This is a preprint of the following publication:
Marti P.; Jallais C.; Koustanaï A.; Guillaume A. and Mars F. Effect of driver's distraction on gaze behaviour, mental workload and takeover quality In: Proceedings of the Driving Simulation Conference 2021 Europe VR, Driving Simulation Association, Munich, Germany, 2021, pp. 99-106

Effect of driver's distraction on gaze behaviour, mental workload and takeover quality

Paul Marti[1], Christophe Jallais[2], Arnaud Koustanaï[1], Anne Guillaume[1], Franck Mars[3]

(1) Renault SAS, LAB, Nanterre, France, e-mail: {paul.marti, arnaud.koustanai, anne.guillaume}@renault.com
(2) IFSTTAR, LESCOT, Lyon, France, e-mail: {Christophe.jallais}@univ-eiffel.fr
(3), LS2N, Nantes, France, e-mail: {franck.mars}@ls2n.fr

Abstract –

With the advent of highly automated cars (SAE level 3), new uses are emerging. The driver can delegate the control of the vehicle to an automation system and may engage in non-driving activities. As a consequence, the driver may withdraw not only from the physical control of the vehicle but also from the monitoring of the driving environment. In this study, we examined the impact of non-driving activity on gaze data, cardiac data and the quality of take-over. We collected 66 trials in an autonomous driving simulator (SAE level 3) in two mental workload conditions induced by two distinct task-difficulty levels. The results showed an effect of the non-driving task difficulty on mental workload measured with the NASA-TLX but not on cardiac data. Visual strategies were also influenced by the difficulty levels but not by the quality of the take-over. However, the orientation of gaze at the time of take-over request appeared to determine the quality of take-over, with better performance observed for driver looking at the road scene compared to distracted drivers.

Keywords: *Automated driving; Non-driving task; critical events; Out of the loop; Human factors.*

Introduction

SAE International has defined six levels of driving automation, ranging from no automation (level 0) to fully automated driving (level 5). At level 3, control can be delegated to the automated system within the limits of its operational domain. Drivers are no longer required to continuously monitor the system and the driving environment. They can engage in non-driving-related tasks. However, they must still be able to safely regain control of the vehicle at any time when the system requires it. This may occur when the automation cannot handle the current driving situation. When autonomous driving is active, drivers withdraw from physical control of the vehicle for an extended period of time. If they decide to perform non-driving tasks, they may divert their attention from the road [Nau16]. This is not without consequences when a takeover is requested by the system.

The first consequence of the delegation of vehicle control to the automated system is the disruption of the driver's perceptual-motor loop [Mol19]. In the case of manual driving, visuomotor coordination, based on the combination of visual information and steering actions, is continuously maintained. The driver remains calibrated to the environmental conditions and vehicle dynamics. This is not the case during autonomous driving. The consequences can be observed before the take-over request (TOR) during automated driving and after the TOR when returning to manual driving. Prior to the TOR, even when the driver is explicitly required to monitor the driving scene, greater gaze dispersion has been observed with fewer guiding fixations directed towards the road ahead and more look-ahead fixations [Mar12, Nav16, Sch19]. Mackenzie & Harris (2015), using videos to simulate highly automated driving, found also more distant fixations directed toward potential hazards. After the TOR, the consequences can be observed on the steering performance. Drivers may have difficulty in regaining control to avoid an obstacle, even when instructed to monitor the driving situation with their hands constantly on the wheel [Nar16]

In highly automated cars (SAE level 3), drivers are inclined to engage in non-driving activities [Pfl16]. The more automated driving is, the more drivers may do it [Car12]. This obviously has implication for monitoring of driving environment [Car12, Mer12]. For example, Zeeb et al. (2015) showed that participants performing non-driving task did not monitor the road from 2 to 55 seconds in SAE level 3 vehicle. It has also been shown that in automated driving, reaction times of drivers performing secondary tasks substantially increase compared to task-free drivers [She17]. Even after regaining control, previous engagement in secondary task results in slower and more abrupt obstacle avoidance manoeuvres when automated driving is compared to manual driving [Bue16, Rad14, You18, Zee15, Zee16]. Neither the workload level associated with the non-driving task [Bue16], nor the modality of the task visual vs. cognitive distraction [Rad14] appears to have an effect on the take-over performance.

With the increase of level automation, it was noted a decrease in the driver mental workload during autonomous driving without NDT [Win14]. However, the drivers' engagement during automated driving in a non-driving activity could increase mental workload related to the activity achievement. Bueno et al. (2016) used, a posteriori, the NASA-TLX test to measure the mental cost of performance in non-driving activity. They showed an increase in the NASA-TLX score according to the increased activity difficulty. In other studies, using electrocardiogram (ECG), heart rate was found to increase with the difficult auditory dual-task [Meh09] and auditory presentation–verbal response working memory task [Meh12]. The increase in heart rate was also coupled with a decrease of heart rate variability while drivers performed a secondary-task [Hei17, Hid18]. Hidalgo et al. (2018) found that the increase in heart rate was greater when performing a secondary-task that required more cognitive resources.

Based on the previous considerations, the first objective of this study was to investigate the correlation between ECG, NASA-TLX and gaze behaviour when performing a non-driving activity. Drivers were engaged in a non-driving activity with two different difficulty levels for two minutes before the TOR. The second objective was to determine the potential links between the mental workload associated with the task, visual behaviour and the quality of the takeover performance. It was hypothesized that increase in non-driving task complexity would affect visual strategies which, in turn, would reduce the quality of the takeover performance.

Materials and Methods

Participants

Eighteen subjects (9 females; 9 males; mean age = 24,7 years old ; SD = 4,7) participated in this study. They had normal to corrected vision with contact lenses to facilitate the recording of gaze data. They reported having no health condition that could interfere with the recording of cardiac data. They held a valid driver's license (average = 5496,84 km/year, SD = 5267,7) and signed written informed consent to participate in this study.

Experimental setup

An adjustable seat, a steering wheel, a gear level, clutch, accelerator and brake pedals composed the fixed-base simulator (see Figure 1). The simulated vehicle was equipped with an automatic transmission in manual driving. The driving scene was developed with SCANeR Studio (v1.8) and displayed on three screens (Field of view ~= 120°). A small screen was dedicated to the dashboard. An 11"-tablet was set at the centre of the console, as in the central stack of a real vehicle.

Figure 1. Driving simulator setup

Gaze orientation was recorded using an eye tracker (Smart Eye Pro version 5.9) including four cameras (2 below the central screen and one below each peripheral screen). Calibration was divided in two steps. The first step consisted in creating a 3D model of the driver's head using an 11-points calibration procedure. The second step was the gaze calibration using a 15 points procedure. Gaze data was recorded at 60Hz by the driving simulator software.

Electrocardiogram (ECG) was recorded using a Biopac MP160 at 615 Hz. Three electrodes were placed on the subject's chest. At the beginning of the study, participants were instructed to remain motionless to calibrate the ECG.

Procedure

Installation and instructions

The participants were equipped with electrodes for ECG recording. Then, they settled comfortably in the simulator and the gaze calibration procedure was performed. Next, they were told how to make transitions between autonomous and manual driving. Icons and sounds of the HMI were presented on the tablet (Figure 2)

Figure 2. Pictograms displayed on the HMI: A: autonomous driving available; B: autonomous driving activated; C: take-over request (8s); D: take-over request (45s)

Participants were instructed to change their driving mode each time it was available. To switch from manual to autonomous mode, they had to press a button on the HMI when they saw the “disponible” icon (See A in Figure 2). The status of the vehicle thus changed to autonomous mode and the “autonome” icon was displayed (See B in Figure 2). At this time, participants could release the control of the vehicle to the automation, remove hands from the steering wheel and feet from the pedals. However, they were informed that, in the event of an emergency takeover request (See C in Figure 2), they would have 8 s to resume control of the vehicle. For this, they could press a button on the tablet, press pedals, or turn steering wheel.

Non-Driving Task

The right side of the HMI contained a multimedia area to display the non-driving task (NDT). It consisted in 12 mental operations. One- and two-digit numbers were used to induce low and high levels of mental workload, respectively. Each operation was displayed for 10 seconds. In the last 4 seconds, the participant had to choose an answer on a digit circle. A progress bar showed remaining time to answer. It was blue during 6 s and became red for the last 4 s (see Figure 3).

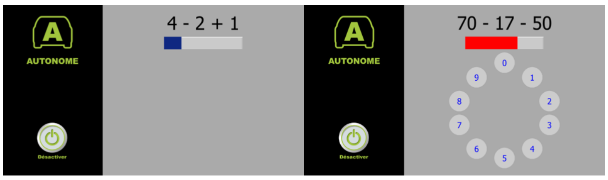

Figure 3. Mental calculation task. Up: early phase of the easy calculation task (0-6 s). Down: final phase of the complex task with the response circle (6-10 s)

Critical and non-critical takeovers

During the driving session, a critical TOR was issued while the participant was following a lead vehicle from 3 s headway. A vehicle was coming on the left lane, close behind the participant. Then, the lead vehicle began an evasive manoeuvre because stationary car blocked the lane. This event occurred while the participant was selecting a response on the digit circle. The task was interrupted, and a TOR was issued. To take back control successfully, the participant had to brake and change lanes while avoiding either the obstacle or the vehicle on the left lane. At the time the TOR was issued, the time headway to the obstacle vehicle was 8 seconds (see Figure 4).

To avoid participants expecting critical events every time they completed NDT, non-critical events occurred sometimes. The non-critical events consisted in a slight lateral deviation of the car due to erased road markings. Participants had to simply regain control by turning the steering wheel and stabilize the vehicle in the lane.

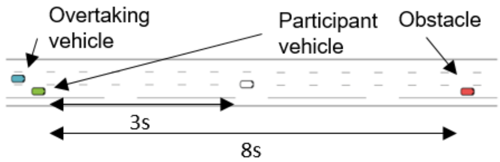

Figure 4. Critical Case. From the left vehicle to the right vehicle; blue vehicle: overtaking vehicle; green vehicle: participant vehicle; white vehicle: head-up vehicle; red vehicle: obstacle

Scenarios and independent variable

After receiving instructions, participants experienced the transitions between manual and autonomous driving in a training session. They also performed each difficulty level of the NDT while driving on a three-lane highway, at 110 km/h, with moderate traffic.

The experiment consisted in four trials (Figure 5). They all included several NDT with different duration (between 1 minute 40 seconds and 2 minutes 20 seconds), sometimes followed by a critical or non-critical TOR or an automated driving without NDT. Non-critical TOR was introduced to prevent participants from expecting avoidance to be performed on each alert. The NDT preceding the critical TOR always lasted 2 minutes. After each trial, they performed the Nasa-TLX test to evaluate their subjective mental workload associated with the task. The order of trials was counterbalanced across participants.

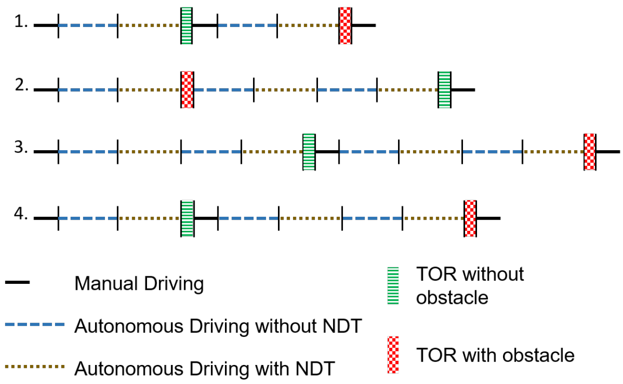

Figure 5. Organization of the trials

The 4 tests were divided into 2 blocks of two tests. Each block included the easy task and the complex task with a counterbalance. The objective of the two blocks was to introduce additional stress to completing the task by instructing participants just before the second block that performance on the task would be analyzed and ranked. However, the analyses did not show any effect of the instruction. Thus, the second block of trial has been considered as a repetition of the first one. The total experiment lasted 2 hours.

Data analysis

Cardiac Data

The analysis of the ECG data was performed on the 4 minutes of autonomous driving preceding the take-over request. A ratio was calculated by dividing the 2 minutes with the non-driving task by the two minutes without task, for the heart rate (HR) and the heart rate variability (HRV).

Area of interests (AOI)

The visual scene was divided into two parts (Figure 6). The first zone, called "situation" (green zones), included relevant areas to get information about the road, i.e. the three screens comprising the central and side mirrors. The second zone, called "distraction" (red zones), referred to the areas that do not allow drivers to get information about the road scene. It included the dashboard (D), the tablet (HMI) and the environment outside the screens.

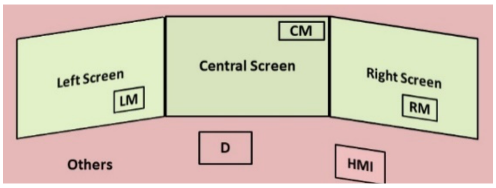

Figure 6. Distribution of areas of interests

Quality of take-over

We defined 2 phases for the takeover:

- “Phase 1” started with the TOR and ended with the driver’s first action on the vehicle.

- “Phase 2” started immediately after Phase 1 and ended when the front bumper of the participant’s vehicle reached the same longitudinal position as the rear bumper of the stationary vehicle.

In order to define the criteria for assessing the takeover performance, we examined the vehicle data. For phase 1, we only considered the time of the first action on the vehicle. For phase 2, we looked at seven indicators: minimum speed, maximum left lateral deviation, maximum left acceleration, maximum left steering wheel angle, time to collision with the obstacle vehicle, minimal distance to the vehicle in the left lane and collisions with any vehicle. Collision was the only binary criterion. Other criteria were defined as interval [mean - standard deviation; mean + standard deviation] to isolate outliers. On this basis, quality of the takeover performance was considered poor when at least one of the following criteria was met:

- Time to collision with the stationary vehicle < 1.5 s.

- Left side position > 5 m (the vehicle moved beyond the lane on the left of the initial lane)

- Near-collision with the left vehicle: distance < 1 m.

- Collision with a vehicle

Among of the 66 takeovers, 16 were thus categorized as poor quality.

Results

Each participant completed 4 trials, resulting in a total of 72 dataset including the vehicle, ECG, mental workload and gaze behaviour data. Due to technical problems, 6 datasets were incomplete and excluded from analysis. The Shapiro-Wilk test showed that data distributions were normal, allowing to perform ANOVAs.

Assessment of mental workload

NASA-TLX scores

The within-subject ANOVA showed that subjective workload increased with task complexity [$F(1,62) = 16.62$; $p < 0.001$; $\eta2 = 0.197$] (Figure 6). Furthermore, subjective workload decreased after the second presentation of the task [$F(1,62) = 4.2$; $p < 0.05$; $\eta2 = 0.05$] (Figure 7).

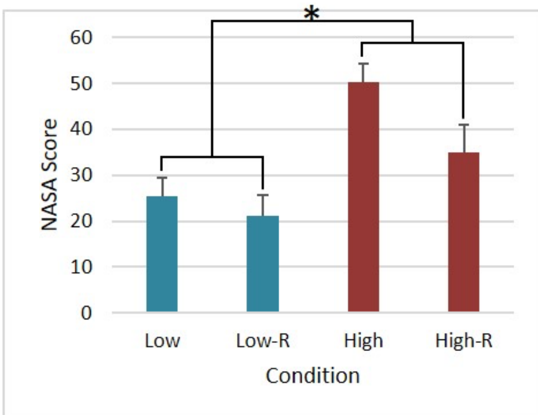

Figure 7. NASA-TLX Score by Condition (Low: Low Workload; Low-R : Low Workload Repetition; High : High Workload; High-R, High Workload Repetition)

Electrocardiogram data

We performed repeated measures ANOVAs on both ECG variables with two categorical predictors: load and repetition.

NDT HR increased when participants performed NDT [$F(1,62) = 60.21$; $p < 0.001$; $\eta2 = 0.48$]. There was no effect of repetition (F<1), task's difficulty (F<1), and task's difficulty*Repetition (F<1).

For HRV, a main effect of the NDT task [$F(1,62) = 34.0305$; $p < .001$; $\eta 2 = 0.48$] was observed: HRV decreased while performing a NDT. There was no effect of repetition (F<1), task's difficulty (F<1), or task's difficulty*repetition (F<1).

Analysis of gaze behaviour during the non-driving activity

Visual strategies were analysed by a two-way ANOVA (task's difficulty x repetition). We considered four indicators: the number of fixation (NF), the fixation time (FT), the number of short fixations (FT < 2s) and the number of long fixations (FT > 2s). These indicators were first calculated on the entire data set to determine whether there was a main influence of factors on fixation characteristics. Next, the fixations oriented towards the situation zones and towards the distraction zones were distinguished.

Situations areas

The ANOVA showed that the difficulty of NDT yielded to a significant reduction of all gaze indicators: NF [$F(1,62) = 5$; $p < .05$; $\eta 2 = 0.075$] (Figure 8), FT [$F(1,62) = 10.52$; $p < .05$; $\eta 2 = 0.145$] (Figure 9), FT<2s [$F(1,62) = 4.06$; $p < .05$; $\eta 2 = 0.061$] (Figure 10), FT>2s [$F(1,62) = 9.78$; $p < .05$; $\eta 2 = 0.134$] (Figure 11). Neither the effect of repetition (F<1), nor the interaction between NDT's difficulty and repetition interaction (F<1) was significant.

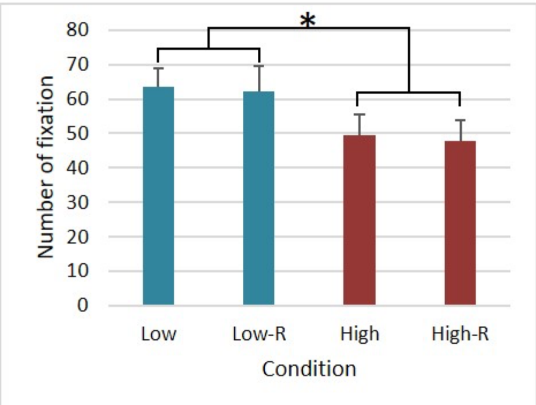

Figure 8. Number of fixation in situations areas

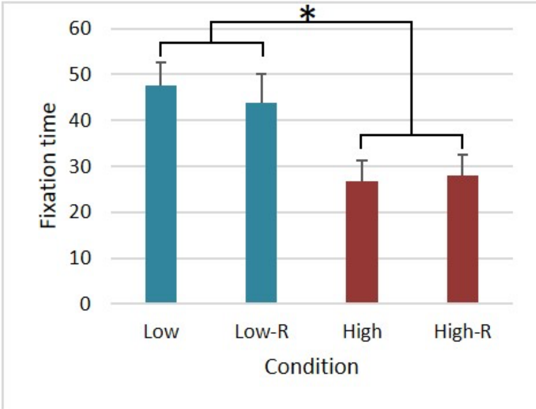

Figure 9. Fixation Time on situation areas

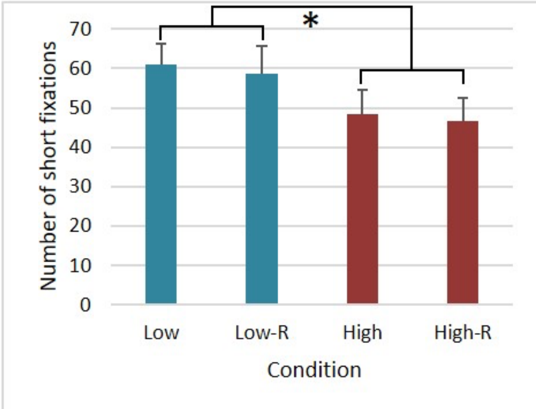

Figure 10. FT < 2s on situation areas

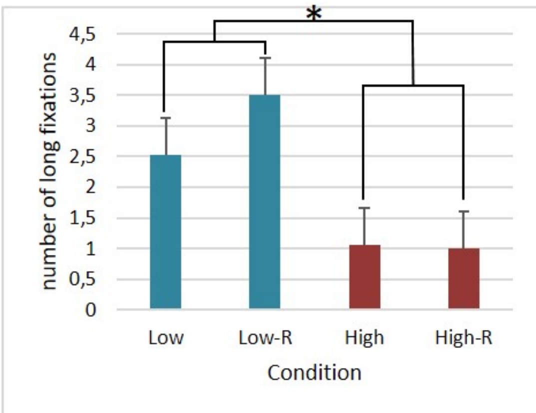

Figure 11. FT > 2s on situation areas

Distraction

When considering the distraction areas only, the analyses revealed a significant effect of task difficulty on FT [$F(1,62) = 8.94$; $p < .05$; $\eta 2 = 0.126$] (Figure 12) and FT>2s [$F(1,62) = 10.2$; $p < .05$; $\eta 2 = 0.141$] (see Figure 13). NF (F<1) and FT<2s (F<1) remained similar in the two conditions. No effect between NDT's difficulty and repetition interaction was observed.

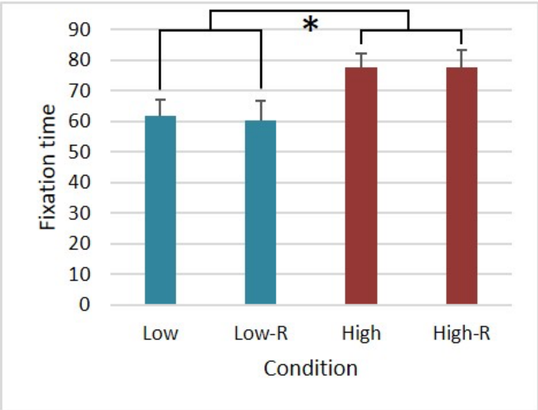

Figure 12. Fixation Time on distraction

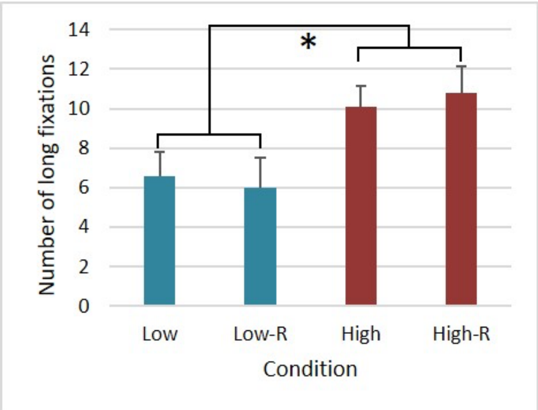

Figure 13. FT > 2s on distraction

Relation between gaze behaviour and take-over quality

In order to determine the links between visual strategies and the quality of the takeover, we performed several analyses. An in depth-analysis of the matrixes of transitions between 13 AOI were performed using partial least squares regression (PLS). A similar method was previously used by Schnebelen et al. (2020, 2021) to estimate the consequences of automated driving on driver gaze behaviour. The objective of this method was to find the best estimation of the variables Y by the variables X. In our study, Y was the takeover quality and X was the transition matrix between AOIs during the non-driving activity. The result of this analysis is not reported here as it did not yield satisfactory results. In other words, it was not possible to accurately predict the quality of the takeover based on the gaze patterns that occurred over a period of 15, 30 or 60 seconds prior to the TOR. Then, we performed several chi-squared analyses to test specific hypotheses about the relationship between the quality of the takeover and the location of fixations right before the TOR, at the moment of the TOR or during the take-over. Among all the analyses, only one stood out: the location of gaze at the time of TOR (see Table 1).

Table 1. Analysis of gaze behaviour and take-over quality

	Situation	Distraction	Total
Low quality take-over	5	11	16
Total take-over	36	30	66

The Chi-squared test ($Chi^2 = 4.62$, *p=0.03*) showed that gaze was significantly more often directed toward the distraction area at the moment of the TOR in the case of a low-quality take-over.

Analysis of task's difficulty and take-over quality

Finally, the link between the difficulty of the task and the quality of the takeover was examined (Table 5). The Chi-squared test ($Chi^2 = 0.33$, *p=0.56*) showed that the takeover quality was not a function of task's difficulty (see Table 2).

Table 2. Analysis of task's difficulty and take-over quality

	Easy task	Complex task	Total
Low quality take-over	7	9	16
Total take-over	33	33	66

Discussion

This study had two complementary objectives. The first objective was to examine the impact of a non-driving task with two different workload levels on gaze behaviour, ECG data and take-over quality. The other objective was to establish how gaze behaviour may determine take-over quality.

The results revealed an effect of the non-driving task difficulty on the subjective assessment of mental workload. Drivers scored higher on NASA-TLX for the complex task than for the easy task, which is consistent with expectations. However, although ECG data allowed us to distinguish driving without activity from driving with activity, we did not find results equivalent to those reported in other studies for the physiological assessment of mental workload [Hid18, Meh09, Meh12]. Indeed, the level of difficulty did not show any effect on the cardiac data. As Veltman & Gaillard (1998) suggested, it seems that subjective effort and physiological measures do not provide the same information about mental effort and that the link between task difficulty and mental workload could be hardly assessed by physiological measures. Additionally, our task included a motor component to select the response on the tablet, which may have substantially influenced the cardiac data [Mat08].

Although the increase in task difficulty resulted in more mental workload and a significant visual disengagement from the driving scene, it did not affect the quality of the take-over. Participants passed the critical avoidance test to the same proportion whether they performed the easy or the complex task at the time of the takeover request. This is consistent with the results reported by Bueno et al (2016), who found no effect of the mental workload associated with a non-driving task. They used a visual adaptation of the Remote Association Test which induced a cognitive, visual and motor load.

A detailed examination of the gaze data revealed that the only determinant of the take-over quality was the location of the fixation at the very moment of the take-over request. 13.89% of drivers were looking at the road at the time of the TOR had a low quality takeover. This percentage rose to 36.67% for drivers looking away. Therefore, the risk of having a low quality takeover was 2.64 times higher for drivers distracted by the task. The drivers who were looking at the driving scene at the time of the take-over request were more likely to effectively avoid the obstacle than those who were distracted. During the non-driving activity drivers continued to intermittently look at the situation areas. The drivers who carried out the most complex activity looked at the road less often and for a smaller duration compared to the drivers with the easy task. They also made longer fixations on the task and more often. However, although the drivers monitored the situation differently depending on the task's level, this had no impact on the quality of takeover. It seemed that the perception of the immediate environment was more important than the overall understanding of the scene in our case.

Even if it is well documented that fixed-base simulators offer a good relative validity compared to high-end simulators or instrumented vehicles Blaauw et al. (1982), the immersion offered by the simulator we have used is limited. Further studies with more sophisticated setups and richer driving scenarios are still needed to achieve a better understanding of the attentional mechanisms at play during takeovers.

Conclusions

Contrary to our expectations, the difficulty of the task carried out at the time of the TOR had no effect on the quality of the take-over. Although the participants in our study had longer fixations outside the driving scene and less frequent fixation in the driving scene during the difficult task, it seems that some of them were able to divide their attention between the task and the driving scene. In the end, the most decisive element to explain the difficulties of recovery turns out to be the position of the gaze at the time of the take-over request, even though the participants had 8 seconds to act. It may be relevant to redirect drivers' attention as quickly as possible to the road scene as soon as the takeover is requested to allow time for distracted drivers to focus their attention on the take-over. That means that all the attention of the driver must be channelled to enable the best reconstruction of the situation awareness in the short time available. To further analyse the visual strategy during the secondary task, it would be interesting to assess the situational awareness of drivers to try to determine if take-over success is a combination of situation awareness and the fixation at the time of take-over, or it mostly depends on the gaze orientation at the time of the take-over request.

References

Blaauw, G., 1982. Driving experience and Task Demands in Simulator and Instrumented Car: A Validation Study, *Human Factors*, p. 473-486. doi:10.1.1.925.6181

Bueno, M., & al., 2016. How different mental workload levels affect the take-over control after automated driving, *IEEE 19th International Conference on Intelligent Transportation Systems (ITSC),* p. 2040-45.

Carsten, O., & al., 2012. Control Task Substitution in Semiautomated Driving: Does It Matter What Aspects Are Automated?, *Human Factors: The Journal of the Human Factors and Ergonomics Society*, vol. 54, nº 5, p. 747-61.

Heine, T., & al., 2017. Electrocardiographic Features for the Measurement of Drivers' Mental Workload, *Applied Ergonomics*, vol. 61, p. 31-43.

Hidalgo-Muñoz, A. R., & al., 2018. Respiration and Heart Rate Modulation Due to Competing Cognitive Tasks While Driving, *Frontiers in Human Neuroscience*, vol. 12, p. 525.

Mackenzie, A. K., & Harris J. M.., 2015. Eye Movements and Hazard Perception in Active and Passive Driving, *Visual Cognition*, vol. 23, nº 6, p. 736-57.

Mars, F. & Navarro, J., 2012. Where We Look When We Drive with or without Active Steering Wheel Control, *PLoS ONE*, vol. 7.

Matsuda, T., & Makikawa, M., 2008. ECG monitoring of a car driver using capacitively-coupled electrodes. *Annual International Conference of the IEEE Engineering in Medicine and Biology Society.* p. 1315-1318.

Mehler, B. & al., 2009. Impact of Incremental Increases in Cognitive Workload on Physiological Arousal and Performance in Young Adult Drivers, *Transportation Research Record: Journal of the Transportation Research Board*, vol. 2138, nº 1, p. 6-12.

Mehler, B. & al., 2012. Sensitivity of Physiological Measures for Detecting Systematic Variations in Cognitive Demand from a Working Memory Task: An on-Road Study across Three Age Groups, *Human Factors*, vol. 54, nº 3, p. 396-412. d

Merat, N. & al., 2012. Highly Automated Driving, Secondary Task Performance, and Driver State, *Human Factors*, vol. 54, nº 5, p. 762-71.

Mole, C. D., & al., 2019, Getting Back Into the Loop: The Perceptual-Motor Determinants of Successful Transitions out of Automated Driving, *Human Factors*, vol. 61, nº 7, p. 1037-65.

Naujoks, F. & al., 2016, Secondary Task Engagement and Vehicle Automation – Comparing the Effects of Different Automation Levels in an on-Road Experiment, *Transportation Research Part F: Traffic Psychology and Behaviour*, vol. 38, p. 67-82.

Navarro, J., & al., 2016. Obstacle Avoidance under Automated Steering: Impact on Driving and Gaze Behaviours, *Transportation Research Part F: Traffic Psychology* and *Behaviour*, vol. 43, p. 315-24.

Pfleging, B., & al., 2016. Investigating user needs for non-driving-related activities during automated driving, *Proceedings of the 15th International Conference on Mobile and Ubiquitous Multimedia,* p. 91–99.

Radlmayr, J. et al., 2014. How Traffic Situations and Non-Driving Related Tasks Affect the Take-Over Quality in Highly Automated Driving, *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, vol. 58, no 1, p. 2063-67.

Schnebelen, D. & al., 2019. Looking at the Road When Driving Around Bends: Influence of Vehicle Automation and Speed, *Frontiers in Psychology*, vol. 10.

Schnebelen, D. & al., 2020. Estimating the Out-of-the-Loop Phenomenon from Visual Strategies during Highly Automated Driving, *Accident Analysis & Prevention,* vol. 148.

Schnebelen, D. & al., 2021. Model-based estimation of the state of vehicle automation as derived from the driver's spontaneous visual strategies. *Journal of Eye Movement Research*, *13*(2), 10.

Shen, S., & Neyens, D. M., 2017. Assessing Drivers' Response during Automated Driver Support System Failures with Non-Driving Tasks, *Journal of Safety Research,* vol. 61, 2017, p. 149-55.

Veltman, J. A., & Gaillard A. W. K., 1998. Physiological Workload Reactions to Increasing Levels of Task Difficulty, *Ergonomics*, vol. 41, no 5, p. 656-69.

Winter, J. C. F. de, & al., 2014. Effects of Adaptive Cruise Control and Highly Automated Driving on Workload and Situation Awareness: A Review of the Empirical Evidence, *Transportation Research. Part F: Traffic Psychology and Behaviour,* vol. 27, no Part B, p. 196-217.

Yousfi, E., 2018. Conscience de la situation et performance de conduite lors de la reprise en main en conduite automobile déléguée, *http://www.theses.fr,* 2018.

Zeeb, K., & al., 2015. What Determines the Take-over Time? An Integrated Model Approach of Driver Take-over after Automated Driving, *Accident Analysis & Prevention,* vol. 78, p. 212-21.

Zeeb, K., & al., 2016. Is Take-over Time All That Matters? The Impact of Visual-Cognitive Load on Driver Take-over Quality after Conditionally Automated Driving, *Accident; Analysis and Prevention,* vol. 92, p. 230-39.