Transportation Safety: A Cognitive Study about Use Mobile Phone while Driving in Turkey

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***Abstract*—This research employed two types of programs to examine the response time to the presented stimuli, as well as missed targets among 20 subjects. The data was also collected on different times of day for all groups of volunteers. Participants completed a questionnaire concerning their experience using a cell phone. For each program, subjects completed six tasks (Baseline, Mental Arithmetic, Synonyms, In Person Conversation, and Cell Phone Conversation). In the stimulus-response, subjects were asked to press certain keys on a keyboard, corresponding to the stimuli presented on the screen. In conclusion, it was found that tasks involving mental imagery were significantly different than tasks requiring simple communication.**

***Index Terms*—cognitive process, cell phone, safety transportation**

I. Introduction

There is growing evidence that using a mobile phone (hands-free) while driving is an unsafe driving. Talking on a cell phone while driving may not be the only driver distraction of concern, one study found that driving performance decrements were only slightly different between cell phone conversations and passenger conversations [1].

Gugerty *et al*. [2] investigated this difference and found that teams, comprised of one member performing a simulated driving task, interacted slower verbally with the remote conversations than with in-person conversations, suggesting that it is more difficult to converse remotely.

The mean verbalization rate showed that the conversations were 15% slower with remote conversations than with in person conversations [2]. In a recent study it was determined that hands-free and handheld phones are very similar in the amount of increased workload caused by phone use [3].

Strayer *et al*. [4] suggest that it is the cell phone conversation, and not the cell phone type, that distracts the attention of the driver from the external environment to an engaging internal environment associated with the conversation.

Strayer *et al*. [4] performed an experiment in which subjects performed a simulated driving task and were exposed to several billboards in the driving scene, and then subsequently were tested on their recall of these billboards. It was shown that "even when the participants eyes were directed at objects in the driving environment, they were less likely to remember them if they were conversing on a cell phone" [4].

The inattention to the driving scene is supported in a similar study involving eye tracking. McCarley, *et al*. [5] have shown that in dual-task situations, eye movements were more frequent when attempting to detect scene differences. This suggests that conversation can "impair peripheral guidance of attention toward the target" [5]. Matthews *et al.* [6] compared cognitive workload between handheld, hands-free, and personal hands-free phones.

Their study suggests that personal hands-free phones, such as a phone with a Bluetooth connection, had the lowest total subjective workload.

Amado and Ulupmar [7] conducted a study to compare the effects of passenger conversations and remote conversations on attention and peripheral detection.

Baker and Madell [8] conducted an experiment where 24 male college students were identified as underachievers or achievers, and then were given reading comprehension tests under two conditions.

Belojevic *et al*. [9] state that "Neuroticism is often thought to be reflected in self-oriented thoughts; worry and anxiety, each of which act as a distracter from learning and recall subjects performed the Stroop task with different "types" of audiences present. In this study, subjects completed the Stroop task under varying conditions [10].

Szymura and Necka [11] compared visual selective attention and personality to assess selectivity, distraction susceptibility, sustained attention, and dual task performance.

Eysenck and Graydon [12] examined how personality may effect attentional distraction. Twelve subjects were identified as either stable extroverts or neurotic introverts based on an Eysenck Personality Inventory scale.

Evidence from other studies addressing driver's risk perception indicated that people perceived the behaviour of mobile phone use when driving to be safer and reported stronger intentions to use mobile phone in hands-free mode than in handheld mode [13]-[15]

Fig. 1 and statistics to be released concerning the use of mobile phones whilst driving - some startling and unsettling figures.

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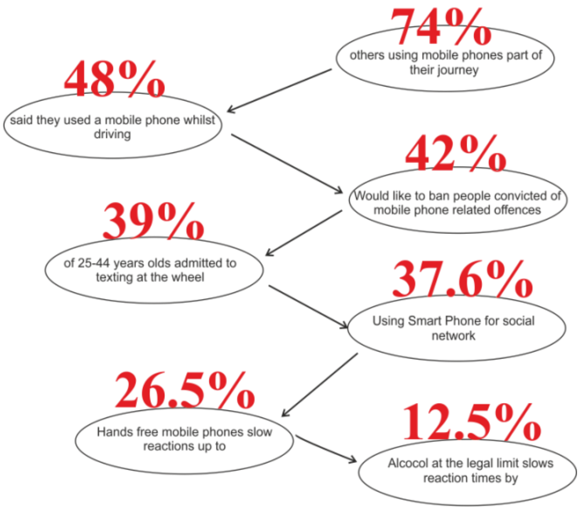

Figure 1. Atraction using a mobile phone while driving (Adopted to [6], [8], [12], [14]-[18])

In Turkey hand-free cell phone conversation is very important problem while driving. In this case accident happened while driver use cell phone recently. So, this study investigate driver behavioral and cognitive situation while Turkish driver in driving time.

And also the following seven variables were computed to indicate the safety of the while driving in Turkey drivers:

- Hits or close calls "while driving"
- Time to contact - the smallest gap of time between the avatar and any oncoming vehicle "while driving"
- Start delay - the amount of time between a car passing the crosswalk and participants initiating crossing "while driving"
- Missed opportunities - when participants allow a gap greater than or equal to 1 times their pre-determined crossing speed "while driving"
- Wait time - the amount of time participants wait to cross the street "while driving"
- Looks away from traffic - the ratio of time participants spent looking away from the monitors (e.g., at their cell phone) to time spent looking at the monitors/traffic before beginning to cross "while driving"

While start delay, missed opportunities, and wait time may not appear to be more risky and same time use cell phone while driving.

II. Method

This study included 20 subjects (10 male and 10 female). All participation was voluntary. The age range for the subjects was 21-50 years. The average age was 28.12 years.

The volunteers were chosen as legitimate drivers with existing driving licenses. One of the inclusion criteria of choosing the volunteer is their existing occupation and daily schedule. The preference was to include most of the volunteers who are professional vehicle drivers and generally drive at nighttime. All subjects possessed valid driver's licenses, owned & used a cell phone, and had normal or corrected to normal vision.

The experiment was conducted at any convenient location for each subject in Suleyman Demirel University Faculty of Architecture in Turkey. Subjects seat in front of a PC computer, at a comfortable distance away from the screen. A blank poster board surrounded the computer in order to prevent unintentional distractions during testing.

The data was also collected on different times of day for all groups of volunteers. The time range of day has been classified based on work schedule and sleep schedule of a regular person.

The test is interested in in depended and depended variables. The independent variables for this study were distractions posed to the subject such as a cell phone conversation, in-person conversation, mental arithmetic, synonyms, the dependent variables in this study were reaction time and percent misses.

Participants completed a questionnaire concerning their experience using a cell phone (see Appendix A). Responses provided insight into average usage per day including frequency of text messaging, using mobile internet, and making or receiving calls. Participants completed a measure regarding their typical driving patterns Within the measure they completed a ―Driving Diary‖ which asked them to outline each time they typically drive on Mondays and Thursdays. This outline was to include all drive and the length of each drive in minutes.

Prior to testing, a thirty-minute driving video was created. The driving video was created for use in Heath & Rider's (2007) previous work. Prior to testing, subjects were briefed on the nature of the study and procedures. Following this briefing, subjects were asked to sign a consent form.

During the first 30 minutes of the stimulus response portion, subjects were asked to complete 4 training trials of the program to account for the learning curve. Following the training trials, subjects spent approximately 50 minutes participating in the stimulus-response program.

Subjects were asked to complete five trials each for the stimulus response program on two computer programs, the stimulus response program as well as recording hits and misses for the driving video scene analysis.

Eight of the subjects (four male and four female) completed the driving video program first, followed by the stimulus-response program. The remaining eight subjects (four male and four female) completed the stimulus-response program first, followed by the driving video program. The five rounds were the same for both programs and subjects completed them in the same predetermined order.

Age was found to be a significant factor in the ANOVA, and a Tukey multiple comparison tests was performed in order to discover which age groups differed significantly from another. Table I displays the average response times for each age group for each task.

TABLE I. AVERAGE RESPONSE TIMES FOR EACH AGE GROUP FOR EACH TASK

Task	**Age**	**Average Response Time**
Baseline	M	0.71
	F	0.92
Mental Arithmetic	M	1.21
	F	1.60
Synonyms	M	0.80
	F	1.15
Person Conversation	M	0.77
	F	0.91
Cell Phone Conversation	M	0.77
	F	1.10

Gender was also found to be significant. The comparison of response times is listed in Table II.

TABLE II. AVERAGE RESPONSE TIMES FOR GENDER FOR EACH TASK

Task	**Age**	**Average Response Time**
Baseline	21-30	0.68
	31-40	0.81
	41-50	1.15
Mental Arithmetic	21-30	1.54
	31-40	1.48
	41-50	1.21
Synonyms	21-30	0.90
	31-40	0.98
	41-50	1.12
Person Conversation	21-30	0.77
	31-40	0.90
	41-50	1.10
Cell Phone Conversation	21-30	0.80
	31-40	0.90
	41-50	1.12

In our methods EEG data used were downloaded from EEG recorded from normal subjects. The following bipolar

EEG channels were selected for analysis: FP1 and frontal lobe section. The different stages of EEG signals were determined by two physicians. EEG data were acquired with Ag/AgCl disc electrodes placed using the 10—20 international electrode placement system and to use logistic regression method for analyses our EEG data.

$$\text{logit}(P\_1) = \ln(P\_1/(1-P\_1)) = \beta\_0+\beta\_1 x\_1+\cdots+\beta\_n x\_n = \beta\_0 + \sum\_(i=1)^n [\![\beta\_i x\_i]\!] \quad (1)$$

In Eq. (1), β_0 is the intercept and $\beta\_1, \beta\_2, \ldots, \beta\_n$ are the coefficients associated with the explanatory variables $x\_1, x\_2, \ldots, x\_n$.

In this specific case of brainwave data, one must understand the pattern of these data. The required output can be classified as binary 0 and 1.

The explanation of logistic regression can be described with the logistic function, which is a logistic curve (called a sigmoid curve), and the function for logistic regression is a sigmoid function ([19], [20]).

$$g(z)=1/((1+e-z)) \quad (2)$$

In logistic regression, the optimal decisions are based on class probabilities $P(y|x)$. Binary classifications are shown in formula (3)

$$y=1 \text{ if } \log[\![(P(y=1|x))/(P(y=0|x))]\!]>0 \text{ and } y=0 \text{ otherwise} \quad (3)$$

The output interpretation of the logistic regression can be represented by the hypothesis $0 < h(x) < 1$. The hypothesis prediction output is $y = 1$ if $h(x) \geq 0.5$ and $y = 0$ if $h(x) < 0.5$

III. DISCUSSION

The main objective of this study was to determine the effects of cognitive tasks on the ability of a driver to identify hazards that may occur on the Turkish roadway. Previous research has found that conversing on a cell phone can increase braking response time by up to 24% [16]. Other studies have also compared the distraction of cell phone conversation to changing radio stations, conversing with a passenger, and driving under the influence of alcohol, among others [17], [18], [21], [22].

The mean and standard deviation of the averaged EEG data bands in the right and left frontal lobes in different sessions shows that in Table III.

TABLE III. THE MEAN AND STANDARD DEVIATION OF THE AVERAGED EEG DATA BANDS IN THE RIGHT AND LEFT FRONTAL LOBES IN DIFFERENT SESSIONS

Driving use mobile phone		**The Mean (Approximately)**	**Standard Deviation (Approximately)**
RIGHT FRONTAL LOBE	Amp	186	206
	Theta	212	201
	Alpha-1	106	220
	Alpha-2	108	225
	Beta-1	155	234
	Beta-2	721	530
	Amp_Question	152	185
	Theta_Question	156	210
	Alpha-1_Question	72	160
	Alpha-2_Question	86	120
	Beta-1_Question	126	201
	Beta-2_Question	668	580
	Amp_Decision Making	85	203
	Theta_Decision Making	996	201
	Alpha-1_Decision Making	172	410
	Alpha-2_Decision Making	160	411
	Beta-1_Decision Making	170	387
	Beta-2_Decision Making	766	589
LEFT FRONTAL LO	Amp	123	160
	Theta	151	150
	Alpha-1	75	121
	Alpha-2	71	141
	Beta-1	121	134
	Beta-2	600	243
	Amp_Question	295	740
	Theta_Question	288	810
	Alpha-1_Question	140	385
	Alpha-2_Question	132	634
	Beta-1_Question	198	650
	Beta-2_Question	608	895
	Amp_Decision Making	148	234
	Theta_Decision Making	170	276

BE	Alpha-1_Decision Making	85	182
	Alpha-2_Decision Making	90	265
	Beta-1_Decision Making	160	250
	Beta-2_Decision Making	588	389

Driver distraction is thought to play a role in 20-30% of all road collision [23]. Distraction is caused by a competing activity, event or object from inside or outside the vehicle. Safety problems related to driver distraction are escalating as more technologies become available for use in motorized vehicles. Such a technology, already widely available and accepted, is the mobile phone.

The vast majority of drivers (39 % to 45%) report using their mobile phone at least sometimes while driving, and it is estimated that at any given moment during the day, 2 to 6% of the drivers is using a mobile phone [24].

The mobile phone distracts drivers in two ways: it causes physical distraction and cognitive distraction. Physical distraction occurs when drivers have to simultaneously operate their mobile phone and operate their vehicle. Cognitive distraction occurs when a driver has to divert part of his/her attention from driving to the telephone conversation.

Mobile phones potentially distract driver in several ways, but cognition is very significant factor than others (Physically, Visually, Auditory) so cognitively: instead of focusing their attention and thoughts on driving, drivers divert their attention and focus on the topic of the phone conversation [25].

Government and industry should develop a jointly funded research program on the risks and benefits of the use of wireless communication in the transportation sector. Joint funding will enlarge the resource base and enhance the credibility of the effort.

Developed countries throughout the world are adopting different policies toward the use of the hand-held cellular phone while driving. There is little hard evidence about what is happening in different countries. Rigorous research should be undertaken to determine the impact of these different policies on the risks and benefits of using cellular phones while driving, while taking into account differences in cultural norms related to driver distraction

IV. Conclusion

In this study to found that performing mental arithmetic were highly significantly different from the baseline. All three of these tasks which are cell phone conversation, in person conversation, and synonyms were highly significantly different from the mental arithmetic task. Accordingly, the findings of the current work may be used in transportation safety education for drivers, at least in Turkey. Currently, safety education for drivers in Turkey focuses on the traffic rules (e.g., “Do not use a mobile phone while driving”).

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Appendix

Cell Phone Use History

1. What brand and model smartphone do you own?____

2. Does your current cell phone plan include 3G or faster mobile internet access?____________________________

3. How long have you owned your current smartphone (in months)?______________________________

4. What type of keyboard does your smartphone have?_______________________________ _____

5. How long have you been using the type of keyboard that you are using today?_______________________

6. When did you first begin using any smartphone with mobile internet access?___________________________

7. During a 24 hour day, how many hours, on average, do you keep your cell phone with in reach in your pocket, on your desk while working, by your bed while your sleeping, in your while a driving etc.?__________________________________ ___

8. How often, on average, you use any mobile internet application (facebook, twitter etc.)_____________

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