**Conversing with mobile phone while driving and its impact on driving behavior**

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**Abstract** – The current paper reports on the results of a pilot study aiming to investigate the effect of mobile telephone use on the driving performance of 5 amateur and 5 professional drivers. Their driving acuity was tested through a driving simulator. Analysis and interpretation of the results occurred comparing the drivers' driving performance while talking, reading messages and writing a message on the mobile phone (intervention time) with the drivers' driving performance engaged in no activity (control time). The variables affected by the mobile phone were the "steering", the "lane offset" and the "duration of lane offset". Moreover, the drivers involved in a car crash in the last five years appeared to differ from those who were not involved in a crash in both "lane offset" and "following distance". The results of this pilot study will inform the design of a large experimental study on 50 professional and 50 amateur drivers.

## 1. INTRODUCTION

Road Traffic Crashes (RTCs) constitute the 3rd most frequent cause of death and injury on an international scale. Every year 1.2 million RTCs occur in European countries, while 50.000 people die in fatal RTCs, 1.7 million are injured and around 150.000 are handicapped. The productive years lost because of RTCs are more than those lost due to cancer and cardiovascular diseases [1]. Greece, occupies the 3rd place in fatal RTCs among the European Union countries [2]. In addition, RTCs are the 1st cause of death among young individuals (15-25 years old) in Greece. The severity of the phenomenon is also very alarming. In 1991 Greece presented 11 deaths per 100 RTCs, whereas in West Germany this was 2.5 and in Italy 4.5 per 100 RTCs. Although a decrease of 24% in the rate of fatal RTC was observed from 1991 to 2003, more recent data from the European Union rank 7 out of 13 regions of Greece among the 10 most dangerous regions in Europe for RTCs [3].

In the last two decades there is a wealth of research on the effect of mobile telephone use on driving performance and crash risk [4]. This scientific interest in mobile telephone has been led by the increased number of drivers (60% to 70%) using a mobile phone while driving and by the fact that 1% to 4% of the drivers use a mobile phone at any given moment during the day [5]. Epidemiological studies suggest that over 50 minutes a month of mobile telephone use during driving is associated with *a five-fold increase in accident liability* [6], with a *risk comparable to intoxication* at the legal maximum [7] and with a *higher proportion of rear-end collisions* [8]. A major issue of concern is that drivers do not consider mobile telephone use as risky as other activities a driver may be engaged with simultaneously to driving (e.g. food or liquid consumption, children's care while driving etc.) [9].

Research has identified a number of behaviours and measures that are affected by the use of a mobile telephone while driving. These include impaired gap judgment [10,11], reduced sensitivity to road conditions [12]; poor lane maintenance [13,14], increased heart rate and

subjective workload [15,12], and a reduction in headway [16]. The most reported problem with using mobile telephones, however, is the increase in reaction times to driving-related events (e.g. brake lights, etc.), and an increase in the number of such events missed altogether [16-22]. This has a great direct influence upon driver safety. Research with simulators has confirmed that increased risk of mobile phone usage is highly linked to the impairment caused to some very crucial aspects of driving performance [13,15,19,24-25]. Dragutinovic and Twisk [5] acknowledged inattention and physical and cognitive distraction as the major effects of mobile conversation. Physical distraction occurs when drivers undertake multiple tasks while driving such as searching or dialling numbers in their mobile phone, while cognitive distraction occurs when drivers have to divert part of their attention from driving to a telephone conversation. Garcia-Larrea et al. [26] identified a general decrease in attention to sensory inputs, common to both handheld and hands-free telephones. This reflects a general consensus in the literature that though hand-held telephones maybe particularly detrimental to concurrent motor tasks, hands-free telephones can also interfere with driving behaviour [16,20,22]. Although evidence is strong, no consensus has been reached yet on the processes and mechanisms which explain this link between driving performance and mobile telephone use. Taken together the evidence thus far, suggests that conversing via mobile telephones (either hand-held or hands-free) interferes with the processing of visual information during driving. This may seem to contradict many studies that support sensory-specific attentional resources [27], especially the superior performance of both a visual and auditory task compared to two tasks that share the same modality [28-29]. However, multiple resource theory [30], proposes four dimensions on which tasks may overlap, and therefore, draw on the same limited pool of attentional resources. For instance, one dimension distinguishes between processing stages, including perception, cognition and responding. If the conversation requires cognition, or perhaps a verbal response to a question, this may interfere with any aspect of driving that employs those respective processing stages. Thus, multiple resource theory can happily accommodate the notion that a conversation could draw upon the same attentional resources that are used for critical sub-tasks in driving.

In Greece, there is no surveillance system or any registered data on mobile phone related crashes (Greek Ministry of Internal Affairs, 2007, 2008), although prevention of RTCs is one of the first priorities for the Greek government (Greek Ministry of Transport, http://www.yme.gr/?getwhat=7&tid= 21&aid=1750&id**)**. Despite the huge number of fatalities under driver causation, this particular area of safety research is still neglected in Greece. Additionally, in Greece there are no records on the number of drivers who use a mobile phone or the number of offenses or traffic collisions due to cell phone use while driving (Home Office, 2007, 2008). In contrast to other European countries, Greece has no academic Department or Division on Traffic Psychology in Schools of Behavioural Sciences or any institution of tertiary education. The Laboratory of Health and Road Safety (LaHeRS) is one of the few known centres that exist in Greece conducting research in the area of driving performance and road safety (www.ctr-crete.gr/lahers/). Previous observational studies conducted by LaHeRS have identified that Greek drivers lead certain lifestyle patterns – mobile phone use included – that increase the risk of a crash. This finding has been replicated in various studies (Medline indexed) and has introduced certain concerns about culturally-specific characteristics that may interfere with increased crash risk. As LaHeRS has been devoted to exploring the involvement of human factor in car crashes, it is among its objectives to use experimental research to gain a better understanding of the mechanisms and mediating factors in risk involvement.

In the light of these findings, the current research project aims to introduce a pilot study on the effects of mobile telephone use on driving performance through experimental and observational research methods. Among the main objectives of this pilot study were the following: i) preparation of the experimental facilities, ii) pilot testing of the research tools, and iii) familiarization of the research staff with the study procedures. This pilot study will inform the design of a larger experimental study on 50 professional and 50 amateur drivers, which has been scheduled to be carried out in order to produce up-to-date knowledge on the involvement of human factor in the phenomenon of road traffic crashes.

## 2. METHODOLOGY

### 2.1 Study participants/recruitment

A sample of 10 male drivers participated in the study (5 professionals and 5 amateur). The professional drivers were drawn conveniently from the professional drivers' registries and the main taxi ranks, while the amateur drivers were approached at public places by the researchers. The power of the pilot study was calculated "a-posteriori" due to the fact that the available data were randomly generated without any preliminary report produced by the project team. The inclusion criteria were the following: a) age above 18 years, b) possession of a driving license, c) sufficient reading, writing, and communicating skills, d) informed consent prior to participation in the pilot study.

### 2.2 Data collection

#### *2.2.1 Experimental study*

*Procedures:* Laboratory tests were conducted using the VS500M driving simulator manufactured by Virage Simulation Inc. TheVS500M driving simulator is comprised of the car cockpit mounted on a moving base that simulates the movements of the car while driving. The visual system consists of three High Definition 52" screens and two 19" High Definition screens which create a 210o visual field around the driver. The driver has at his disposal the exact same instrumentation and controls that he would have in a conventional car while, at the same time, the simulator records the performance of the driver for the later evaluation of his driving performance.

All the participants were asked to drive the simulator for twenty minutes. In the first ten minutes the drivers had to drive without using a mobile phone while the next ten minutes involved driving with the use of a mobile phone. The simulated environment involved the participant's car moving in the right lane, a second vehicle moving in front of the participant's car in the same lane, a third vehicle following the participant's car in the same lane and a fourth vehicle moving next to the participant's car in the left lane.

Each participant was instructed to drive while keeping the safety distance of 3 to 4 seconds from the front vehicle that was indicated by the researchers. In the event of participants' driving at a lower speed than expected, the front vehicle exited the highway and the experiment was cancelled.

The researchers spent 5 minutes to familiarize each participant with the simulator and the study procedures before the start-up of the experiment. Immediately after the short presentation, the driver had to turn on the engine of the simulator and start driving. During implementation, one of the researchers was in charge of monitoring the process of the experiment, keeping the time limits of each intervention task as well as maintaining notes in

relation to the participants' performance. The second researcher was in charge of delivering the individual intervention tasks, such as calling the participants on their mobile and filling in the respective questionnaire. Participants' driving performance was recorded by a professional camera for reasons of accuracy.

*Content of the intervention:* The intervention contained different tasks/assignments. Participants' driving performance was evaluated while undertaking three different tasks using their mobile phones, which were assigned at the course of their ten minutes intervention time. More specifically, during the first minute (0'-1'), the participants drove without using their mobile phone , just to reach the ideal distance from the vehicle in front of them. Between the second and the fourth minute of driving (2'-4'), the participants received a phone call and had a conversation with one of the researchers (Task 1). Between the fourth and the seventh minute (4'-7'), the participants received two text messages and were instructed to read them out loud while driving (Task 2). In case the participants read the text messages before the end of the seventh minute, they were asked to repeat reading both texts from scratch. Between the eighth and the tenth minute (8'-10') they were asked to reply with a text message to the information that was requested from them through one of the received text messages (Task 3).

### *2.2.2 The self-reported questionnaire*

A structured questionnaire was used to collect necessary data from the sample of the drivers that participated in the pilot study. Prior to their participation in the experiment, all participants were given an information note which contained all the necessary information relevant to the study such as the aim and the objectives of the research. Participants' right to anonymity and confidentiality were safeguarded and a written consent document was distributed and signed by them prior to the completion of each questionnaire.

A self-reported questionnaire was used to collect information from the participants who were involved in the experimental study. The questionnaire was designed to identify factors that predicted drivers' performance while driving. The self-reported questionnaire is divided into three sections. The first section elicited information on the age, the educational level, the marital status, the weight and height of the participants. The second section examined the driving patterns history of crash involvement and driving behaviours of the participants (total kilometres driven, involvement in driving violations, driving safety measures, engagement in any activities while driving etc.). The third section contained items related to the frequency of use, the beliefs about using a mobile phone as well as the precaution measures taken by the driver while driving, and simultaneously using the mobile phone. The questionnaire was self-administered and the interviewer's role was limited in providing clarifications when necessary.

## 2.3 Outcome Measures

### *2.3.1 Experimental study*

The following parameters of the participants' driving performance were evaluated in both scenarios (with/without mobile phone):

a) Following distance: The following distance from the front vehicle was estimated in seconds (every value over 1000 was ignored).

b) Lane offset: Lane offset represented the distance in absolute value (in meters) between the centre of the vehicle and the centre of the lane.

c) Duration of lane offset: The duration of the deviation from the centre of the lane was also estimated when "lane offset" was greater than 0.3m.

d) Steering: The "steering" represented the deviation from the centre. "Steering" was evaluated with the values of -1.0 (100% left), 0.0 (absolute centre) and 1.0 (100% right). The value close to 0.001 was considered invalid, and thus ignored.

## 2.4 Statistical analysis

The statistical package SPSS v. 20.0 was used for the data analysis. A database, specially designed for the study, was developed for entering and storing the data. This database was evaluated for accuracy and completeness. The analysis included the following:

### *2.4.1 Within group comparisons*

(a) Within each driver's category (professional/amateur), comparisons were drawn between driving performance (the 4 parameters described above) while using a mobile phone and without using a mobile phone.
(b) Within each driver's category (professional/amateur), multivariate models were developed to explore the effect of mobile phone use (3 scenarios of mobile phone used) as well as other variables of the driver's background (socio-demographic information, driving patterns and history, frequency of use and beliefs about mobile phone) to measure driving performance (good/bad performance while using the mobile phone).

### *2.4.2 Between group comparisons*

Comparisons (of the four parameters described above) were drawn between amateur and professional drivers in relation to their driving performance while using a mobile phone.

## 3. RESULTS

### 3.1. Socio-demographic characteristics

The socio-demographic characteristics of the participants are presented in Table 1.

**Table 1**. Socio-demographic characteristics of the participants

| | Professional Drivers N=5 | | Amateur Drivers N=5 | |
|---|---|---|---|---|
| | n | % | n | % |
| **Age*** | 34.2, 4.764 | | 35.40, 16.742 | |
| **Educational level** | | | | |
| a. Formal education | 1 | 20 | 0 | 0 |
| b. High school | 2 | 40 | 0 | 0 |
| c. Vocational training | 2 | 40 | 2 | 40 |
| d. University/ College | 0 | 0 | 1 | 20 |
| e. Postgraduate | 0 | 0 | 2 | 40 |
| **Driving time per day** | | | | |
| a. 30m-1h | 0 | 0 | 2 | 40 |
| b. 1h - 2h | 0 | 0 | 2 | 40 |
| c. >3h | 5 | 100 | 1 | 20 |

**Mean, standard deviation*

### 3.2 Within group comparisons

a) The non-parametric tests (related samples Wilcoxon Signed Rank Test) showed that "lane offset" within the "control" time differed at a statistically significant level from "lane offset" while reading a message (Task 2) and while writing a message (Task 3) (<0.05). Moreover, "steering" within "control" time was found to differ at a statistically significant level from "steering" at intervention time, and specifically from "steering" while talking on the mobile phone (Task 1) (p=0.07), "steering" while reading a message (Task 2) (p=0.09) and "steering" while writing a message (Task 3) (p= 0.05). Likewise, "duration of lane offset" during the "control" time, was found to differ at a statistically significant level from the "duration of lane offset" while talking on the mobile phone (Task 1) (p=0.028) and while reading a message (Task 2) (p=0.05).

b) Non-parametric Mann Whitney tests were calculated to explore the effect of mobile phone use and other driver's background information on driving performance. Based on the analysis, the participants who had an accident in the last 5 years differed in "lane offset" while talking on the mobile phone (Task 1) with the ones that did not have an accident in the last 5 years ($p<0.05$). Additionally, the participants who had an accident in the last 5 years differed in "following distance" while reading a message on the mobile phone (Task 2) with the ones that did not have an accident in the last 5 years ($p<0.05$).

### 3.3 Between group comparisons

Between group comparisons were run using non-parametric Mann-Whitney tests. Based on the analysis, no statistically significant difference was identified between the two categories of drivers in any of the outcome measures.

## 4. DISCUSSION

The aim of the current project was to produce up-to-date knowledge in the wider field of road safety research through observation and experimental research methods. Therefore, the main focus was on exploring how the human factors affect the driving performance while conversing on the mobile phone.

Through the pilot study it was found that the driving performance within drivers' categories (professionals and amateurs) was significantly affected by the use of the mobile phone. More specifically, the variables that appeared to be affected by the mobile phone were the "steering", the "lane offset" and the "duration of lane offset" which seemed to be worst when driving while using the mobile phone as compared to driving while not using the mobile phone. Moreover, within the group comparisons, the drivers who were involved in a car crash in the last five years appeared to differ from those who did not involve in a crash in both measures of "lane offset" and "following distance". This observation could be an indicator that the use of a mobile phone while driving may render drivers more prone to road traffic crashes. However, this conclusion could come out in a more concrete way through a large-scale survey.

The current pilot study was also important in identifying technical limitations that should be improved during the upcoming large-scale experimental survey on a larger sample of drivers. Among the issues that were identified as problematic, and were thus corrected, was the fact that the "control" time and the three different tasks did not have the same duration. Therefore, to compare the results that were produced from the different tasks with "control" time, it was necessary to have this number over time, in order to get a rate ("steering" variations per second). The same approach was also followed for "lane offset" measurement.

### 4.1 Conclusion

To conclude, the project has a high scientific value and a great social impact. It will summarize evidence-based knowledge produced with observational and experimental research in a country with limited epidemiological and research data on crash risk and driving performance. Additionally, it uses novel methods and cutting edge equipment to collect experimental data (visual models, driving simulations etc.). Greek bibliography does not contain any similar examples of experimental work in the field of mobile phone use while driving. Even at European and international level the collection of experimental data on the subject of mobile phone use while driving using simulators is an emerging technique, which however shows great promise. Finally, the project is expected to advance knowledge and introduce tools to be used in future interventions for primary and secondary prevention of road accidents and road safety promotion in various population groups.

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