MOBILE PHONE USE DURING DRIVING: EFFECTS ON SPEED REDUCTION AND EFFECTIVENESS OF COMPENSATORY BEHAVIOUR

Pushpa Choudhary
Research student, Transportation systems engineering,
Department of Civil Engineering,
Indian Institute of Technology (IIT) Bombay
Powai, Mumbai-400 076, India
Tel: +91-22-2576-4348; E-mail: pushpa11choudhary@gmail.com

Nagendra R Velaga (Corresponding Author)
Assistant Professor, Transportation systems engineering,
Department of Civil Engineering,
Indian Institute of Technology (IIT) Bombay
Powai, Mumbai-400 076, India
Tel: +91-22-2576-7341; E-mail: n.r.velaga@iitb.ac.in

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ABSTRACT

This study analysed and modelled the effects of conversation and texting (each with two difficulty levels) on driving performance of Indian drivers in terms of their mean speed and accident avoiding abilities; and further explored the relationship between the speed reduction strategy of the drivers and their corresponding accident frequency. 100 drivers of three different age groups (young, mid-age and old-age) participated in the simulator study. Two sudden events of Indian context: unexpected crossing of pedestrians and joining of parked vehicles from road side were simulated for estimating the accident probabilities. A multiple linear regression model for mean speed and a binary logistic regression model for accident probability were developed. Results of the models showed that in the presence of conversation and texting, drivers significantly compensated the increased workload by reducing their mean speed by 2.62 m/s and 5.29 m/s respectively. Logistic models for accident probabilities showed that the accident probabilities increased by 3 times and 4 times respectively when the drivers were conversing or texting on a phone during driving. Further, the relationship between the speed reduction patterns and their corresponding accident probabilities showed that all drivers compensate differently; but, among all the drivers, only few drivers, who compensated by reducing the speed by 30% or more, were able to fully offset the increased accident risk associated with phone use.

Keywords: *Distraction, Conversation, Texting, speed, accident probabilities, compensatory behaviour.*

INTRODUCTION

Driver distraction is defined as a situation when an explicit activity competes for driver's attention; and it has been identified as one of the major contributed factors to the accidents *(1)*. The main sources of driver distraction inside the vehicle are: mobile phone use (for conversing and texting), conversing with passengers, eating, operating in-vehicle digital devices (e.g., radio, CD-player etc.) while driving. Among all these distraction sources, mobile phone use is quite prevailing *(2)*. In a cross-sectional study conducted at 11 intersections in Alabama (US), it is shown that phone conversation during driving was the cause for 31.4% of the distracted driving *(3)*. Similarly, it is reported that 14.1% and 3.4% of the drivers use mobile phone during driving in Spain and the United Kingdom respectively *(4, 5)*. This increased prevalence of phone use during driving has caused considerable number of accidents. For instance NHTSA reported that mobile phone use during driving caused 12% of fatal crashes and 6% of injury crashes of all distraction affected crashes in United States in 2014.

As the driver's attentional resources are limited, if a driver attempts to perform any secondary task, then the reallocation of the attentional sources may lead to deteriorated driving performance; this is measured in terms of mean speed *(6)*, reaction time *(7)*, situation awareness *(8)* and lateral control *(9)* etc. But, research suggests that all these changes in performance may not be truly impairment; in fact these are the outcomes of driver's conscious or unconscious compensatory behaviours adopted for reducing the increased workload *(10, 11)*. Mainly observed compensatory behaviours are: reduction in speed *(10)*, change in the relative attention given to the driving task *(11)* and maintaining larger headways from the front vehicles *(12)*. Among all these compensatory measures, driver's behaviour alteration is generally seen in driver's mean speed selection during distracted driving conditions *(6)*. The speed of a driver is considered as one of the most important factors which influence the accident occurring probability as well as severity. Therefore, any alteration in the speeding behaviour during distracted driving also affects the accident risk involved in driving.

Though distraction effects of phone use on mean speed and situation awareness are investigated by various researchers in the last two decades *(7, 13)*, very few studies have focused on both conversation and texting tasks. Moreover effect of complexity levels of phone use is also not being studied well. Therefore, the present study investigates and statistically models the impact of distraction due to both conversation and texting (each with two difficulty levels) on mean speed and accident involvement probability. All the factors such as: demographic characteristics, driving characteristics and distraction conditions, which can affect the driver behaviour are considered in the present study for analysing the performance of drivers. Further, the study aims to analyse how the changes in speed choices of drivers affects the risk of being involved in an accident for a sudden event while being distracted.

STATE-OF-THE-ART LITERATURE REVIEW

Mobile phone use during driving is an ongoing safety problem; and vast literature is available on distraction effects of mobile phone use during driving. Before actually starting the experiment for present study, various literatures have been studied for in-depth understanding of mobile phone distraction effects on driving performance. As, the present study concentrated on mean speed and accident risk associated with phone use, therefore the following subsections of the paper summarize the literature reviewed on distraction effects of mobile phone use on mean speed and accident probability. Then, the identified research gaps are mentioned in the next subsection.

Effect of Mobile Phone Use on Mean Speed

Drivers generally try to compensate additional workload due to any driver distractions (e.g., sending a text message while driving) by reducing their speed *(9, 13)*. In large number of the studies, speed reduction is a commonly documented trend when drivers use mobile phones during driving *(10, 14, 15)*. There exist various factors which can affect driver's mean speed behaviour in distracted and non-distracted driving conditions. Type of the distraction (visual or cognitive) is the most influencing factor for the compensatory behaviour (i.e., speed reduction). The compensatory behaviour of reducing the speed is observed in both: conversation *(15, 16, 17, 18)* and texting *(8,19)*, because in texting task the visual scanning of the roadway gets reduced *(9, 20)* hence texting results in higher workload therefore larger speed reductions are observed for texting while driving conditions *(10, 13 19)*. Some of the studies also accounted for the effect of age on speed of the driver *(21, 22)*. The overall results of these studies show that in distracted driving conditions older drivers tend to drive slower compared to younger drivers. Additionally, it is shown that female drivers drive slowly when compared to male drivers *(6, 15)* in distracted driving conditions. The other widely studied factor which affects the mean speed of the driver is the phone use modality: hands free and hand held, and it has been proven in some of the studies that even the detrimental effects of phone use on lane deviation and situation awareness are equal for both the phone modes; but the effects on speed is more significant for hand-held phones *(18, 23)*. Complexity of road environment also affects the speed of the drivers. It is observed that as the complexity of the road environment increases, the compensation for increased workload also increases i.e. more speed reduction is observed in complex road scenarios such as: urban area *(8, 18)*, windy road *(17)* etc. Further, the interaction effects of these complex scenarios with conversation and texting tasks result in larger amount of speed reduction *(17, 18)*. From above mentioned review of existing literature, it is understood that drivers compensate distractions by reducing their speed for the perceived increased workload in order to maintain the adequate safety levels. But, still it is unclear that whether this speed reduction strategy is actually helping in maintaining the same level of accident risk as present in non-distracted driving.

Effects of Mobile Phone Use on Accident Probabilities

A naturalistic study by *(24)* and a simulator study by *(8)* compared the accident frequencies in distracted and non-distracted driving and found that if the driver's visual attention is shifted away from driving due to phone use, then the accident probabilities increases to 2 times and 8.3 times respectively in comparison to non-distracted driving. The accident risk associated with phone use is assessed in terms of surrogate measures, for example, *(25)* investigated the risk of a safety critical event (SCE) caused by phone use during driving and the results showed significant increment in SCE associated with phone use during driving. One of the possible reasons behind the increased crash rates is that, the drivers are less likely to initiate the deceleration process as they approach hazardous situations when they are conversing over the phone *(14)*. A review study concluded that the reduction in speed is the subconscious outcome of managing the supplementary load produced by phone use but still impairing situation awareness abilities *(12)*.

Research Gap

Overall, the studies have documented the observed speed reduction during distracted driving as a compensating behaviour for the increased workload. It has also been recorded that the speed reduction strategies are not helping in reducing the increased accident risk associated with phone use *(10, 12)*. If the drivers were assumed to drive at the same speed during phone use as in non-distracted driving, their driving performance might become even worse. Hence it can be assumed that the compensation strategy adopted by the driver might be helping in reducing the increased accident risk to an extent. But surprisingly, very little research has been conducted to specifically address the issue of quantifying the effects of speed reduction strategies on the accident risk associated with phone use. Moreover, the effect of complexity levels of the secondary tasks on driver's mean speed is still not very well understood. Though in case of other distractions such as S-IVIS (Surrogate In Vehicle Information Systems), the difficulty level of secondary task has been studied *(9, 26)* but in case of phone use, very few studies have examined the effect of difficulty levels of phone use task (conversation and texting) on drivers' speed and situation awareness *(27,28)*. The other important factor which is not very well studied is that how the phone-use habits of the driver affects the speed behaviour and situation awareness abilities of the drivers. Moreover, most of the studies have performed ANOVA test *(14, 15, 16,)* for finding out the significance of distraction, but very few studies have actually modelled the distraction effects statistically*(8)*.

Most of the research on effects of mobile phone distraction has been conducted in developed countries. An online survey of 527 drivers in India revealed that 82% of the drivers use mobile phone during driving and 31% of these phone users met with accidents *(29)*. Despite this huge prevalence, not much research has been devoted to distraction studies in developing countries, where the traffic and driver behaviour are different from developed countries.

Within these contexts, the present study examines the impact of conversation and texting on the speed of drivers and their situation awareness abilities for responding to the sudden hazardous events. To overcome the above mentioned research limitations, some specific aspects are included in the present study:

1) The hazardous events designed in the simulator for testing the situation awareness of the drivers, are true representative of real world events during driving in Indian context.
2) Both conversation and texting effects are examined for two levels of difficulty.

3) Statistical models (linear regression for mean speed and binary logistic model for accident probability) are developed to test the driving performance.
4) All the factors: demographic characteristics, driving history, phone use habits and different distraction conditions are being considered for analysing the driving performance.
5) More specifically, this study attempts to quantify the extent up to which the speed reduction strategies are able to offset the increased accident risk associated with phone use.

METHODOLOGY AND DATA COLLECTION

The data reported in this study are collected through a driving simulator approach. Scenarios replicating the Indian rural highway road conditions are developed in the simulator for investigating the impact of performing the secondary tasks associated with phone use (texting and conversation, with two difficulty levels: simple and complex) during driving. Mainly two performance measures are analysed in the study: speed and situation awareness in terms of accident involvement probabilities for sudden events. Data is collected for 100 licensed drivers of three different age groups. Following subsections of the paper explain each component of methodology and data collection process.

Driving Simulator

An open cab (fully instrumented) driving simulator shown in Figure 1 was used for the study. In this simulator, a simulated road scenario is displayed in a three LED system which provide a horizontal view of 150^{o}. The simulator is equipped with power steering, brake pedals and gear selector (with manual transmission) etc. and thus exhibits an appropriate vehicle behaviour.

Figure 1 Driving simulator used for the study.

Secondary Task Design

For distracted drives, participants were presented with two types of secondary tasks while driving: conversing and texting on phone. For conversation task, simple questions were asked to the driver (e.g., “Where did you go for your last trip?”). In order to test conversations which demanded more cognitive attention of the driver, a difficulty level in the conversation tasks was presented by asking complex questions like logical puzzle and arithmetic problems *(30)*. For texting tasks, the drivers were instructed to reply in short texts (up to 10 characters) for questions like “What is your favourite colour?” The difficulty level was presented by asking questions which required the drivers to reply in longer texts (more than 10 characters) *(9)*.

Test Scenarios and Events

The driving scenarios used in the present study represented a common road scenario of Indian rural highways. The simulated road environment contained 4-lane (each lane of 3.5 m width) undivided highway, with simple geometric and traffic conditions. Each participant drove for five different driving conditions: normal (without phone use), simple conversation, complex conversation with increased difficulty, simple texting and complex texting with increased difficulty.

Each of the driving case was presented for 3.5 km straight road section. To check the driver's awareness to the sudden events, two different types of events were included: pedestrian crossing from the sidewalk and road joining event by parked vehicles. In the pedestrian crossing event, pedestrians started crossing the road in front of the subject vehicle when it was 130 m away from them and in the road joining event, parked vehicles (a car and a truck) started crossing the road in front of the subject driver in the same manner as stated above in order to join the oncoming traffic stream. The drivers were asked to brake instantly as soon as they see the event happening. If the driver failed to decelerate before the event and collided to the pedestrians or the vehicles involved in the events, then it was considered as an accident.

Participants

In total, hundred licensed drivers who belonged to three different age groups: young (age<30), mid-age (30≤age<50) and old-age (age≥50), took part in the study. Out of the hundred participants, twenty seven participants were professional divers, working in a transport company. A questionnaire seeking details regarding demographics, driving characteristics (experience and instances of crash involvement etc.) and phone use habits (in everyday life as well as during driving) was presented to each of the participants when they came for the experiment. These details of the participants are used as explanatory variables for analysing and modelling the driving performance. Statistical details of all these explanatory variables (such as mean, standard deviation (SD) and percentage distribution of the sample size in each category of explanatory variables) are shown in Table 1. The data show that 55%, 39% and 6% of the participants were of young age, mid-age and old-age with 4.5 years, 11.92 years and 34.33 years of driving experience respectively. Statistics on phone use habits of the participants reveal that prevalence of *talking during driving* trend in India is high. Despite the ban on phone use during driving, 36% of the participants are in a habit of responding to all the calls they get while driving (*frequently conversing*) and 25% drivers respond to one or two calls per day during driving (less frequently *conversing*). The data on *texting during driving habits* shows that, *texting during driving* is not a prevailing trend here.

Table 1 Description and statistical details of variables from the questionnaire

Variables	Description	Type*	Levels/values	Mean	SD	Percentage
Driver demographics						
Age	Driver's age	Cat	Young**	24.14(years)	2.79	55
			mid-age	36.05(years)	5.43	39
			old-age	54.67(years)	5.04	6
Gender	Driver's gender	Cat	Female**			13
			Male			87
Driving characteristics						
Driving experience (in years)	How many years of driving experience the driver has	Con	Young	4.50	3.36	
			mid-age	11.92	8.17	
			old-age	34.33	5.89	
License owning period	How long has the driver been in possession of the driving license	Con	In years	9.078	8.81	
Trip type	Type of trip made generally	Cat	Work**			40
			Recreational			60
Traffic offence due to phone use	Whether the driver had been fined for using mobile phone in the last three years	Cat	No**			100
			Yes			0
Accidents	Whether the driver met with an accident due to distraction by mobile phone use in the last three years	Cat	No**			100
			Yes			0
Mobile phone habits						
Mobile phone use in day to day life						
Phone type	Which type of mobile phone the driver uses	Cat	Touch screen**			87
			Normal			13
Calls	How many calls the driver receives/makes in a day	Con	In numbers	13	15.79	-
Text messages	How many text messages the driver writes/reads in a day	Con	In numbers	60	97.97	-
Mobile phone use during driving						
a) Conversation						
Frequently conversing	Whether the number of calls received= at least three per day	Cat	No/ Yes			36
Less frequently conversing	Whether the number of calls received =at most two per day	Cat	No/Yes			25
Rarely conversing **	Whether the number of calls received = one or two per week	Cat	No/Yes			39
b)Texting						

Frequently texting	Whether the number of texts sent =at least three per day	Cat	No/Yes			4
Less frequently texting	Whether the number of texts sent = once or twice per week	Cat	No/Yes			12
Rarely texting**	Whether the number of texts sent =once or twice per month	Cat	No/Yes			84

** Type: con=continuous variable, cat=categorical variable, ** Reference categories*

Procedure

Initially, the drivers were presented with a questionnaire covering the details mentioned in Table 1. Each participant performed a trial run on the simulator before the actual experiment so that the driver can become familiar with the simulator. After the completion of trial run, the drivers were presented with non-distracted and distracted drives. Data for mean speed and accident involvement probabilities was collected for five different driving conditions: No phone use, simple conversation, difficulty level in conversation, simple texting and difficulty level in texting. The order of presenting distracted and non-distracted drive was randomized across all the participants. The collected data was analysed for calculating impairment in the driving performance and results are presented in the following section.

Analysis and Results

Independent and Dependent Variables Identification:

Mean speed and driver’s ability to respond to sudden events (Accident/ No accident) are considered as indicators for driver’s performance and taken as dependent variables. As the objective of the study is to examine the negative impacts of phone use during driving, the main five independent variables are the categorical variables which represent all different phone use conditions as: No phone use, simple conversation, difficulty level in conversation, simple texting and difficulty level in texting. Additionally, other factors which are assumed to affect the driver’s performance (such as age, gender, driving characteristic and phone use habits etc. mentioned in Table 1) are also taken as independent variables. Models for mean speed and accident involvement probabilities are developed by taking into account the variables mentioned in Table 1 and all the phone use conditions.

Modelling Mean Speed

Each driver has a tendency to go on a comfortable speed which depends on many factors such as: driver’s demographic characteristics, driver’s driving characteristics, driving conditions (road environment and presence/absence of additional workload in terms of secondary tasks), and thus the choice of speed is different for each individual. The boxplots shown in Figure 2 exhibit the mean speed (m/s) behaviour of the 100 participants across all different driving conditions. Here, the compensatory behaviour by speed reduction can be observed as the boxplots in distracted driving (for both: conversation and texting) are located at lower levels compared to non-distracted driving. From the boxplots it can also be observed that, in case of non-distracted driving the similarity in speed choices exist whereas in distracted driving the speed choices are comparatively spread in a wider range which shows the prevalence of varying levels of compensating behaviour among all the drivers.

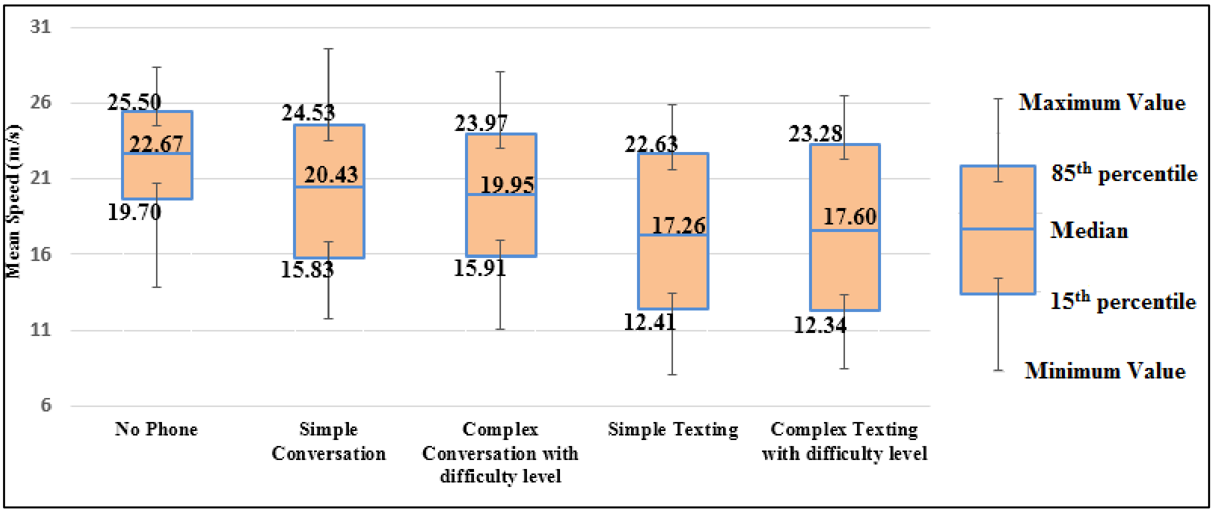

Figure 2 Boxplots of mean speeds (m/s) across different driving conditions

To quantify the effects of phone use and other factors on speed, two multiple linear regression models are developed for two different distraction conditions (conversation and texting). All the variables mentioned in Table 1 and all phone use conditions are taken as explanatory variables and mean speed (in m/s) is taken as a dependent variable. In variable selection process, Pearson correlation coefficients are calculated for the variables; and multicollinearity is carefully checked while developing the models. Mean speeds are modelled by stepwise (forward) regression approach using R software version 3.2.3. The final models shown in Table 2, present all the significant factors with their parameter estimates (β), t-value and p-value along with R^2 coefficient for the model. Here, the intercept shows the mean speed of the driver who has all the attributes of reference categories.

Table 2 Results of multiple linear regression models for mean speeds of the drivers

	Conversation				Texting			
Coefficients	Estimate(β)	Std. Error	t-value	Pr(>|t|)	Estimate(β)	Std. Error	t-value	Pr(>|t|)
Intercept	22.29	0.57	38.64	0.00	23.29	0.62	37.27	0.00
Gender (Male)	2.06	0.53	3.845	0.00	1.52	0.58	2.62	0.01
Mid-age	-3.29	0.37	-8.69	0.00	-4.51	0.41	-11.02	0.00
Old-age	-3.78	0.77	-4.89	0.00	-5.12	0.83	-6.11	0.00
Conversation	-2.62	0.43	-5.96	0.00	-	-	-	-
Texting	-	-	-	-	-5.29	0.47	-11.13	0.00
R-square		0.33				0.5		

The results presented in Table 2 show that both conversation and texting have significant effects on the mean speed of the drivers. The model shows that texting is causing more reduction in mean speed (5.29 m/s) in comparison to conversation (2.62 m/s). Interestingly, in both the models the difficulty level of the secondary task did not prove to be significant, these results are consist with previous study results which tested the different difficulty levels for phone conversation *(27,28)*. One possible explanation could be that the drivers were aware of being observed, and hence in-order to optimize their performance in both driving and secondary task, they reduced their speed to the lowest comfortable level in both the cases.

The model also shows that the demographic factors (such as age and gender) are significantly affecting the driver's mean speed behaviour. Mid-age and old-age drivers drive significantly slower than young age drivers in both conversation model (3.29m/s and 3.79m/s) and texting model (4.52m/s and 5.13m/s); and also male drivers go at higher speeds. Interestingly, the variable *phone use habits* is not significant in both the models suggesting that the drivers who use phone more frequently perceive the same level of increased risk associated with phone use as with the drivers who rarely use phone while driving. In line with the previous research *(6)*, the phone type (interface: touch screen / manual button) is not a significant factor.

Overall, it can be concluded from the models that, the drivers develop a self–regulatory behaviour of compensating the additional workload of phone use by reducing their speed. To see whether this compensatory strategy is working for all the drivers, the risk of being involved in accidents is analysed and presented in the next sections.

Modelling Accident Probabilities

Accident probability is an estimated probability for a driver to meet with an accident during sudden events. It is modelled as a binary logistic model where the dependent variable is a binary variable: *1* if accident happened due to sudden occurrence of the hazardous event and *0* other wise. Two different binary models are developed for conversation and texting distraction conditions by taking into account all the explanatory variables mentioned in Table 1 and all the phone use conditions. Effect of mean speed (m/s) on accident probability is also checked by keeping mean speed as a continuous variable in both the models.

Table 3 Results of binary logistic models for accident probabilities in different driving conditions

	Conversation				**Texting**			
Coefficients	Estimate(β)	*exp(β)*	t-value	Pr(>|t|)	Estimate(β)	*exp(β)*	t-value	Pr(>|t|)
Intercept	-5.9	0.00	-3.9	0.00	-6.01	0.00	-3.87	0.00
Speed	0.13	1.14	2.1	0.02	0.13	1.14	2.10	0.03
Conversation	1.12	3.08	2.1	0.03	-	-	-	-
Texting	-		-	-	1.38	3.98	2.18	0.02

Column *exp(β)* in Table 3, shows the odds ratio (i.e. the percentage change in accident probability with unit increase in explanatory variable). Results indicate that for both the models the presence of secondary task (conversation and texting) is increasing the accident probability by 3 times and 4 times respectively while the level of difficulty of the secondary task is not having any significant effect on accident probability. Higher accident probabilities are associated with the texting task as during texting the frequency and duration of observing the road gets reduced significantly compared to the conversation task *(31).*

The generally observed fact that *the accident risk increases significantly if the vehicle moves at higher speed*, is proven from the present study results also. In both the models, 1m/s increment in mean speed increases the accident risk by 14%. Ideally, accident probability should reduce as the drivers compensate by reducing their speed during distracted driving. From Figure 3, it is observed that the accident probabilities are increasing with increased speed and accident probabilities are higher in distracted driving when compared to non-distracted driving at the same speed level. For example, as highlighted in Figure 3(A), one's accident involvement probability is 0.22% at 20m/s speed in non-distracted driving while this probability increases to 0.68% (3 times) if the driver does not compensate for the increased workload by reducing the speed during conversation. But, if the driver compensates for the supplementary pressure of phone use by reducing the speed, then in order to maintain the similar level of accident risk as present in non-distracted driving, 40% speed reduction is required. Similarly in case of texting (Figure 3(B)), if a driver is driving at 20m/s in non-distracted driving then 50% speed reduction is required during distracted driving for maintaining the same level of risk as for non-distracted driving.

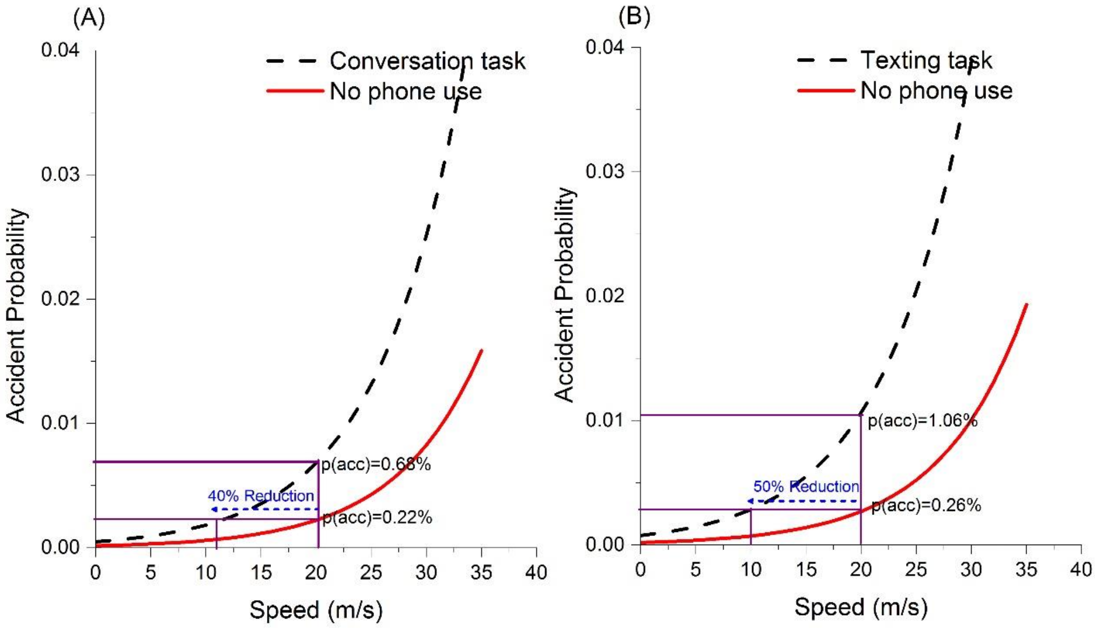

Figure 3 Comparison of accident probabilities in non-distracted and cognitively distracted driving conditions

The above mentioned speed reductions are the required speed reductions (estimated from the model) for offsetting the increased risk associated with distracted driving. But, different drivers have their own perception of increased workload and hence the compensation done (by speed reduction) is also different for different drivers. Figure 4 (left y-axis) shows the frequency distribution of each speed reduction category of all the drivers for both the distracted driving conditions (conversation and texting). The Figure shows that most of the cases, speed reduction is up to 30%; and some of the cases, the drivers opted for speed reduction in the range of 30-50%; whereas in very few cases the drivers reduced their speed by more than 50%.

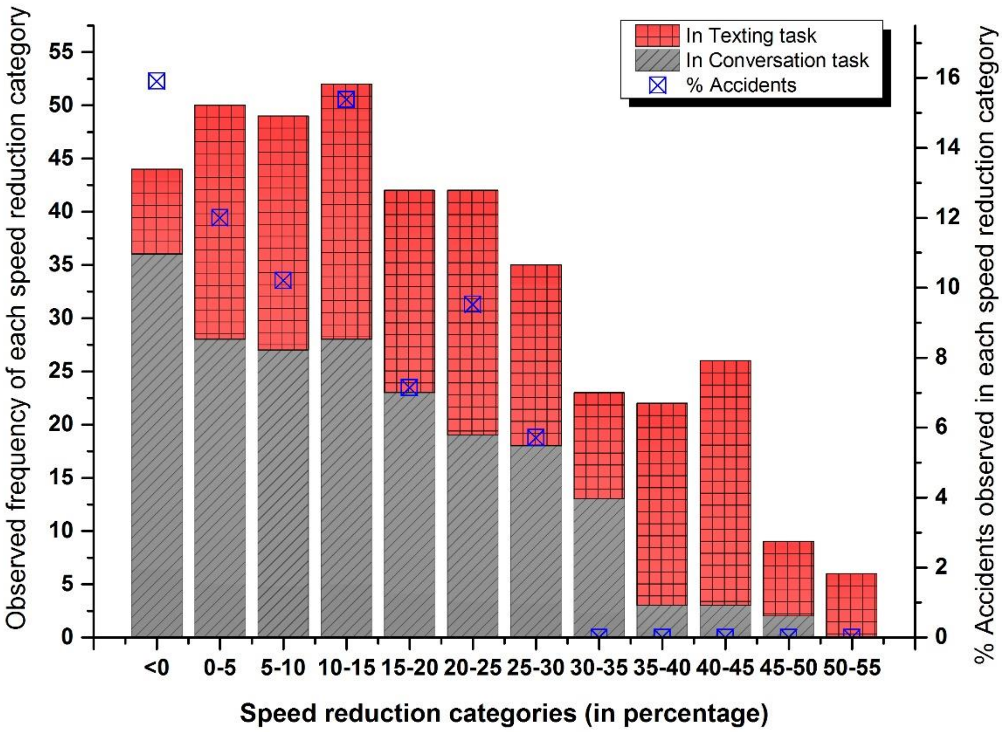

Figure 4 Speed reduction patterns of drivers in distracted driving conditions

The extent to which various levels of speed reductions are offsetting the increased accident risks, can be examined from Figure 4 (right y-axis), where the right y-axis shows the observed percentage accident frequency in each speed reduction category for both the distracted driving conditions (conversation and texting). Here, percentage accident frequency is taken as the ratio of number of accident cases observed in each speed reduction category to the total number of cases observed in the corresponding speed reduction category. From the Figure it can be observed that the drivers who reduced their speed by more than 30% were able to compensate for the increased workload safely (did not meet with an accident), whereas the drivers who reduced their speed by less than 30% were still exposed to risks of being involved in accident due to distraction. And up to 30% speed reduction, it can be observed that as the speed reduction performed by the driver increases the associated risk with phone use decreases.

The effect of phone use turns out to be worse when the driver does not realise the increased workload by the secondary task and does not compensate for it by reducing their speed; Figure 4 shows that approximately 16% drivers of this category met with an accident which is the highest among all categories. Thus the compensating behaviour of the drivers is not successful unless the drivers are exactly predicting that how much to reduce for a safe ride. Therefore, the drivers should not take it as a fool proof strategy to avoid any critical driving situations. Moreover, too much reduction in travel speed can also potentially increase the chances of meeting with an accident with inattentive drivers behind the distracted driver.

CONCLUSIONS

The present study investigated the effect of mobile phone use (both: conversation and texting) on driving performance of 100 Indian drivers with rural highway environment on a driving simulator. The performance was checked by statistical modelling of two measures: mean speed (multiple linear regression) and probabilities of accident involvement (binary logistic regression). Results of regression models for speed showed that age, gender and distraction due to conversation and texting are the significant factors affecting the mean speed of the driver. From the models it is clear that if the drivers are distracted due to phone use they try to compensate by reducing their speed in order to maintain the adequate level of safety. To examine the success rate of this compensatory strategy, the probabilities of accident involvement are analysed with respect to speed changes. The relationship between speed and accident probabilities showed that if the drivers are driving at the same speed in both distracted and non-distracted driving, i.e. no compensation is done for the increased workload, then the accident probability increases by 3 times and 4 times during conversation and texting respectively. It is observed that to fully offset the increased accident risk, the required level of speed reduction is 30% or more. But, from the present study it was also observed that around 80% of the drivers did not compensate up to the desired level, hence most of the drivers were underestimating the increased accident risk associated with the phone use especially during sudden events.

The underestimation of risk, because of compensation can give the drivers a false belief of being safe when using phone while driving. The present study emphasizes that mobile phone use during driving cannot be considered to favour road safety even after adopting the compensatory measures. Moreover, the present study focused only on simple rural road geometry and normal traffic conditions, but, as the attentional workload is higher in urban and complex road environment, the consequences of phone use could be more dangerous. These results are important in explaining the fact that the speed reduction strategies would not achieve the greatest safety benefits and can be useful for education and training programmes of drivers and also in public awareness campaigns for improvement of road safety.

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