Texting with a smartphone in a dashboard mount.

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ABSTRACT

In the Netherlands, handheld phone use while driving is prohibited. However, mobile phone use while driving is allowed when the phone is placed in a dashboard mount. Many studies have shown that handheld texting is a major concern for traffic safety because it negatively affects driving performance and increases crash rates. The objective of this study was to investigate driving performance during handsfree texting and to compare it to handheld texting while driving. Participants were seated in a driving simulator wherein they drove three times on the same dual carriageway while wearing a head mounted eye-tracker. While driving, participants texted once handheld, once handsfree and during one drive they did not text (baseline). During the handheld and handsfree texting drives they received three short test messages to which they had to reply. These questions were easy to understand and elicited one-word replies of approximately ten characters. Whenever a participant did not know how to reply, they were instructed to answer the Dutch equivalent of ‘I don’t know’ (‘weet ik niet’) or something of their preference. Participant’s gaze behavior was measured using a head-mounted eye-tracker, driving performance was measured by using the standard deviation of both the lateral position and speed and subjective workload was measured using the Rating Scale for Mental Effort (RSME). The results show that participants looked significantly more often at the phone in a dashboard mount compared to when they were texting handheld. Additionally, the total dwell time on the smartphone was also longer while texting handsfree compared to texting handheld. There were no significant differences between the texting drives on the number of glances longer than 2 seconds, longest glance and mean fixating duration at the smartphone. Compared to the baseline drive, the total dwell time in the mirrors was much shorted during the two texting drives. The standard deviation of the lateral position and the standard deviation of speed was lower during both texting drives. Lastly, the experienced subjective workload was higher during both texting drives compared to the baseline drive, and was highest during the handheld texting drive. These results indicate that handsfree texting is at least as unsafe and detrimental to the execution of the driving task as handheld texting.

Keywords: distraction, smartphone use, simulator, eye tracking.

1. INTRODUCTION

This paper reports the results of a simulator study on the effect of handheld and handsfree mobile phone use while driving. It is currently prohibited in the Netherlands to hold a smartphone in your hand while driving. At the same time, using the mobile phone in a dashboard mount to use the navigation or send text messages is allowed. This discrepancy could lead to the (mis)perception that using the mobile phone while mounted in a dashboard mount is safer compared to mobile phone use by hand. Thus, it is necessary to identify the effects of texting using a dashboard mounted phone.

It is well known that using a mobile phone while driving is dangerous and distracting. Using a mobile phone while driving increases the chances of a (police registered) accident by 3,47 compared to driving without performing a secondary or distracting task (Dingus et al, 2019). Another study (Lyngsie et al., 2013) found that sending handheld text messages with a smartphone while driving in a simulator increases accident risk with a factor 5. Cairds et al. (2014) performed a meta-analysis (28 studies) of the effects of texting on driving performance. They found that both typing and reading text while driving affected eye movements, stimulus detection, reaction time, collisions, lane positioning, speed variance and headway.

Is it currently unknown what the specific risk is for texting while driving with a mobile phone placed in a dashboard mount. However, studies have looked into other tasks drivers perform with a dashboard mounted mobile phone. Knapper, Hagenzieker & Brookhuis (2015) found that drivers who entered destinations on a dashboard mounted phone reduced speed while driving, swayed more and had their eyes off the road longer compared to rides where they did not have to enter destinations. A study by Choi et al. (2013) looked at driving performance during texting and destination entry on a navigation on driving performance. They found that participants performed worse at keeping a constant speed and distance to the vehicle in front , alongside a deterioration of the lateral performance.

As previously discussed, not much is known about texting with a smartphone in a dashboard mount and the effects it has on driving performance. Therefore, the goal of this study is to examine what the effect is of texting with a dashboard mounted phone while driving on driver performance and gaze behavior, and how does this compare to the effects of handheld texting.

2 METHOD

2.1 Instruments

A simulator experiment was conducted to investigate how people drive while texting using a mobile phone either by hand or by dashboard mount. The driving simulator was a fixed base driving simulator developed by ST-software (http://stsoftware.net) that uses three 50-inch LCD flatscreens (60Hz). In order to measure eye-movements, participants wore a Pupil-labs binocular eyetracker (Kassner, Patera & Bulling, 2014). Participants also completed a Schuhfried Vienne Test System ‘Determinations’-task (VTS). This computer task measures stress tolerance and the ability to react under situations with complex stimulus conditions (Neuwirth & Benesch, 2007). Participants then underwent a short eye-sight test. This was done to make sure participants were able to see properly while driving and more importantly, read and write text messages on a smartphone. The threshold of proper eyesight was 0,5; this is the legal lower limit in the Netherlands in order to drive a vehicle. Finally, participants filled in a paper version of the Rating Scale for Mental Effort (De Waard, 1996) which measures subjective mental workload. Participants indicated how hard they found the drive to be on a scale from 0 (not hard) to 10 (extremely hard).

2.2 Participants

33 participants were tested. Due to difficulties with the eye-tracker (one participants wore glasses so they could not wear the eye-tracker, and the quality of the recording was insufficient for 4 participants) and simulator sickness (one participant) we ended up with 27 participants (41% male) that were fully tested with an average age of 42.4 years (SD = 9,1; Min = 24, Max = 59).

2.3 Procedure

Upon arrival, participants received an explanation of the experiment during which they could ask questions. After mutual satisfaction, an informed consent was signed. Participants then filled in a questionnaire on driving experience, age, gender and phone use. The eye-test and the Determination-test were next. Finally, the participants practiced with the mobile phone that was going to be used; they answered two short texts. Participants then entered the driving simulator and were fitted with the eye-tracker. To get acquainted with the driving simulator, participants spent several minutes driving on a winding road with instructions to try different speeds as long as they remained on the road. After this short driving practice, the eye-tracker was calibrated and recording was started. Additionally, another camera was positioned next to the participants in order to record the participants' actions with the mobile phone. Participants were also instructed to immediately stop in case any sort of nausea, headache, dizziness or other symptoms of simulator sickness arose.

Participants drove the same short stretch of highway (approximate 4.4 kilometres including the access ramp) three times. They were instructed to stay in the right lane without overtaking. Other traffic maintained a speed of 100 km/h, stayed in the same lane with a safe distance from the participant. A navigation voice indicated the end of the drive. During one drive participants texted with dashboard mounted mobile phone (handsfree texting condition), once with the phone in hand (handheld texting condition) and one drive was without texting (baseline condition). The order was determined by counterbalancing.

During the two drives in which participants texted, they received three questions to which they had to respond without using autocorrect. After each ride, participants were asked to fill in the RSME-scale (De Waard, 1996). After three rides, both the eye-tracker and camera recordings were stopped and participants were asked to get out of the driving simulator. Participants were then asked to fill in a short questionnaire on their experience with the driving simulator and the use of the eye-tracker. Finally, participants were thanked for their participation and they received their reward.

3. RESULTS

This paper will discuss the most important results considering driving performance and gaze behaviour. For all the results please see Doumen, van der Kint & Vlakveld (2019)[1].

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[1] https://www.swov.nl/en/publication/appen-achter-het-stuur-met-de-telefoon-een-houder

3.1 Driving performance

3.1.1 Speed

A repeated measures ANOVA revealed a significant difference between driving conditions on speed: F(2,52)=17.692, *p*<,001, partial eta-squared=,405. Post-hoc tests with Bonferroni-correction show that the average speed was higher during the baseline ride compared to both rides that involved texting: handheld texting (t(27)=4,998, *p*<,001) and handsfree texting (t(27)=4,427, *p*<,001). No significant differences on speed were found between the two rides wherein participants texted. For means and SD's see Table 1.

3.1.2 Standard-deviation of the average speed.

A Repeated Measures ANOVA revealed significant differences between the three rides on the standard-deviation of the average speed: F(2,52)=9,578, *p*<,001, partial eta-squared=0,269. Post-hoc tests with a Bonferroni-correction revealed that during both texting rides participants had a higher standard-deviation of the average speed compared to the baseline ride. This was the case for rides while texting handsfree (t(26)=-4,690, *p*<,001) as well as rides with handheld texting (t(26)=1,567, *p*<,001. For means and SD's see Table 1.

3.1.3 Standard-deviation of the lateral position (SDLP)

A Repeated Measures ANOVA revealed significant differences between the three rides on the standard-deviation of the lateral position (SDLP): F(2,48)=20,33, p<0,001, partial eta-squared=0,46. Post-hoc tests with a Bonferroni correction showed a significantly lower SDLP during the baseline ride compared to the handheld texting ride (t(25)=-6,798, *p*<0,001) and handsfree texting ride (t(25)=-4,717, *p*<0,001. For means and SD's see Table 1.

Table 1 – Means and standard deviations for each condition.

	Condition		
Measure	**Handsfree texting**	**Handheld texting**	**Baseline**
Average speed	M=96,20, SD=3,41	M=96,27, SD=3,92	M=99.09, SD=1,93
SD of speed	M=4,56, SD=2,30	M=4,45, SD=2,36	M=2,91, SD=1,57
SDLP	M=0,47, SD=0,21	M=0,50, SD=0,19	M=0,24, SD=0,11

3.2 Gaze behavior

This paragraph will discuss participants' gaze behaviour during texting rides. Because participants did not text during the baseline ride, this ride is not included in the analyses on average time spent looking at the phone and the number of gazes at the phone.

3.2.1 Time spend looking at mirrors

A Repeated Measures ANOVA with a Greenhouse-Geisser correction was performed to examine differences on the total time spend looking at the inner and outside mirrors between the three rides. Results show significant differences between the three rides on time spend looking at the mirrors: F(1,337)=41,035, *p*<0,001, partial eta-squared=0,603. Post-hoc tests with a Bonferroni-correction show that compared to the baseline rides (M=7,166s, SD=4,196), participants spent less time looking at their mirrors in the texting by hand ride (M=2,434s, SD=2,008; t(27)=6,022, *p*<0,001) and the texting with the phone in a dashboard mount ride (M=2,997s, SD=2,445; t(27)=6,793, *p*<0,001. There was no significant difference between both texting rides.

3.2.2 Average time spend looking at the mobile phone

A Repeated measures ANOVA showed no significant differences on the average time spent looking at the mobile phone between the two texting rides(F(1,26)=2,656, *p*=0,115). Additionally, no significant differences were found with a Repeated Measures ANOVA on the longest gaze directed at the smartphone between the two texting rides (F(1,26)=0,537, *p*<0,470). See Table 2 for means and SD's.

3.2.3 Number of gazes at the mobile phone

A paired t-test was performed to examine whether the number of gazes at the phone differed between texting rides. The results show that participants looked more often at the phone when it was mounted in a dashboard mount than when the phone was used to text by hand: (t(26)=-3,04, *p*<0,005, d=-0,58). See table 2 for means and standard deviations.

Table 2 – Means and standard deviations for each condition.

	Condition	
Measure	**Handsfree texting**	**Handheld texting**
Average time spend looking at smartphone	M=1,1s, SD=0,3	M=1,2s, SD=0,3
Longest gaze directed at smartphone	M=2,3s, SD=0,7	M=2,5s, SD=1,1
Number of gazes	M=25 times, SD=7,5	M=22 times, SD=6,7

4. DISCUSSION AND CONCLUSION

The results show that drivers have a higher variation of speed as well as a higher variation of the lateral position while texting and driving compared to when they do not text. This means that drivers have trouble maintaining a constant speed and that they are more likely to sway while driving. We also found that drivers reduced their speed while texting while they did not during the baseline ride. The results also showed that it does not matter whether the drivers uses a dashboard mount to text or whether he texts by hand; the same results are found in both conditions. These results are supported by Caird et al. (2014), Knapper, Hagenzieker & Brookhuis and Lyngsie et al. (2013) who also found these effects of texting on driving performance and speed. It was expected that there would be a difference in motor skill deterioration between the two texting condition that would be noticeable in the SD of the lateral position but this was not the case. An explanation could be that the stretches of highway were relatively straight. Also, the SD of the lateral position might not be the only way of measuring motor skill deterioration. Reducing the average speed in the texting conditions could be an indication of a compensation strategy. By lowering their speed during a secondary task the driver gives himself more time to react (Yannis et al., 2016). However, we also found that there was more variation of the speed in the texting conditions. This could indicate that the speed adaption is not a conscious choice but instead unconscious behaviour. Additionally, texting while driving could demand a lot of mental effort, leading to difficulties maintaining a constant speed.

The results regarding gaze behaviour showed that participants looked less often in their mirrors when they had to text compared to the ride when they did not have to text. This directly affects the situational awareness and the ability to detect danger. We did not find a difference on the time spent looking at the mirrors between the two texting conditions.

The results found indicate that the negative influence on driving performance of handsfree texting is similar to that of handheld texting. This gives rise to the thought that handsfree texting might be just as dangerous and distracting as handheld texting. Penalizing only handheld texting leads to misinterpretation of the dangers of handsfree texting. People might think that – because it is legal – handsfree texting is safe.

More research is needed on this topic. A more advanced motion based simulator might give more accurate measurements on the motor controls while driving and texting. Additionally, research should also consider other non-driving related tasks similar to texting such as putting on some music, entering info or monitoring navigational systems or social media use.

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