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Editorial

**Driver Distraction and Inattention: Engagement during manual, assisted, and automated driving modes.**

Trent Victor, Michael Regan, Alexandra Fort, Christophe Jallais

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We are in an era of mobility transformation [ERTRAC, 2018]. Pervasive personal communication technologies and in-vehicle digitalization already impacts daily life, while vehicle automation is on the cusp of widespread impact. Consequently, there is a critical need to understand distraction and the limits of attention in many modes of transportation – both in-vehicle modes (manual-, assisted-, and automated driving) and in new forms of transportation – as they all are affected by digitalization and limits of attention. Distracted driving has long been a contributor to motor vehicle crashes [National Center for Statistics and Analysis], and is flourishing in these new digitalized mobility environments [Cunningham & Regan, 2018].

The bi-annual International Conference on Driver Distraction and Inattention (DDI) was initiated in 2009 by Michael Regan (University of New South Wales, Sydney) and Trent Victor (SAFER, Vehicle and Traffic Safety Center at Chalmers, and Volvo Cars). The 6th DDI conference (2018) was co-organized by SAFER, IFSTTAR (French Institute of Science and Technology for Transport, Development and Networks), and the Australian Road Research Board (ARRB).

This Special Issue expands on some presentations from the 6th DDI conference held in Gothenburg, Sweden (October 15-17, 2018). The main focus of the DDI conference series is on driver distraction and inattention, presentations and papers on distraction affecting other road users. During DDI conferences, recent developments and trends in the field of inattention and distraction in driving are presented. Presentations and discussions are organized covering basic and applied research, challenges in mitigating distraction and inattention, the latest policy developments, and priorities for research and countermeasures development. Therefore, research about new forms of mobility (e.g. autonomous vehicles, electric vehicles), emerging sources of distraction (e.g., smartphone, touchscreen) and driver monitoring were discussed [Proceedings of the DDI2018 conference can be downloaded here: [http://ddi2018.org/?page\\_id=1272](http://ddi2018.org/?page_id=1272)].

The adverse effects of distraction have been studied and reported extensively at DDI conferences. Distraction as a new health problem for pedestrians was studied by Vollrath and colleagues. Activities of students before and while crossing the street were observed near major high schools. Using the mobile phone substantially reduced safety-related behaviours before crossing the street and 10.5% of the students used their phone while crossing the street. Using data from the Australian Naturalistic Driving Study (ANDS), Young and collaborators revealed that drivers spend approximately 45 percent of their driving time engaging in potentially distracting tasks. Using different methodologies, Young and collaborators and Petzholdt and collaborators studied contextual characteristics that influence the decision to initiate a secondary task. Both research groups found that drivers are in agreement in some contexts, such as waiting until a vehicle is stationary. In other contexts, Young found drivers do not consider factors that may impact risk (e.g. weather, lighting) and Petzholdt found opinion was split. Further, Petzholdt found that drivers' explanations for their decision to text was explained by scenarios with low demand on attention or handling, and the idea that there would be some margin of error.

The theme of the 6th conference was “Driver Engagement during Assisted Driving”. Within vehicle automation, some key safety issues hinge on operator responsibilities while using automation [Seppelt & Victor, 2016]. Terminology describing these responsibilities (such as Overreliance, Driver

engagement, Driver-in-the-loop, Fall-back readiness, Receptiveness, and Availability) are related to Distraction and Inattention. These issues were addressed in several papers, presentations, keynotes, and a panel discussion at the 6<sup>th</sup> conference.

Euro NCAP's strategy on assisted and automated driving, and their new Occupant Status Monitoring rating element, were presented. These and existing automation standards, regulations, and design guidance were discussed in the panel. Tivesten and collaborators developed an out-of-the-loop crash prediction algorithm suitable for eye-tracker-equipped vehicles with highly reliable but supervised automation. Three pre-conflict behavioural patterns were found to be associated with increased risk of crash involvement: low levels of visual attention to the forward path, high Percent Road Centre (i.e., gaze concentration), and long visual response times to attention reminders if visually distracted. Interestingly, these behaviours were found despite the presence of attention reminders. Beyond eye trackers for driver monitoring, Woerle and colleagues studied physiological measures to detect drivers becoming drowsy and falling asleep during highly automated driving. Using electroencephalography (EEG) as a ground truth, electrodermal activity (EDA) and electrocardiography (ECG) were found to differentiate between sleep and wakefulness. These papers address and discuss implications for the implementation of driver monitoring systems in in-vehicle systems, a topic of increasing relevance in ratings and regulation.

Further, on the topic of driver engagement in automation, the impact of long (1 hour) and short (10 min) durations was studied for three successive periods of automated driving by Bourrelly and collaborators. Poorer take-over performance (longer reaction time and a sharper avoidance manoeuvre) and increased drowsiness was found in a longer autonomous period compared to a shorter one. Their results indicate that sequencing the autonomous phase into several short periods is preferable to a long automated driving phase.

The 6<sup>th</sup> DDI conference saw an increase in the number of studies showing the importance of new issues associated with automation and the necessity to keep drivers in the loop to regain the control of the car in a safe way. Future studies will likely take into account what kinds of secondary tasks the drivers could do when in a highly automated mode. Therefore, new research on distraction and inattention topics should deal with the level of engagement/disengagement of the driver during the use of such automated systems.

The next, 7<sup>th</sup>, DDI conference will be held in Lyon, France, during 12-14 October 2020 and will have a theme on the disconnected driver. The term disconnected driver can be seen as an expansion of the current focus of the DDI conference towards other states of disconnection with driving such as intoxication, sleeping (in addition to fatigue), sudden sickness, and automation overreliance related states. As this research area matures, we are currently seeing an increase in the efforts within rules and regulation (e.g. EU), introduction of on-market driver monitoring technology (driver monitoring cameras) and other countermeasures. Whilst focus will likely remain on topics related to understanding and quantifying driver distraction and inattention, as in previous conferences, upcoming conferences will likely see reporting of impact assessments of on-market countermeasures such as in-vehicle driver monitoring technologies, as well as assessment or shaping of regulations and safety ratings. Further, we will likely see an increase in focus on automation-related topics, related driver states, other road users, and other domains of road transport.

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