded that answer to mobile phone calls is more related to personality traits like sensation seeking than objective risk of driving environment. As a result, traffic safety campaigns against using mobile phone on roads should be focused on personality trait of drivers.

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