**Simulation of Texting Impact on Young Drivers'**
**Behaviour and Safety on Motorways**


## ABSTRACT

Texting while driving seems to be a widespread behaviour, which has been associated with a non-negligible proportion of road accidents, especially among younger drivers. The impairment of the driver's behaviour and the related risks may be increasing on motorways, taken into consideration the fact that there are high vehicle speeds and the necessary reaction time is decreased. This research aims at investigating the impact of texting on young drivers' behaviour and safety on motorways. For this reason, a driving simulator experiment was carried out, in which 34 young participants drove in different driving scenarios (moderate/high traffic, good/rainy weather). Lognormal regression methods were used to investigate the influence of text messaging as well as various other parameters on the mean speed and the mean headway. Moreover, binary logistic methods were used to investigate the influence of texting and other parameters on the probability of an accident. Results suggest that texting leads to statistically significant decrease of the mean speed and to increased headway in normal and in specific traffic and weather conditions on motorways, as drivers appear to produce compensatory behavior while texting. Furthermore, texting leads to increased accident probability, probably due to longer reaction time of the driver at unexpected incidents. Analyzing the driving performance of those who text while driving may lead to the identification of measures for improving their driving performance such as restrictive measures, training and licensing, information campaigns etc.



Key words: road safety, mobile phone, texting, speed, headway, accident probability

# 1. INTRODUCTION

While driver distraction is estimated to be an important cause of vehicle accidents, the use of mobile phones is considered a major factor that distracts driver attention. The rapid growth of the possession and use of mobile phones (from here after mobiles) in recent years, has generated a wide interest and a range of studies have shown that the use of mobiles has adverse consequences on driver's behaviour and the probability of being involved in an accident. Early research results showed that mobile phone communication is a quite demanding cognitive and operational task, which may compromise decision making while driving (McKnight and McKnight 1993). Recent studies confirm that the use of mobiles while driving may significantly affect driver's behaviour and safety (Patel et.al, 2008, Strayer et al, 2003, MacEvoy et al, 2005, Caird et al, 2008, Horberry et al, 2006).

Texting while driving is a particularly potent yet increasingly likely form of mobile phone use and incidents of texting while driving and accidents relating to texting while driving continue to be on the rise (O'Malley et al., 2013; Wilson and Stimpson, 2010). In driving simulator studies, texting has been reported to be very disruptive as well (Neyens and Boyle, 2008; Hosking and Young, 2009).

Percentages of drivers receiving, reading or replying to messages on their mobiles while driving reach 70%, 81% and 92% respectively (Atchley, 2011; Nelson et al, 2009). Texting while driving remains a common behaviour even in countries where law prohibits it. In Australia, 27% of drivers admit texting while driving and in the United States of America (USA) the respective percentage among young drivers reaches 60% (White et al, 2010; Vlingo, 2009). Using the keyboard of the mobile is considered even more dangerous than talking on the mobile while driving, as accident probability increases by 23.24, 5.93 and 1.04 times respectively for commercial driver texting, dialing, and talking, compared to free driving (i.e. without talking or texting) (Olson et al., 2009). This is probably because texting or dialing requires frequent and long observation of the phone. Looking away from the road for more than 3 seconds increases the accident probability (Klauer et al, 2006).

In addition, texting entails a motor act (typing) which requires additional resources. In this framework, Hosking et.al (2009) asked 20 participants to drive a computer simulated roadway that contained a number of emerging threat events, a car following episode, and a lane-change task. Results indicated that drivers were particularly impaired when sending text messages and less so when receiving. In particular, it was found that drivers' ability to maintain their lateral position, their ability to detect and respond to traffic signs, the amount of time spent looking at the road, and their following distance, were all impaired when sending and receiving text messages.

Texting causes difficulty in retaining a stable position within traffic lanes (Crisler at al, 2008), doubles reaction time (Cooper et al, 2011). When texting, drivers react more slowly to information in the peripheral field of vision, drive more slowly, sway more and watch the road less often compared to when using the call function (SWOV, 2010).

In a driving simulator research (Drews et al, 2009) 20 participants drove a simulated roadway while sending and receiving text messages using their mobiles. Additionally, the text messages sent and received in this study were shared between actual friends, thus the actual communication was likely more representative of every-day text messages. The driving tasks consisted of following a periodically braking lead vehicle down a 65 mph two-three lane roadway. Results indicated that when texting, participants expressed greater following variability, greater lateral variability, reduced response time to the lead vehicle, and an increase in collision frequency. Brake response times associated with reading were reported to be higher than those associated with writing. However, because the reading and writing portions of this research were not balanced, the actual amount of driving time associated with reading was likely very low.

Furthermore, Cheung et al. (2010) found that due to texting while driving, the lateral deviation increased by 280% compared to free driving. The vast majority of the respondents to a survey in the USA (95%) admitted texting while driving despite recognizing the increased associated risk (Atchley et al, 2011). The risk associated with texting while driving is estimated 5 times higher than that associated to driving under alcohol influence (Klauer et al, 2006). Sometimes, distracted drivers adopt behaviours to compensate for their delayed responses (Horrey and Simons, 2007). However, few young drivers alter their driving behaviour to make up for the recognized increased risk of texting while driving (Atchley et al, 2011, Nelson et al, 2009).

The combination of all the aforementioned findings with a research based on motorways - where the vast majority of the accidents are considered serious – can provide further insight on the impact of texting on drivers' behaviour and safety. Examining specifically the case of young drivers, one of the most vulnerable groups of drivers and very keen mobile users, may also contribute to the better understanding of texting as a driving distraction and its consequences.

Within this context, driving simulators have become a widely used tool for examining the impact of driver distraction, with respect to individual driver differences and / or roadway design, as examining distraction causes and impacts in a controlled environment helps provide insights into situations that are difficult to measure in a naturalistic driving environment.

This research aims to investigate the interrelation between texting while driving, speed, headways and accident probability of young drivers on motorways, through a driving simulator experiment. Particularly, mean speed, mean distance from the vehicle ahead and the possibility of an accident are the independent variables that examined in order to render the impact of texting on drivers' safety and behaviour on motorways. Likewise, the effect of texting in combination with road type (motorway), traffic characteristics (moderate / heavy traffic), environmental conditions (good weather, rain) and driver characteristics (gender, annual mileage, driving habits) is further explored (Table A1).

## 2. METHODOLOGY

Within this research, a driving simulator experiment was implemented in order to investigate the impact of texting on driving in combination with specific driver and road environment characteristics. The driving simulator experiment took place at the Department of Transportation Planning and Engineering of the National Technical University of Athens where a motion based quarter-cab driving simulator is placed (Gkartzonikas, 2012).

### 2.1 Overview of the experiment

The driving scenario included driving on a motorway entry ramp, in moderate traffic, followed by driving on a motorway (speed limit 100km/h to match the geometric and road environment characteristics), first in moderate and then in heavy traffic and activating the alarm function on the mobile. It is noted that road type was considered a one level variable (motorway) as no statistically significant difference was found between driving on the motorway ramp and on the motorway. Furthermore, different weather conditions were examined (good and rainy weather). In the rain scenario, grip on the road and sight conditions/visibility were decreased. Additionally, participants were requested to fill in a questionnaire about their driving habits and their driving behavior, with regard to texting,.

### 2.2 Sample

The sample consisted of 19 male and 15 female drivers, aged between 18 and 24 years old with a valid driving license and an average driving experience of 3.5 years. Participants used their own mobile phones to be familiar with the device while 20 participants used mobile phones with touch-screens and 14 without. Furthermore, participants completed a demographic questionnaire and did not receive any benefit regarding the participation of the experiment.

### 2.3 Procedure

A familiarization session or ‘practice drive’ was the first step of the simulator experiment. During the familiarization with the simulator, the participant practiced in handling the simulator, keeping the lateral position of the vehicle, keeping stable speed, appropriate for the road environment and braking and immobilization of the vehicle. When all criteria mentioned above were satisfied the participant moved on to the next phase of the experiment.

After the practice drive, each participant was asked to drive the main part of the experiment. Drivers had to read or write a sms while driving the same five minutes route in good weather or in rain. After a brake, they drove the same route but under the opposite weather conditions. Half of the participants drove firstly in good weather and half in rain so that their familiarization with the simulator during the third drive would not influence the results. Drivers were asked to maintain their usual driving behaviour throughout the entire experiment. It is noted that driving conditions in the virtual environment cannot be identical to those perceived by the driver in reality, especially in rain. However, the relative influence of the various parameters on driver's behavior and safety should not be significantly affected by the use of a simulator.

At specific, pre-defined locations of the journey, a supervisor of the experiment sent and received text messages to and from the driver. Each texting process lasted 60 to 90sec and required some mental alertness. While driving in moderate traffic, drivers received a 180 character sms asking for specific directions on traveling from the centre of Athens to the NTUA campus by public transport. In heavy traffic, drivers again received a 180 character sms asking for directions on how to prepare a simple recipe. In both cases, drivers had to send an sms reply. While still in heavy traffic, drivers were also asked to set the alarm function on their mobiles.

## 2.4 Analysis Method

Six models were developed to analyse the impact of texting on young drivers' behaviour and safety in terms of speed, headway and accident probability. Specifically, log-normal linear regression models were developed for mean speed and headways and binary logistic regression models for accident probability, separately for moderate and heavy traffic. Accident probability was modeled as a binary variable, equal to one when an accident occurred during the simulated drive, otherwise, equal to zero.

The selection of variables was based on univariate tests and on t- or Wald test to determine their statistical significance. Correlated statistically significant variables were identified. If two or more variables were correlated, the variable to be included in the model was selected based on its statistical significance and its relevance to the objectives of the analysis. A variable was kept in the final model if the corresponding parameter estimate was significant at 90% confidence level, by means of t- or Wald- tests. This confidence level was considered acceptable for the present analysis, given the relatively small sample size. The quality of the model was determined by means of the $R^2$ coefficient for the linear regression models and by means of the likelihood ratio test (LRT) for the binary logistic regression models.

The elasticity of the three independent variables was also calculated in order to estimate the responsiveness and sensitivity of each dependent variable which are connected with the changes in each independent variable (Washington, Karlaftis & Mannering, 2003). This allowed the comparison of the impact of different variables on texting while driving. The relevant elasticities were also calculated to classify variables with respect to the magnitude of their effect on the dependent variable in a straightforward way.

## 3. RESULTS

The often usage of mobile for texting while driving was stated by 47% of the participants, 24% stated that they using them quite often and 20% of them always. Moreover, the majority never stop by the road to text. These findings indicate that texting while driving is a common behaviour among young drivers, and considered a non-risk increasing factor; therefore, few young drivers try to compensate for it (Table 1).

***Table 1 to be inserted here***

A preliminary presentation of the three independent variables is introduced in Table 2 and hence a better understanding of the method can be achieved. Particularly, table 2 shows no difference in mean speed under good weather or rain. Mean headway is shorter while texting compared to free driving, in both traffic conditions. Furthermore, headways are longer during rain compared to good weather. Reading or writing a sms increased the number of accidents under all different conditions. It is noted that individual drivers participating in the experiment were not compared to each other in terms of driving performance nor classified based on the number of accidents they had. The number of accidents was exploited only as an indication of accident occurrence under different weather or traffic conditions and for different driving behaviours.

***Table 2 to be inserted here***

In summary, the dependent variables in the statistical analysis are the mean speed, the distance from the vehicle ahead (headway) and the accident probability. Due to their large number, the independent variables examined are not presented here but they are all presented in detail in Table A1.

### 3.1 Modelling Mean Speed

On motorways, driving in rain leads to a statistically significant decrease of mean speed compared to driving in good weather, in moderate as well as heavy traffic. In moderate traffic, both text-reading and accident occurrence predicted higher mean speeds. In moderate traffic, male drivers using mobiles with touch-screens and traveling longer distances per week, maintain higher speeds, than female drivers using mobiles without touch-screens and traveling shorter distances per week.

Instead, mean speeds were lower for increased mean distances from the central axis in moderate traffic and by drivers who enjoy driving. In both traffic conditions, drivers maintain lower mean speeds while reading a sms and even lower while writing a sms compared to free driving. Moreover, setting the alarm function and keeping increased mean distances from the central axis lead to lower mean speeds in heavy traffic. Male drivers using mobiles without touch-screens and travelling longer distances per week, maintain higher mean speeds, than female drivers using mobiles with touch-screens and travelling longer distances per week. Furthermore, drivers who enjoy driving and didn't fail to send a sms, kept lower mean speeds in heavy traffic.

Sms reading/writing variables were not the ones with the highest impact on mean speed (Table 3). In moderate traffic, this was the mean distance from the central axis, a result also found in other studies (Hosking et. al, 2006). Its impact on mean speed is 16.14 times higher than that of driving in the rain. Free driving has a 2.38 times higher impact on mean speed than sms reading. The use of a mobile with a touch-screen, the driver's gender and the travelled distance per week seem to have similar effect on mean speed as sms reading.

In heavy traffic conditions, sms writing has a 1.48 times higher impact on mean speed than sms reading and 1.32 times higher impact than alarm activation. Furthermore, sms writing has a 3.5 times higher impact on mean speed than using a mobile with a touch-screen, the driver's gender and the travelled distance per week. "Mean distance from the central axis" has again the highest impact on mean speed, a 20.78 times higher impact than driving in the rain.

Generally, in either traffic conditions, the variable with the highest impact on mean speed of young drivers, on motorways, is the mean distance from the central axis of the road. Its impact on mean speed is 6.84 and 5.66 times higher than sms reading, in moderate and heavy traffic respectively. Mean speed is also affected by the use of mobiles with or without a touch-screen. Drivers using a mobile with a touch-screen tend to keep a lower speed. The touch-screen variable has a 1.74 and 2.35 times higher impact on mean speed than sms reading in moderate and heavy traffic respectively. Drivers enjoying driving also tend to keep lower speeds. The variable "enjoying driving" has a 1.84 times higher impact on mean speed than sms reading in moderate traffic and a 1.53 times higher impact in heavy traffic.

The relatively low, still acceptable, $R^2$ values indicate that the examined independent variables can partially predict the dependent one. The examination of additional independent variables, either not recordable or partially recorded and thus, excluded from this analysis, may provide more insight on the examined dependent variables.

Summarizing, the above results indicate that the mean distance from the central axis, sms writing, free driving, rain and the touch-screen have a significant impact on mean speed.

***Table 3 to be inserted here***

### 3.2 Modelling Headway

Driving in the rain leads to a statistically significant increase of headways, compared to driving in good weather, in moderate or heavy traffic. In both traffic conditions, drivers maintain longer headways while reading a sms. Additionally, during free driving, participants maintain even longer headways compared to while writing a sms. In both traffic conditions, male drivers using mobiles without touch-screens and travelling longer distances per week decreased headways, compared to female drivers using mobiles with touch-screens and travelling shorter distances per week. In heavy traffic, increased headways were observed while setting the alarm function.

Results indicate that, in both traffic scenarios, the variable with the greatest impact on headways is free driving (Table 4). In moderate traffic, free driving has a 1.2 times greater impact on headways than sms reading and a 2.7 times higher impact than driver's gender. Sms reading has a 2.2 times greater impact on headways than that of driver's gender. The variable "rain" has a similar impact on headways as sms reading. As far as distance travelled per week is concerned, its impact on headways is 2.6 times higher than that of the touch-screen.

In heavy traffic, free driving has an impact 3.5, 1.3 and 1.9 times higher than that of rain, sms reading and alarm activation respectively. The impact of rain is approximately 1.3 times higher than that of alarm activation and touch-screen. Finally, distance travelled per week, has a 1.6 times higher impact on headways than touch-screen.

Summarising, the above results indicate that sms reading, free driving, rain, touch-screen and the distance travelled per week have a significant impact on headways.

As in the speed models, the relatively low $R^2$ values indicate that the examined independent variables can partially predict the dependent. Still they are acceptable and might be improved with the examination of additional independent variables which were either not recordable or partially recorded, and thus excluded from this analysis.

***Table 4 to be inserted here***

### 3.3 Modelling Accident Probability

Minimum distance from the central axis and time distance from the vehicle ahead are the only variables with a negative impact on accident probability both in moderate and heavy traffic. Driving in rain leads to a statistically significant increase of accident probability compared to driving in good weather, in moderate and heavy traffic, on motorways. In moderate traffic, accident probability was increased while reading a sms and even more increased while writing a sms, compared to free driving. In heavy traffic, accident probability was increased while writing a sms and even more increased while reading a sms, compared to free driving. Longer minimum distances from the central axis caused decreased accident probability while higher ratio of driver's speed to mean speed led to increased accident probability, in both traffic conditions. Keeping higher time distance from the vehicle ahead also increased accident probability. Moreover, drivers using mobiles with touch-screens and having a driving experience of more than 3 years had increased accident probability compared to drivers using mobiles without touch-screens and a driving experience of less than three years, in both moderate and heavy traffic.

In moderate traffic, the discrete variable with the highest impact on accident probability is rain (Table 5). Specifically, its impact is 1.9, 1.8, 3.6 and 2.8 times higher than that of sms reading, sms writing, touch-screen and driving experience over three years respectively. Additionally, sms writing has an impact on accident probability 2.0 and 1.1 times higher than that of the touch-screen and sms reading respectively. The continuous variable with the greatest impact is the ratio of driver's speed to mean speed, with an impact of 12.5 times higher than that of "time distance from the vehicle ahead" and 3 times higher than that of minimum distance from the central axis.

In heavy traffic, rain and the ratio of driver's speed to mean speed are again the variables with the greatest impact on accident probability. In this case, the impact of rain is 2.8, 3.0, 5.0 and 2.2 times higher than that of sms reading, sms writing, touch-screen and driving experience over three years respectively. Furthermore, the impact of sms reading on accident probability is 1.1 and 1.8 times higher than that of sms writing and touch-screen respectively. The impact of the ratio of driver's speed to mean speed is 3.4 times higher than that of the minimum distance from the central axis.

Generally, texting was found to increase accident probability. In moderate traffic, accident probability is 1.9 and 2 times higher when driver reads or writes a sms compared to free driving. Respectively, it is 1.8 and 1.7 times higher in heavy traffic. This is an indication that sms reading and sms writing are equally dangerous during driving on motorways. Accident probability is also affected by the ratio of the driver's speed to the mean speed. Those driving faster than the mean driving speed showed an increased accident probability in both traffic scenarios.

***Table 5 to be inserted here***

## 4. DISCUSSION

Understanding the impact of texting on driving performance and, in turn, on traffic safety and public health, remains an important area of research. A number of studies have examined how texting adversely affects driving performance, with a modest body of experimental research involving driving simulation and on-road studies.

The present research aims to investigate the impact of texting on the behaviour and safety of young drivers on motorways through a driving simulator experiment. The effects of texting were examined in combination with traffic and weather conditions and driver characteristics. Variables were identified based on a number of tests and also correlations between variables were checked. The variables were selected on the basis of their statistical significance and their relevance to the objectives of the analysis.

Results indicate that texting while driving, clearly increases the accident probability. On the other hand result show a reduction in speed and increased headways in both traffic scenarios. This is explained by the fact that drivers appear to produce compensatory behavior while texting. Falling farther back from lead vehicles and driving slower partially compensates for redirecting attention away from the immediate traffic environment. However, prolonged and repeated glances to type text messages likely negate the additional time and distance that is gained through these adaptive behaviors due to not seeing important changes in the traffic environment (Caird et al, 2014).

Regarding more specifically results, in moderate traffic, sms writing causes slightly higher speed reduction, shorter headways and higher accident probability than sms reading. In heavy traffic, sms writing causes slightly greater speed reduction than sms reading and a small accident probability reduction. This indicates no significant difference between sms reading and writing in association to risk and hence reading a sms or writing a sms may have the same impact towards the young drivers' safety behaviour and safety on motorways.

Drivers using mobiles with touch-screens on motorways tend to reduce their speed more and maintain longer distance from the vehicle ahead. However, their accident probability increases. A possible explanation is that a mobile with a touch-screen is usually bigger than a mobile with regular keys and hence the driver needs to move his thumb at longer distance in order to type a message. Moreover, while using a mobile phone with regular keys, a driver may choose a button by texture, without looking at the device; nonetheless this is not possible in mobile phones with touch-screens.

The examined distraction factors, sms writing or reading, have a greater impact in moderate traffic where reductions in speed and headway are lower. This is probably due to the more defensive driving behaviour which is usually adopted in heavy traffic. Indeed, it is possible that drivers drive more defensively in heavy traffic due to the increased hazards.

Considering the method used, it is noted that no matter how well a simulator experiment is designed, it is rather unlikely that drivers perform exactly as they would in actual conditions (GHSA, 2011). This is because several issues such as the feeling of speeding and rain cannot be fully represented; a known limitation of simulator experiments. Other issues such as the adoption of different driving behaviours when observed; the feeling of safety while driving on the simulator and "simulator sickness" due to long drives should also be taken into consideration.

This study may serve as a basis for further similar experiments on motorways with larger sample and participants of various ages with various years of driving experience. According to previous studies, although young drivers show increased ability to share attention between concurrent tasks, they are more vulnerable to distraction (Young & Regan, 2007). Moreover, the impairment caused by texting should be explored in more complex road environments, traffic density, adverse weather conditions etc. The comparison of different distraction factors would allow for their classification in terms of risk. Finally, the contribution of new technologies used for texting to the improvement of road safety could be examined.

## 5. REFERENCES

1) Atchley, P., Atwood, S., & Boulton, A. (2011). The choice to text and drive in younger drivers: behavior may shape attitude. Accident Analysis and Prevention, 43, 134–142.

2) Caird, J., Johnston, K., Willness, C., Asbridge, M., & Steel, P. (2014). A meta-analysis of the effects of texting on driving, Accident Analysis & Prevention, 71, 311-318.

3) Caird, J., Willness, C., Steel, P., & Scialfa, C. (2008). A meta-analysis of the effects of cell phones on driver performance. Accident Analysis and Prevention 40, 1280-1293.

4) Cheung, D. (2010). Texting while driving: its effects on driving performance and texting behaviour, Diploma Thesis, Faculty of Life Sciences, University College London.

5) Cooper, J., Yager, C., & Crysler, S. (2011). An investigation of the effects of reading and writing text-based messages while driving. Texas Transportation Institute.

6) Crisler, M., Brooks, J., Ogle, J., Guirl, C., Alluri, P., & Dixon, K. (2008). Effect of wireless communication and entertainment devices on simulated driving performance. Transportation Research Record. Journal of the TRB, 2069, 48–54.

7) Drews, F., Yazdani, H., Godfrey, C., Cooper, J., & Strayer, D. (2009). Text messaging during simulated driving. Human Factors: The Journal of the Human Factors and Ergonomics Society, 51(5), 2009, pp. 762-770.

8) Governors Highway Safety Association. (2011). Distracted driving. What research shows and what states can do. Washington DC.

9) Gkartzonikas, C. (2012). Impact of texting on young drivers' traffic and safety on motorways by the use of a driving simulator, Diploma Thesis. Department of Transportation Planning and Engineering, School of Civil Engineering, National Technical University of Athens, Greece.

10) Hosking, S.G., K.L. Young, and M.A. Regan. The effects of text messaging on young drivers. Human Factors: The Journal of the Human Factors and Ergonomics Society, 51(4), 2009, pp. 582-592.

11) Horberry, T., Anderson, J., Regan, M. A., Triggs, T. J. & Brown, J. (2006). Driver distraction: The effects of concurrent in-vehicle tasks, road environment complexity and age on driving performance. Accident Analysis and Prevention, 38, 185-191.

12) Horrey, W. J., & Simons, D. J. (2007). Examining cognitive interference and adaptive safety behaviours in tactical vehicle control. Ergonomics, 50, 1340-1350.

13) Klauer, S. G., Dingus, T. A., Neale, V. L., Sudweeks, J. D., & Ramsey, D. J. (2006). The impact of driver inattention on near crash/crash risk: an analysis using the 100-car naturalistic driving study data. National Highway Traffic Safety Administration, Washington DC.

14) McEvoy, S. P., Stevenson, M. R., McCartt, A. T., Woodward, M., Haworth, C., & Palamara, P. (2005). Role of mobile phones in motor vehicle crashes resulting in hospital attendance: a case-crossover study. British Medical Journal, 331, 428.
15) McKnight, A. J., & McKnight, A. S. (1993). The effect of mobile phone use upon driver attention. Accident Analysis and Prevention, 25, 259-265.
16) Nelson, E., Atchley, P., & Little, T. (2009). The effects of perception of risk and importance of answering and initiating a cellular phone call while driving. Accident Analysis Prevention, 41, 438–444.
17) Neyens, D. M. & Boyle, L. N., (2008). The influence of driver distraction on the severity of injuries sustained by teenage drivers and their passengers. Accident Analysis and Prevention, 40, 254–259.
18) O'Malley, E., Shults, R. A., & Eaton, D.K., (2013). Texting while driving and other risky motor vehicle behaviors among US high school students. Pediatrics, 131, e1708–e1715.
19) Olson, R. L., Hanowski, R. J., Hickman, J. S., & Bocanegra, J. (2009). Driver distraction in commercial operations vehicle. Virginia Tech Transportation Institute.
20) Patel, J., Ball, D. J., & Jones, H. (2008). Factors influencing subjective ranking of driver distractions. Accident Analysis Prevention, 40, 392-395.
21) Strayer, D. L., Drews, F. A., & Johnston, W.A. (2003). Cell phone-induced failures of visual attention during simulated driving. Journal of Experimental Psychology: Applied, 9(1), 23-32.
22) SWOV. (2010). Use of the mobile while driving. Fact Sheet. SWOV Institute for Road Safety. August.
23) Vlingo Corporation. (2009). Vlingo consumer mobile messaging habits report. May.
24) Washington, S. P., Karlaftis, M. G., & Mannering, F. L. (2003). Statistical and Econometric Methods for Transportation Data Analysis. Chapman & Hall / CRC Press. Boca Raton FL.
25) White, K. M., Walsh, S. P., Hyde, M.K., & Watson, B. C. (2010). Mobile use while driving: An investigation of the beliefs influencing drivers' hands-free and hand-held mobile use, Transportation Research Part F: Traffic Psychology and Behavior, 13(1), 9-20.
26) Wilson, F. A., & Stimpson, J. P., (2010). Trends in fatalities from distracted driving in the United States, 1999 to 2008. American Journal of Public Health 100, 2213–2219.
27) Young, K., & Regan, M. (2007). Driver Distraction: A Review of the Literature in Distracted Driving edited by Faulkset et al. Sydney: Australasian College of Road Safety, 384.