European Transport \ Trasporti Europei (2024) Issue 97, Paper n° 6, ISSN 1825-3997

https://doi.org/10.48295/ET.2024.97.6

Distraction Effects of Manual Texting and Voice Messaging When Approaching Pedestrian Crossings on Urban Roads: a Driving Simulator Study

Alessandro Calvi*, Fabrizio D'Amico, Andrea Vennarucci

Department of Civil, Computer Science and Aeronautical Technologies Engineering, Roma Tre University, via Vito Volterra 60, 00146, Rome, Italy

Abstract

The purpose of this study was to assess the impact of texting while driving on driver performance and road safety. In order to achieve this goal, 51 participants took part in a driving simulator study that replicated an urban environment. During the trials, text messages with questions of equal cognitive weight were sent to be answered via 1) a manual texting application or 2) a voice message application. A baseline condition with no secondary task was also tested. Along the simulated route, there were some events that could cause a crash, like pedestrians crossing on-and-off crosswalks. The overall findings indicate that both texting and voice messaging activities while driving have detrimental effects on driving performance and road safety, putting drivers at high risk. The practical applications of the findings of this study are primarily directed at policymakers and stakeholders for the development of effective and targeted campaigns.

Keywords: Driving simulator; Distracted driving; Dual-task study; Texting; Road safety; Pedestrian; Driver behaviour.

1. Introduction

According to international road crash reports, user distraction is one of the leading causes of road accidents (WHO, 2011; ACI, 2022). Driver distraction is typically defined as a combination of three main factors: auditory, such as talking to passengers; tactile, such as manipulating objects; and cognitive, such as performing tasks that require significant concentration and cognitive effort.

Multiple studies (e.g., Lipovac et al., 2017; Nicolls et al., 2022) indicate that drivers frequently use smartphones, which, when engaged in activities such as texting, present all the above-described distraction-related factors. Indeed, texting while driving requires the use of sight (looking away from the road), touch and manipulation of the

* Corresponding author: Alessandro Calvi (alessandro.calvi@uniroma3.it)

smartphone, as well as considerable cognitive effort to perform both tasks, writing and driving, simultaneously.

Several studies (e.g., Benedetto et al., 2015; Caird et al., 2008; Haque and Washington, 2014; Lesch and Hancock, 2004; Matthews et al., 2003) have been conducted to address the issue of driver distraction, emphasizing the negative effects of cell phone use (particularly calling) while driving. Texting while driving, which is common, especially but not only, among young drivers, has been looked at in fewer studies so far (e.g., Al Aufi et al., 2022; Burge and Chaparro, 2018; Foreman et al., 2021; Yannis et al., 2014; Yannis et al., 2016; Kurtz et al., 2021; Morgenstern et al., 2020; Hosking et al., 2009).

According to the results of several studies (e.g., McCartt et al., 2006; Svenson and Patten, 2005; Boboc et al., 2022), the overall and most frequent effects related to calling while driving revealed that there is a consistent difference between using a smartphone hand-held or hands-free (Tornros and Bolling, 2005). The main effect of distraction is latent hazard anticipation, increasing reaction time, headway, lane and speed maintenance, and reducing the time to collision. Even though people recognize these negative effects, they continue to use mobile phones while driving, being deceived by illusory control, which leads them to believe that they can control the distraction. Regarding the complexity of phone conversations, studies have shown that driving performance decreases as the cognitive load involved in the dialogue increases.

Only a few studies have investigated the effects of texting while driving. However, the overall results indicated that texting has a significantly larger negative influence on driving performance than a phone conversation. However, most of these studies have been developed in rural environments and did not investigate very critical and hazardous situations that the drivers should manage while involved in texting activity, especially on urban roads, where there are several additional risk factors (i.e., interactions with vulnerable road users) than on rural roads. It was found that the main impacts of the secondary task (texting) on driving performance are: increased variability in lane position and missed lane changes (Hosking et al., 2009), increased brake reaction time (Burge and Chaparro, 2018; Yannis et al., 2014; Yannis et al., 2016), greater speed variability (Al Aufi et al., 2022; Morgenstern et al., 2020), as well as a higher risk of crashes (Yannis et al., 2014; Yannis et al., 2016). Sending or reading a message on a smartphone, especially when using it by hand, takes the driver’s eyes off the road (Burge and Chaparro, 2018), implicating not only a manual distraction but also a visual one. However, as in the case of calling, some drivers, especially the younger ones, cannot resist using their smartphones for texting while driving.

The present study is part of a wider research project, based on driving simulation tests, aimed at evaluating the distraction effects of smartphone activities while driving, such as calling and driving (e.g., Benedetto et al., 2012; Benedetto et al., 2015; Calvi et al., 2018) and the use of social networking activities (D’Amico et al., 2020). Specifically, this dual-task study focuses on a risky situation: the sudden crossing of pedestrians on and out of crosswalks on urban roads, just in front of drivers who are involved in texting activities with their smartphone (manual and voice messaging). The interaction between the drivers and the pedestrians is investigated to evaluate the effects of distraction on driving performance and safety, with reference to the potential conflict between distracted drivers and vulnerable road users in an urban context when engaged in a high-risk situation that requires urgent action from the driver.

2. Methodology

2.1 Driving simulator

The fixed-based medium-fidelity driving simulator of the Department of Civil, Computer Science and Aeronautical Technologies Engineering at Roma Tre University (Figure 1) was used for the experimental purpose. It consists of a full-cab Toyota Auris with a force-feedback steering wheel, brake and accelerator pedals, and a performance measurement system. The driving scenario is projected on a curved screen by means of three high-resolution projectors (1920 x 1200 pixels, each with a frame rate of 60 Hz). The driving simulator has been fully validated in previous studies for speed and trajectory measures (Calvi, 2018; Calvi et al., 2020a), demonstrating its capability of investigating how different factors, both external and internal to the driver, may affect the perception of driving risk and road safety, using tests that are reproducible for all the sample of drivers with the same simulated events and in a controlled environment.

Figure 1: Roma Tre driving simulator: a pedestrian is crossing while the driver is texting.

2.2 Participants

A total of 51 participants (51% males and 49% females) took part in the driving simulator study. They held a valid driver's license and had not yet participated in previous driving simulator studies. All the drivers reported being quite familiar and expert with the use of smartphones and their apps. Seven participants were excluded due to technical errors in data acquisition or simulator sickness. Thus, the final sample consisted of 44 subjects (21 women and 23 men), with a mean age of 25.1 years (s.d. = 2.9 years).

2.3 Scenario design and experimental procedure

A scenario consisting of a 10-kilometer two-lane urban road was implemented in the driving simulator. Several pedestrian crossing configurations were randomly simulated in three alternative drives (tests) of the same scenario. The urban road (50 km/h speed limit) was characterized by 3.50 m lanes with 4.00 m sidewalks on each side. In the scenario, only a few vehicles were randomly added in the opposite direction to encourage the driver to avoid driving in the left lane. Buildings, intersections, vertical signs and markings, and all the features of a typical urban environment were exactly reproduced in the simulation scenario to give drivers the greatest sense of real driving. A series of critical events were included during the tests, which provided insight into drivers' behavior during highly risky conditions. These events were carried out for each of the drives but were shifted from time to time to achieve the surprise effect and prevent the driver from acting from experience. Specifically, two critical pedestrian crossing events (Figure 2) were investigated as follows: while driving, a pedestrian moved from the right to the left sidewalk, following the zebra crossing markings in the first event (namely, legal pedestrian crossing, LPC, Figure 2a), and out of the crosswalk in the second event (namely, illegal pedestrian crossing, IPC, Figure 2b). The LPC event was designed according to Calvi et al. (2020b): the pedestrian started to cross at the right edge of the road on the proper sign with a speed of 1.4 m/s when the driver is 50 m from the crossing. The IPC event was designed based on the same studies and had the same initial characteristics.

a) Legal Pedestrian Crossing (LPC)

b) Illegal Pedestrian Crossing (IPC)

Figure 2: Legal and illegal pedestrian crossings reproduced in the driving simulator scenario.

Other features and events, such as traffic lights, intersections, parking vehicles, and other pedestrian crossings, were implemented and randomized in the scenario to prevent drivers from memorizing the patterns and their expectations of the events under investigation, especially when they were involved in the texting tasks.

The sample of participants was tested in three different drives of the same scenario, where the pedestrian crossing events were studied under different secondary tasks of the drivers. However, the pedestrian crossing events were designed with the same features, thereby ensuring a reproducible situation for all the drivers. Specifically, the interactions between the drivers and the crossing pedestrians were investigated to evaluate the distraction effects on drivers when receiving and sending text messages using both manual texting and voice-command texting (dual-task condition). Accordingly, three different conditions characterizing the secondary task were investigated in the three drives:

- manual texting, with the phone being held in the driver’s hand, namely Texting Condition (TC); in this drive, the participant was asked to use the qwerty keyboard of the smartphone to send and reply to messages through a dedicated smartphone messaging application;
- voice message, a hands-free texting activity using another dedicated smartphone application to send voice-command texting, namely Voice-to-text Condition (VC); in this drive, the smartphone was fixed on the vehicle's air conditioning vents using a clamp-locked support device, making it easy to use it while driving without having to take the hands off the wheel to listen and send messages;
- no use of smartphones, namely Baseline Condition (BC); in this drive, no secondary tasks were implemented (single-task condition).

The texting activity, either through the use of the smartphone keyboard or through voice command, involves the driver in the task of sending and receiving messages with the experimenter. Specifically, some questions were sent to the driver, and it was asked that she or he responds to the messages within 5 seconds of receipt. The sending of the messages was set according to the driver's position within the simulation scenario, i.e., when the driver was in a section where critical events were not expected, the sending of questions was carried out every 10 seconds, to prevent the driver from being overly involved by the secondary activity and prompted by the harmless consequences of a possible accidental event and from focusing only on the texting activity and not on the primary activity that should remain driving. On the other hand, when the driver was in the road section where the critical event was set, the sending of questions took on a much more stringent time interval in order to be certain of distraction at the time when the critical event occurred.

Text messages were calibrated so that they all had the same cognitive load and that their responses could be as clear as possible and characterized by a low number of letters. In more detail, the content of the messages was divided into the following macro groups: Presentation Questions (i.e., *what is your name? how old are you?*), Color Game (i.e., *what color is the sun? what color is the sky?*), Numbers Game (i.e., *how much is two plus two?*), and Vowel and Consonant Game (i.e., *is the letter A vocal or consonant?*). The same questions were also sent as audio recordings in VC and pre-recorded so as not to affect the quality and reproducibility of the tests.

A strict experimental protocol was applied to the driving simulator tests. Two test session days with an interval of one week were defined: the first with one drive and the second with the remaining two. Each test drive lasted approximately 15 minutes. The order of the drives among the participants was randomized. Before the session, each driver had to drive a training scenario for about 10 minutes to become familiar with the tool. Moreover, a before-test questionnaire and an after-test questionnaire were submitted to the drivers to collect general information about the drivers (demographic data in the before-test questionnaire) and their impressions and feelings on the test (in the after-test questionnaire).

2.4 Data collection

Several driving performances (speeds, distances, etc.) and surrogate safety measures (Time-To-Zebra, TTZ) were collected, analyzed, and compared between the three conditions (BC, TC, and VC) in order to investigate the influence of the texting activities on driving performances in relation to the pedestrian crossing events (LPC and IPC). The variables to describe the driving performance in each event are listed below:

- S_i is the speed at which the driver presses the brake pedal;
- D_i corresponds to the distance between the driver and the pedestrian crossing, where the driver presses the brake pedal;
- TTZ is the Time-To-Zebra recorded when the driver presses the brake pedal;
- d_{max} is the maximum deceleration;
- S_{min} is the minimum speed during the deceleration maneuver, excluding cases where the driver stopped the vehicle before the pedestrian crossed or had a collision with the pedestrian itself;
- D_{min} corresponds to the distance between the driver and the pedestrian crossing, where the minimum speed is recorded.

Moreover, in a selected tangent (500 meters long) of the scenario where no events were set, in the meantime the driver was involved in the texting activities (in TC and VC), the average speed (S_{av}), and the standard deviations of speeds (SD_S) and lateral positions (SD_{LP}) of the sample of drivers were recorded in order to investigate the distraction effects and the presence of possible compensatory strategies of the distracted drivers without any further critical events as pedestrians suddenly crossing the road.

Finally, considering the high-risk events deliberately simulated in the tests, the number of pedestrian-vehicle crashes was recorded for each event and each condition.

3. Results and discussion

The collected data were statistically analyzed. Several statistical tests were used to examine the effects of the texting activities on the variables selected in this study and previously described; for this purpose, one-way ANOVA or non-parametric tests were applied, depending on the characteristics (normality and homoscedasticity) of the data set for each dependent variable investigated. Specifically, the normality of the distributions was evaluated using the Kolmogorov-Smirnov test and the Shapiro-Wilk test, while the homoscedasticity was assessed using Levene’s test. If the assumptions regarding normality and homoscedasticity of the data set were both verified, then the one-way ANOVA test was conducted according to the test’s assumptions. Conversely, if the assumption of normality was violated but homoscedasticity was verified, the non-parametric Kruskal-Wallis test was used; finally, if normality was verified but homoscedasticity was not, then the Brown-Forsythe test was conducted.

Table 1 summarizes the results of the statistical analyses. The average values of each variable selected, along with the standard deviations (in parentheses) and the results of the statistical tests, are given in the table for the two events (LPC and IPC) and the three driving conditions (BC, TC, and VC).

3.1 Crash occurrence

A preliminary descriptive analysis reported that a higher number of accidents in cases of distracted driving were recorded compared to the baseline condition. In more details, in the LPC event, the drivers never had a crash with the crossing pedestrian in BC; no crashes were recorded in VC either, while in TC, one driver had a crash with the pedestrian. The number of pedestrian-vehicle crashes was found to increase for IPC events: 2 crashes in BC (5%), 6 crashes in VC (14%), and even 12 crashes in TC (27%). Among these, some crashes occurred without any reaction of the driver prior to the collision (i.e., braking), with a consequent high impact speed (up to 58 km/h). In particular, 50% of the crashes in VC occurred without an attempt by the driver to avoid the collision with the crossing pedestrian; the percentage was even higher (67%) in TC, according to the higher distraction caused by the texting activity, both based on vocal command and even more when the text was typed manually, holding the smartphone in the hand and looking at it.

Table 1: Average of the Investigated Variables and Their Standard Deviation (in Parentheses) and Results of the Statistical Analysis for Each Event in Each Condition.

Event	*Variable*	*Baseline Condition*	*Texting Condition*	*Voice-to-text Condition*	*Statistical analysis values*	
					Test	*p*
LPC	S_i [km/h]	46.51 (10.58)	43.64 (11.53)	49.02 (18.36)	ANOVA	0.252
	D_i [m]	38.92 (15.03)	33.73 (19.54)	40.08 (29.62)	K. Wallis	0.025
	TTZ [s]	0.87 (0.36)	0.71 (0.39)	0.91 (0.99)	K. Wallis	0.048
	D_{min} [m]	0.58 (0.34)	0.61 (0.42)	0.68 (0.36)	ANOVA	0.469
	d_{max} [m/s^2]	-6.47 (2.36)	-6.83 (2.97)	-6.42 (2.47)	K. Wallis	0.609
	S_{min} [km/h]	13.06 (6.52)	13.33 (7.97)	13.37 (5.82)	B. Forshyte	0.870
	DS_{min} [m]	18.61 (7.04)	18.57 (6.00)	17.17 (6.15)	ANOVA	0.498
IPC	S_i [km/h]	45.35 (7.23)	44.81 (6.96)	45.00 (8.22)	ANOVA	0.265
	D_i [m]	26.30 (7.32)	21.02 (7.45)	25.82 (3.52)	K. Wallis	0.000
	TTZ [s]	0.57 (0.22)	0.49 (0.22)	0.56 (0.18)	K. Wallis	0.004
	D_{min} [m]	0.57 (0.50)	0.48 (0.64)	0.50 (0.35)	ANOVA	0.853
	d_{max} [m/s^2]	-7.61 (2.31)	-7.93 (2.53)	-7.67 (1.97)	K. Wallis	0.149
	S_{min} [km/h]	12.12 (11.23)	12.72 (8.51)	13.05 (7.80)	K. Wallis	0.525
	DS_{min} [m]	12.37 (5.05)	10.49 (5.27)	10.40 (4.71)	ANOVA	0.155

3.2 Distracted driving by texting

The variables selected for investigating the distracting effects of texting while driving along a road segment (tangent, 500 meters long) of the drives where no other events (i.e., pedestrian crossing) were reproduced revealed interesting results, confirming most of the literature findings on this topic of research (Choudhary and Velaga, 2017; Haigney et al., 2000; Kurtz et al., 2021; Morgenstern et al., 2020). In fact, it was found that the average speeds of the drivers (S_{av}) in BC (72.63 km/h) were significantly higher than S_{av} in TC (68.64 km/h), confirming the compensatory effects of the drivers who perceived the higher risk caused by the manual texting activity. Conversely, no significant differences were recorded between BC and VC (72.89 km/h), as the drivers did not perceive such activity (sending and receiving vocal messages) as particularly hazardous. The two other surrogate safety measures, i.e., the standard deviations of speeds (SD_S) and lateral positions (SD_{LP}) of the sample of drivers on the 500-long road segment, demonstrated the safety issues related to the distraction effects caused by the texting activity, both manual and vocal. Indeed, the SD_S recorded in BC (6.39 km/h) was significantly lower than the SD_S recorded in TC (8.41 km/h) and in VC (7.89 km/h). The same results were found for SD_{LP}: 0.19 m in BC, 0.27 m in TC, and 0.22 m in VC, resulting in greater dispersion of speeds and trajectory values.

3.3 Distracted drivers and crossing pedestrian

Legal Pedestrian Crossing (LPC) event.

Although not statistically significant, the values of S_i recorded where the driver started to decelerate provided some differences between the three conditions. Specifically, compared to BC, S_i was lower in TC (-2.87 km/h) and higher in VC (2.51 km/h), confirming the previous results on S_{av} and the compensatory strategies of the drivers in terms of speed choice when distracted by the secondary tasks. Significant differences were observed between D_i recorded in the three conditions: while D_i values in BC and VC were quite similar, a greater difference was revealed in TC, where the driver started to decelerate later, nearer to the pedestrian crossing (5.19 m later than in BC). Consequently, TTZ was also significantly lower in TC than in BC and VC, demonstrating significant negative effects caused by manual texting on road safety. Conversely, no significant differences were observed for D_{min}, d_{max}, S_{min}, or DS_{min}. As expected, the higher d_{max} values were recorded in TC due to the delay in the braking caused by the distraction effects of the texting activities.

Illegal Pedestrian Crossing (IPC) event.

The event of the pedestrian crossing the road out of the crosswalk was deliberately designed in order to greatly surprise the driver, who did not expect such an event, as demonstrated by the high number of crashes that occurred during the tests, especially for the drivers distracted by the texting activities. The results are similar to those obtained for the previous event (LPC), although the values of most of the variables were quite critical in terms of distraction performance and road safety. Indeed, the driver started to decelerate nearer to the crossing pedestrian, with the minimum value recorded again in TC (21.02 m), which was significantly lower than D_i in BC and VC. Accordingly, TTZ values were lower in all three conditions than the correspondent values recorded for the LPC event, with the minimum value (0.49 s) in TC. As well as in the previous event, no other statistically significant differences were observed for the other variables, although all the values were more critical than in the previous event: lower D_{min} and DS_{min} and higher d_{max}, especially in TC.

4. Conclusions

In this study, the distraction effects of using smartphones for texting activities on driving performance and road safety were investigated in an urban environment and in relation to unexpected events related to pedestrians suddenly crossing the road on (LPC) and out (IPC) of the crosswalk. The results have shown that distracted driving caused a high number of vehicle-pedestrian crashes, especially when drivers were engaged in manual texting activities and facing a pedestrian crossing out of the crosswalk. Compared to the baseline condition, where the driver was not using the smartphone, the distraction caused by the texting resulted in a significant delay in starting the deceleration maneuver to avoid a collision with the pedestrian and lower TTZ. These results were more critical in the IPC event than in the LPC. Finally, in terms of speeds, a compensatory strategy by the drivers was observed, with significantly lower speeds recorded during TC. However, such behaviors based on driver's risk perception were not able to prevent drivers from crashing into pedestrians.

Although the results of this study are promising and confirm many previous literature findings, additional simulator studies are planned in order to overcome the actual limitations. Further validation studies that vary the distraction condition and consequently the mental workload of drivers should be performed to confirm these findings and strengthen and generalize the results. Specifically, the analyses should be extended to larger samples of drivers to allow for investigating the effect of distraction in relation to the demographic characteristics and driving experience of the drivers. Indeed, in this experiment, a homogeneous sample of drivers, specifically young drivers, was selected so that any bias due to sample heterogeneity could be reasonably negligible or severely limited.

Moreover, a driving simulator study is underway to track drivers' eye movements using an eye tracking system and examine additional variables to improve the knowledge of the distraction effects caused by texting activities on driving performance and road safety. Other simulation tests are planned to investigate driver distraction caused by social networking activities using the smartphone and compare the effects of distraction on driving performance and road safety with those recorded in calling and texting activities.

The practical applications of the findings of this study are primarily directed at policymakers and stakeholders for the development of effective and targeted campaigns, given that, as revealed by a survey administered to 1,200 young participants in the preliminary phase of this study regarding their driving habits and attitudes, the use of smartphones for texting is widespread, and the risk associated with this activity is grossly underestimated. In the same way, the results could help the mobile phone industry and the auto industry make systems that can detect and stop driver distraction in real-time by controlling the most important predictors of distraction.

References

ACI (2022). Incidenti Stradali [Online]. Available: https://www.aci.it/fileadmin/documenti/studi_e_ricerche/dati_statistiche/incidenti/2021/Report_incidenti_stradali_2021.pdf.

Al Aufi, A., Schmidt, C., Goetz, J., Haleem, K. (2022) "Investigating "Texting while Driving" Behavior at Different Roadway Configurations Using a Driving Simulator Setting", *Transportation Research Record* 2676 (3), pp. 183-200. doi: 10.1177/03611981211049413.

Benedetto, A., Calvi, A., D'Amico, F. (2012) "Effect of mobile telephone tasks on driving performance: a driving simulator study", *Advances in Transportation Studies* 26, pp. 29-44.

Benedetto, A., Calvi, A., D'Amico, F. (2015) "Mobile phone and Driving", In: Z. Yan (Ed.), *Encyclopedia of Mobile Phone Behavior* (Volumes 1, 2, & 3). Hershey, PA: IGI Global, pp. 1341-1355. doi: 10.4018/978-1-4666-8239-9.

Boboc, R.G., Voinea, G.D., Buzdugan, I.D., Antonya, C. (2022) "Talking on the Phone While Driving: A Literature Review on Driving Simulator Studies", *International Journal of Environmental Research and Public Health* 19 (17), 10554. doi: 10.3390/ijerph191710554.

Burge, R., Chaparro, A. (2018) "An investigation of the effect of texting on hazard perception using fuzzy signal detection theory (fSDT)", *Transportation Research Part F* 58, pp. 123-132. doi: 10.1016/j.trf.2018.05.033.

Caird, J.K., Willness, C.R., Steel, P., Scialfa, C. (2008) "A meta-analysis of the effects of cell phones on driver performance", *Accident Analysis and Prevention* 40, pp. 1282-1293. doi: 10.1016/j.aap.2008.01.009.

Calvi, A. (2018) "Investigating the effectiveness of perceptual treatments on a crest vertical curve: A driving simulator study", *Transportation Research Part F* 58, pp. 123-132. doi: 10.1016/j.trf.2018.06.002.

Calvi, A., Benedetto, A., D'Amico, F. (2018) "Investigating driver reaction time and speed during mobile phone conversations with a lead vehicle in front: A driving simulator comprehensive study", *Journal of Transportation Safety & Security* 10 (1-2), pp. 5-24. doi: 10.1080/19439962.2017.1310161.

Calvi, A., D'Amico, F., Ferrante, C., Bianchini Ciampoli, L. (2020a) "A Driving Simulator Validation Study for Evaluating the Driving Performance on Deceleration and Acceleration Lanes", *Advances in Transportation Studies* 50, pp. 67-80.

Calvi, A., D'Amico, F., Ferrante, C., Bianchini Ciampoli, L. (2020b) "Effectiveness of Augmented Reality Warnings on Driving Behavior Whilst Approaching Pedestrian Crossings: a Driving Simulator Study", *Accident Analysis and Prevention* 147, 105760. doi: 10.1016/j.aap.2020.105760.

Choudhary, P., Velaga, N.R. (2017) "Mobile phone use during driving: Effects on speed and effectiveness of driver compensatory behavior", *Accident Analysis and Prevention* 106, pp. 370- 378. doi: 10.1016/j.aap.2017.06.021.

D'Amico, F., Calvi, A., Ferrante, C., Bianchini Ciampoli, L. (2020) "Assessment of driver distraction caused by social networking activities using the smartphone: a driving simulator study", *Advances in Intelligent Systems and Computing* 1212, pp. 24-31. doi: 10.1007/978-3-030-50943-9_4.

Foreman, A.M., Friedel, J.E., Hayashi, Y., Wirth, O. (2021) "Texting while driving: A discrete choice experiment", *Accident Analysis and Prevention* 149, 105823. doi: 10.1016/j.aap.2020.105823.

Haigney, D.E., Taylor, R.G., Westerman, S.J. (2000) "Concurrent mobile (cellular) phone use and driving performance: Task demand characteristics and compensatory processes", *Transportation Research Part F* 3 (3), pp. 113-121. doi: 10.1016/S1369-8478(00)00020-6.

Haque, M.M., Washington, S. (2014) "A parametric duration model of the reaction times of drivers distracted by mobile phone conversations", *Accident Analysis and Prevention* 62, pp. 42–53. doi: 10.1016/j.aap.2013.09.010.

Hosking, S.G., Young, K.L., Regan, M.A. (2009) "The effect of texting messaging on young drivers", *Human Factors* 51 (4), pp. 582-592. doi: 10.1177/0018720809341575.

Kurtz, M., Oehl, M., Sutter. C. (2021) "" "Just One Short Voice Message" - Comparing the Effects of Text- vs. Voice-Based Answering to Text Messages via Smartphone on Young Drivers' Driving Performances", *Safety* 7 (3), 57. doi: 10.3390/safety7030057.

Lesch, M.F., Hancock, P.A. (2004) "Driving performance during concurrent cell-phone use: Are drivers aware of their performance decrements?", *Accident Analysis and Prevention* 36 (3), pp. 471-480. doi: 10.1016/S0001-4575(03)00042-3.

Lipovac, K., Deric, M., Tesic, M., Andric, Z., Maric, B. (2017) "Mobile phone use while driving-literary review", *Transportation Research Part F* 47, pp. 132-142. doi: 10.1016/j.trf.2017.04.015.

Matthews, R., Legg, S., Charlton, S. (2003) "The effect of cell phone type on drivers subjective workload during concurrent driving and conversing", *Accident Analysis and Prevention* 35 (4), pp. 451-457. doi: 10.1016/S0001-4575(02)00023-4.

McCartt, A.T., Hellinga, L.A., Bratiman, K.A. (2006) "Cell phones and driving: Review of research", *Traffic Injury Prevention* 7 (2), pp. 89-106. doi: 10.1080/15389580600651103.

Morgenstern, T., Schott, L., Krems, J.F. (2020) "Do drivers reduce their speed when texting on highways? A replication study using European naturalistic driving data", *Safety Science* 128, 104740. doi: 10.1016/j.ssci.2020.104740.

Nicolls, M., Verity, T., Kayla, B.S. (2022) "The impact of descriptive and injunctive norms on engagement in mobile phone use while driving in young drivers: A systematic review", *Accident Analysis and Prevention* 175, 106774. doi: 10.1016/j.aap.2022.106774.

Svenson, O., Patten, C.J.D. (2005) "Mobile phones and driving: a review of contemporary research", *Cognition and Technology Work* 7, pp. 182-197. doi: 10.1007/s10111-005-0185-3.

Tornros, J., Bolling, A. (2005) "Mobile phone use - Effects of handheld and handsfree phones on driving performance", *Accident Analysis and Prevention* 37 (5), pp. 902-909. doi: 10.1016/j.aap.2005.04.007.

Yannis, G., Laiou, A., Papantoniou, P., Christoforou, C. (2014) "Impact of texting on young drivers' behavior and safety on urban and rural roads through a simulation experiment", *Journal of Safety Research* 49, pp. 25-31. doi: 10.1016/j.jsr.2014.02.008.

Yannis, G., Laiou, A., Papantoniou, P., Gkartzonikas, C. (2016) "Simulation of texting impact on young drivers' behavior and safety on motorways", *Transportation Research Part F* 41, pp. 10-18. doi: 10.1016/j.trf.2016.06.003.

WHO (2011). Mobile phone use: a growing problem of driver distraction. Available: https://www.who.int/publications/i/item/mobile-phone-use-a-growing-problem-of-driver-distraction.