

5th International conference on

Driver Distraction and Inattention

March 20-22 2017| Paris, France

BOOK OF ABSTRACTS



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Co-organisers:

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arrb
GROUP

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About DDI2017



The 5th International Conference on Driver Distraction and Inattention (DDI2017). DDI2017 holds in Paris, France, on March 20-22, 2017, and follows the four highly successful DDI Conferences held previously in Gothenburg, Sweden (2009, 2011, 2013), and Sydney, Australia (2015).

The International Conference on Driver Distraction and Inattention aims to bring participants up-to-date on recent developments and trends in the field of inattention and distraction in driving, and to bring together researchers and practitioners. Participants are invited to present and discuss current work covering basic and applied research, mitigation challenges, the latest policy developments, and priorities for research and countermeasures development.

DDI2017 conference thematics include theory, measurement, effects, crash risks, and prevention/mitigation related to driver distraction and inattention. Presentations take into account new forms of mobility (e.g. automated driving.), other road user groups (e.g. motorcyclists, bicyclists, pedestrians), new modes of HMI interaction (e.g. voice recognition, head up display, gesturing), new sources of distraction from outside the vehicle (e.g. digital advertising, LEDS signs).

DDI2017 is co-organised by IFSTTAR (French Institute of Science and Technology for Transport, Development and Networks), SAFER (Vehicle and Traffic Safety Center at Chalmers, Sweden), and the ARRB Group (the Australian Road Research Board).

IFSTTAR is a major player in the European research on the city and the territories, transportation and civil engineering. The French Institute of Science and Technology for Transport, Development and Networks, born on January 1st 2011, from the merger of INRETS and LCPC, is a Public Institution of a Scientific and Technical Nature, under the joint supervision of the Ministry of Environment, Energy and the Sea and the ministry of higher education and research.

New organisation of reference in the international arena, IFSTTAR conducts applied research and expert appraisals in the fields of transport, infrastructure, natural hazards and urban issues with the aim of improving the living conditions of our fellow citizens and, more widely, promoting the sustainable development of our societies.

SAFER Vehicle and Traffic Safety Centre at Chalmers is a competence centre using competence from 32 partners from academia, industry and public organisations. Our vision: SAFER provides excellent interdisciplinary research, innovation and collaboration to secure close to zero accidents and injuries in traffic and enable Sweden to hold global leadership in the new paradigm where traffic safety is a key factor for implementing a sustainable, connected automated traffic system.

Research at SAFER spans a broad base, covering several disciplines and encompassing both traffic and vehicle safety in real environments. The centre's activities engage the very elite in the field of traffic safety, and the results contribute to increasing the competitive advantages of the centre's partner companies and organisations. Chalmers University of Technology hosts the centre. By using the multidisciplinary scientific competence available within the centre, we will make it a hub for excellence within the field of vehicle and traffic safety.

ARRB provides research, consulting, products and information services to the road and transport industry. ARRB applies research outputs to develop equipment that collects road and traffic information, and software that assists with decision-making across road networks. ARRB is the leading provider of road research and best practice workshops in Australia.

ARRB's member organisations include federal, state and local government bodies responsible for managing the nation's transport and road networks and the New Zealand Transport Agency. ARRB and its members, both individually and collectively as Austroads, recognise the critical role that they play in supporting one another to improve productivity, safety, sustainability and amenity outcomes for the community.

Sponsor and exhibitor acknowledgments

We would like to thank all our sponsors and exhibitors for their contribution to the success of the 5th International conference on Driver Distraction and Inattention.

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Exhibitors

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https://www.smivision.com/

ProtextMe is a proven solution that can be used for high level research of monitoring drivers cellphone usage behavior while driving. This includes usage of SMS, voice calls, WhatsApp, Facebook, facetime, Snap chat and all other apps while driving and number of driver clicks on each app while driving. A management tool that reports all activity with break downs of exact reading of how many clicks, how many minutes of voice calls at what speed and what location and all this in real time. ProtextMe has developed a product in conjunction with Or Yarok which is Israel's leading organization for increased road safety. The ProtextMe platform was developed based on actual real life research by Or Yarok which measured actual driver behavior pattern and psychology. http://protextme.com/

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DDI2017 at a glance

	Monday 20th March 2017	Tuesday 21st March 2017	Wednesday 22nd March
8.00 am			Registration - coffee
8.30 am		Registration - coffee	Keynote 3: Michael Regan
9.00 am		Keynote 1: Kalina Christoff	
9.30 am			Session 7A / Session 7B
10.00 am		Session 3A / Session 3B	
10.30 am			Coffee break
11.00 am		Coffee break	Session 8A
11.30 am		Session 4A / Session 4B	
12.00 pm			
12.30 pm	Registration - coffee	Lunch	Lunch
1.00 pm			
1.30 pm	Opening session	Keynote 2: René Amalberti	Session 9A / Session 9B
2.00 pm	Session 1A / Session 1B		
2.30 pm		Session 5A / Session 5B	
3.00 pm	Coffee break		Stephanie Binder memorial lecture
3.30 pm	Session 2A / Session 2B	Coffee break	Coffee break
4.00 pm		Session 6A - Special session	Special symposium
4.30 pm	Special presentation		
5.00 pm			Closing session
7.45 pm	3-hour evening dinner cruise on the river Seine		

1A	Naturalistic studies	1B	Driver monitoring
2A	Models of distraction and inattention	2B	Driver characteristics
3A	Distraction and automated driving	3B	Driver distraction
4A	Phone distraction	4B	Driver distraction
5A	Human machine interaction	5B	Vulnerable road users
6A	Special session		
7A	Driver characteristics	7B	Counter-measures
8A	Driver monitoring		
9A	Driver distraction	9B	Human machine interaction

Keynote talks

Mind wandering as spontaneous thought: A dynamic framework

Prof. Kalina Christoff, PhD



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Topic: Mind-wandering has recently come to occupy a central position in cognitive psychology and neuroscience. Most theories and research so far have examined it in terms task-unrelated or stimulusindependent mental contents that occur at particular moments of time. A defining feature of mind-wandering, however, are its dynamics: how thought moves over time.

In this talk, I will introduce a dynamic framework for understanding mind-wandering and its neural basis. I propose that mind-wandering is best understood as a member of a larger family of spontaneous thought processes – a family that also includes creative thought and dreaming. I will distinguish between two types of constraints on thought – deliberate and automatic – that can reduce thought's spontaneous movement. Within this framework, fluctuations between spontaneous, automatic, and deliberate modes of thinking correspond to changing interactions among large-scale brain networks. Finally, the framework situates spontaneous thought within a broader conceptual space that allows its comparison to goal-directed thought, as well as to clinical disorders that make thought excessively constrained – such as in rumination and anxiety, or excessively variable – such as in ADHD.

Biosketch: Associate Professor in the Psychology Department and the Brain Research Centre at the University of British Columbia. Her work on the functions of the anterior prefrontal cortex (PFC) has linked this part of the brain to the uniquely human mental processes of introspection and meta-awareness. Dr. Christoff's most recent work focuses on examining spontaneous forms of thought, such as memories and thought streams occurring in the form of mind wandering. She is also interested in examining meditationbased thought phenomena such as mindfulness, and developing clinical applications for fMRI using real-time fMRI feedback to train modulation of activation in specific brain regions.

http://psych.ubc.ca/persons/kalina-christoff/

Distraction and inattention on the road: Biases and profits of a connected world

René Amalberti, PhD



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Topic: Driving is dangerous. This is one of the most demanding rapid process control situation which exists worldwide, and even worse, it is almost only in hands of non-professionals, all with limited formal education and control of their health and cognitive capacities.

That said, driving is a major social standard, providing autonomy to citizens and capacity to work and enjoy, and also a world of paradoxes.

Indeed, although it is obvious that any driver distraction is lengthening the reaction times and therefore is potentially consequential for road safety, the road and car design are “machines” producing billions of distractions for many good reasons, some -most?- being safety-related (alerting system, navigation guidance and intelligent on-board assistances, car audio alerting on future problems and preventing sleepiness), some being commercial sales-related (side road advertisements) and some being passengers-related (which is also one central social benefit of driving). Most or even all of these distractors and dual-side, good (for some aspects) and bad (for other aspects) at the same time. It is very probable that a total suppression of distractors should result in worsening road safety, both by the effect of cognitive disconnection with real world, and by the very useful content of many distractors for making contextual driving decision.

This conference tries to show new pragmatic avenues to control risk associated to distractors, adopting a more global vision and escaping a “black and white approach”. There is a growing evidence that the classic scientific approach showing longer reaction times to telephone and other connected on-board distractors sounds trivial, but cannot results in a large capacity improving road safety on the short and midterm for two reasons. First, how can we imagine dramatically improving road safety only firing one or two distractors among billions of other competitive and continuously mushrooming on-board IT’s distractors. Just trying to fire one or two distractors here and there is probably a non-end and non-effective battle. Second, many usual scientific risk analysis often minimizes (misinterprets?) both the capacities of cognitive control, especially routine cognitive control, including human learning capacities, and the value of global ergonomics including the design of a more resilient road and vehicle environment. The conference proposes a taxonomy of road distractors, especially the ones associated to Information technology with a corresponding tentative skill assessment of drivers. This new avenue leads to consider a mix of solutions improving road safety. The priority is not that much given to suppress and fix one specific distractor, whatever it is, since it is a non-end process, but to better contextual control risks associated with distractors. Some solutions are based on global ergonomics requiring an intelligent context analysis filtering, and some based on educating drivers to better use their natural ecological cognitive control of distractions.

Biosketch: Senior Adviser Patient Safety at the Haute Autorité de Santé and risk manager in a medical insurance (MACSF), Paris, France. He pioneered in the mid 80's the concepts of human error, ecological safety, crew resource management, and system safety. In late 1992, he was detached from the military to the European Joint Aviation Authorities (JAA) and became the first Chief Human factors and Flight safety of the JAA, then occupied a series of managerial positions in European and French research programs and administration (Land transport, Industrial and Environmental risks). In the late 90's, he moved his research on patient safety, system approach and resilience. He has published over 100 international papers, chapters, and authored or co-authored 10 books (last book: Navigating safety, Springer, 2013).

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Morel, G. Amalberti, R. Chauvin, C. Articulating the differences between safety and resilience: the decisionmaking of professional sea fishing skippers, *Human factors,* 2008, 1, 1-16

Morel, G. Amalberti, R. Chauvin, C. How good Micro/Macro Ergonomics May Improve Resilience, But Not Necessarily Safety, *Safety Science*, 2009, 47 (2), p.285-294

Hoc, J.M., Amalberti, R., Cognitive control dynamics for reaching a satisficing performance in complex dynamic situations, *Journal of cognitive engineering and decision making, 2007, 1, 22-55*

Driver Distraction: Reflections on a Path to Understanding

Prof. Mike Regan, PhD



Chief Scientist-Human Factors

Australian Road Research Board (ARRB), Australia

Adjunct Professor, University of NSW, Australia

Topic: Driver distraction is a complex issue – to define, understand, and manage. It is one of the few topics in road safety about which multiple books have been written. In this presentation, Mike will discuss some of the issues that he has grappled with in trying to understand what distraction is, how to measure it, how to quantify its impacts, and how to transfer research knowledge into policy that saves lives. His presentation builds on a keynote presented at the 2016 TRB Annual Meeting, and draws on his recent thinking in developing and documenting a model and theory of driver distraction.

Biosketch: Professor Mike Regan is an experimental psychologist with Bachelor of Science (Hons) and PhD degrees in psychology and human factors from the Australian National University. He was the 25th President of the Human Factors and Ergonomics Society of Australia.

Mike is currently Chief Scientist-Human Factors for the Australian Road Research Board (ARRB) in Sydney, Australia. The ARRB is Australia's national road transport research agency. Before that he was a Professor of road and transport safety in the School of Aviation at the University of NSW in Sydney, Australia.

Mike has designed and led around 200 research projects in transportation human factors and safety - spanning aircraft, motorcycles, cars, trucks, buses, and trains. He is the author/co-author of around 230 published documents, including 160 peer-reviewed publications and three books, and sits on the Editorial Boards of 4 peer-reviewed journals, including Human Factors.

Mike is well known internationally for his work on driver distraction and inattention. He is the senior editor and co-author of two books on distraction, has published numerous reports, articles and papers on the topic, co-created and co-convenes the biannual International Conference on Driver Distraction and Inattention, has advised local and international governments and industry on policies to manage distraction, and sits on several international expert committees on the topic.

Mike is the recipient of the Ron Cumming Memorial Medal, the Human Factors and Ergonomics Society of Australia's highest award for a major contribution to human factors and ergonomics research and practice in Australia.

Session 1A - Naturalistic studies

Naturalistic driving study on the usage of smartphone applications while driving

Jakke Mäkelä [1,2] and Tuomo Kujala [1]*

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We present the first results from a study that tracked how Finnish drivers use their smart phones while driving. We monitored 30 heavy-user drivers in Finland in June-September 2016, and recorded the times when they used their phones, the application used at the time of touch, and the location and speed of the car. Touches were used as a proxy for estimating visual distraction due to visual-manual tasks. Our data set allows us to determine whether drivers use their phones differently on different road types (highway, main road, local rural road, urban road). We found that the road type has very little effect on phone use. The drivers produced more touches per hour on urban roads but the instances of use tend to be slightly shorter than on the highway or on main roads. We also collected statistics on the applications that were used. By far the largest amount of distraction is caused by the WhatsApp messaging service, used by a majority of the drivers. An instance of WhatsApp use included a median of 12 touches, and had a median duration of 35 seconds. By contrast, navigation applications (better optimized for on-road-use) included a median of 4 touches and lasted 11 seconds. This suggests that the greatest risk from smart phone use may be currently caused by messaging applications.

The full paper is available in the DDI2017 e-Proceedings.

How many times do young drivers actually touch their smartphone screens while driving?

Gila Albert [1,2]* and Tsippy Lotan [1,3]

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Smartphone usage, and particularly texting, poses a major concern for road safety. The goal of this paper is to suggest a novel and objective means to measure the occurrence of texting while driving among young drivers. A naturalistic study was conducted with 254 Israeli young drivers who installed a research oriented smartphone app which continuously monitors smartphones usage while driving. The app captures the actual number of times drivers are "touching" their smartphone screens, the speed at which these screentouches occur, foreground apps and time stamps. The results, which are based on 3,304 hours of driving performed in 11,528 trips, indicate that young drivers touch their smartphone screen on average 1.6 times per minute of driving. Alarmingly, more than half of the screen-touches are performed while the vehicle is in motion, and some touches occur even at speeds higher than 100 km/h. The screen-touches occurred throughout the trip regardless of trip duration, but more intensively during the beginning of the trip. These findings provide evidence to actual and objective intensive usage of smartphones while driving.

The full paper is available in the DDI2017 e-Proceedings.

A data driven method to extract visual time-sharing sequences from naturalistic driving data

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Keywords: glance behaviour, analysis, visual time-sharing

An attentive driver has an up-to-date model of the surroundings of the vehicle, maintained by sampling information from the road ahead, the sides of the vehicle, the rear view mirrors and the dashboard instruments. Occasionally, the driver also looks at less traffic relevant targets such as a passenger, a navigation device or a mobile phone. While looking at these subsidiary targets, the mental model of the traffic scene becomes less accurate as a function of time (Senders et al., 1967). For this reason, drivers are unwilling to look away from the road ahead, and resort to using several shorter glances to obtain the sought information from other targets (Zwahlen et al. 1988).This switching between the road view ahead and other targets is often referred to as visual time-sharing.

Visual time-sharing analyses have been restricted to additional tasks with well-defined start and end points. We introduce a method to automatically extract visual time-sharing sequences directly from eye tracking data. This facilitates investigations of systems providing continuous information without well-defined start and end points. Further, it becomes possible to investigate time-sharing behaviour with other types of glance targets such as the mirrors.

Eye tracking data from an on-road study with 12 participants (about 100 hours of driving), aimed to test an in-vehicle information system, is used here for illustration. We define a visual time-sharing sequence based on the time duration between glances towards the target of interest. Analyses of return-time maps and within-sequence reduction in percentage time looking forward suggests that four seconds is an appropriate maximum between-glance duration when grouping glances into visual time-sharing sequences. Analyses of the extracted visual time-sharing sequences indicate that the number of glances within a sequence provide an indication of the complexity of the visual information sampled, and also that transition matrices based on sequences, as compared to glances, provide important complementary information, since the obscuring effect of frequent repeated glances to the same target are removed.

In conclusion, grouping glances to the same target into visual time-sharing sequences, such that one sequence describes one distinct information sampling occurrence, adds an additional layer of information to glance analyses. The generalization of visual time-sharing extraction allows analysis of non-task related targets. It provides a valuable tool to extend glance analyses to include information about tactical glance behaviour, especially when more detailed environmental information is available.

This work was supported by the European Commission under Grant Agreement 288611:FP7-ICT-2011-7 and by the Swedish Energy Agency.

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Zwahlen, H. T., Adams, C. C., & DeBals, D. P. (1988). Safety aspects of CRT touch panel controls in automobiles.

Session 1B – Driver monitoring

Analysis of a driver model sensitivity to various types of distraction

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Keywords: distraction, driver state estimation, parameter identification, steering behaviour

Because distraction contributes to a significant number of road fatalities, a great deal of work has already been conducted to design an algorithm able to make a diagnosis of the driver distractive state. This has been mainly achieved through the analysis of the driver's gaze, steering behaviour or psychophysiological indicators (Nakayama et al. 1999; Dong et al. 2011; Yang et al. 2012). Recently, some effort has been made to base the diagnosis on a driver model, by performing a parameter analysis or by analysing the model predictive performance (Hermannstädter and Yang, 2013; Ameyoe et al., 2015). The present study falls into this category.

Considering that distractive activities may influence the visual sampling of the environment, the control of the steering wheel, or both at the same time, a driver model that represents the visual and motor control of steering was chosen (Saleh et al., 2011; Mars et al., 2011). The visual component of the model combines visual anticipation and compensation into a desired steering angle, which is in turn converted into a steering wheel torque by the neuromuscular component of the model. The present study analysed the two subsystems of this model in conditions of visual, visuomotor, motor and cognitive workload.

Thirty-five participants participated in the experiment, which was conducted on a driving simulator. For each trial, the participants drove around an experimental track that consisted of 20 bends separated by sections of straight road. The protocol interleaved periods of baseline driving (no distraction) and periods of distracted driving. Four types of distraction were tested: cognitive (backward counting task), visual (reading a peripheral text), visuomotor (dialing task with mandatory visual control) and motor (dialing while looking at the road). For all conditions, steering behavior was assessed by means of the standard deviation of lateral position (SDLP) and the steering wheel reversal rate (SWRR). In addition, four of the driver model parameters were identified using prediction error methods (Ljung 1999): the gain of the visual anticipation process, fed by the angular deviation of a far point (K_p), the gain of the visual compensation process, fed the angular deviation of a near point ((K_c), the gain of a motor corrective reflex, fed by the difference between the desired and real steering angle (K_t) and the neuromuscular time constant, which represents the neuromuscular dynamics (T_n).

At the behavioral level, the results show that all distraction conditions but the cognitive one increased SWRR and SDLP, with a significantly larger effect on SDLP only for visual and visuomotor distraction compared to motor distraction. Looking at the four model parameter values, cognitive distraction did not have any significant effect. Motor distraction influenced T_n only. Visual distraction influenced T_n, K_t and K_c. Visuomotor distraction influenced all four parameters. Thus, it appears that all types of distraction can be discriminated on the basis of the analysis of parameter identification, which is an encouraging step toward automatic model-based driver state estimation.

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Yang Y, Mcdonald2 M, Zheng P (2012) Can drivers' eye movements be used to monitor their performance? a case study. *IET Intell Transp Syst,* 6, 444–452.

Measuring driver fatigue based on eyelid opening level

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Keywords: Driver fatigue, eyelid opening

Already in 2003 (Hargutt, 2003), a method was developed that assesses driver fatigue based on eyelid opening level. The original algorithm evaluates driver state using eyelid-opening level measured based on induction between two copper coils attached to the upper and lower eyelid. The algorithm categorizes every blink in one out of four categories covering the range between alert and extremely fatigued. Since that time, the method was used successfully to assess driver fatigue for a variety of research questions on driver state (e.g. disease, alcohol, drugs, assistance systems).

Recently, the development of functions for highly automated or autonomous driving brought new spotlight onto online assessment of driver state e.g. fatigue. Because measures based on driving behaviour (like in existing driver fatigue detection systems) cannot be used in highly automated driving, measures based on direct observation of the driver (e.g. through a camera system) are needed. However, to be able to assess unobtrusively driver fatigue in the car, our existing algorithm needs to be independent from the previously used copper coils, e.g. by using data provided by a camera-based eye-tracking system.

Data from an experiment in the driving simulator will be presented that was used to transfer the original algorithm to signals provide by a camera system. N=30 drivers drove in the driving simulator for 2.5 hours on an empty highway with night-time simulation. Eyelid opening level was measured with SmartEye Pro. For reference, driver state was assessed with a variety of different measurement approaches (online expert rating and driver rating using Karolinska Sleepiness Scale (KSS), online annotation of symptoms for fatigue, driving performance). To validate the adapted algorithm, repeated KSS ratings are used as ground truth for driver fatigue because it is the only measure that covers the full range between awake and asleep and is based on a subjective combination of different symptoms of fatigue. Overall, results indicate that the algorithm differentiates successfully different levels of driver fatigue using signals from the remote eye-tracking system only. The relations between the algorithm and other measures of fatigue as well as still existing limitations of the camera based assessment and their implications will be discussed.

Preventing driving accidents via detection of driver-induced steering oscillations

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We propose an approach of classifying the driver-induced steering oscillation of a simulated car driven by a cognitively distracted human driver. The inadequate cognitive engagement of the driver would result in delayed steering response of the latter. Applying the control theory for the system (driver-car), we hypothesize that such a delayed response would result in an oscillating trajectory of the car. To verify our hypothesis, we experimented with the following two driving conditions: (i) normal driving and, (ii) texting (on mobile phone) while driving. The first condition corresponds to the cognitively adequate driving with non-delayed steering response, while the second one accounts for the delayed response due to the required additional cognitive engagement of the driver while performing the primary task of driving. In order to classify each of these two cases, we propose an approach of analysing the power spectrum of the lateral acceleration of the car. The experimental results suggest that magnitude of the power spectrum of normal driving (without delay in steering response) could be well distinguished from driving with delayed steering response in most cases of the human drivers. The difference in the power spectra is due to the subtle, yet identifiable steering oscillations caused by the delays of response of the cognitively distracted drivers. The proposed approach of detecting steering oscillations as early signs of unsafe driving could ultimately facilitate the development of devices that would warn the (distracted) driver well before a traffic accident might eventually occur.

The full paper is available in the DDI2017 e-Proceedings.

Session 2A – Models of distraction and inattention

Minimum required attention

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Keywords: distraction, driver behaviour, attentional processes, mental models, situation awareness, visual search

Many definitions of driver inattention and distraction have been proposed over the years, but they are difficult to operationalise, and inconsistencies between and within definitions are commonplace (Foley et al. 2013). Instead of focussing on distraction, we believe that a more accessible way forward is to start with defining what it means to be an attentive driver.

Here we propose a human-centred driver attention framework, the minimum required attention theory (MRA). MRA describes which role the attention of the driver plays in the situation awareness of the traffic system (see Salmon et al. 2012 for a review on situational awareness). A driver is considered attentive when he or she samples sufficient information to meet the demands of the system, i.e. that the driver should be able to form and maintain a good enough mental representation of the relevant part of the situation at hand. A driver should only be considered inattentive when this mental representation is not maintained well enough, regardless of whether the driver is concurrently executing an additional task or not.

Four stages are involved in the operationalisation of MRA: defining prototypical situations, determining the information carrying agents/targets in each prototypical situation, setting up the minimum requirements on information sampling for each target/agent, and measuring when and how a driver samples information from each target/agent. Stages 1 – 3 set up the MRA requirements, whereas Stage 4 can be seen as the application phase, where it is checked whether a driver violates the requirements and should be considered distracted. During the presentation, we will exemplify the four stages and demonstrate how the minimum requirements are set up for a number of prototypical situations related to motorway driving.

The MRA theory is anchored in well-established theories of driver attention, which postulate that drivers actively adapt to situational demands and allocate their resources based on external requirements and internal motivations. MRA has the potential to provide the stepping stone for unbiased and operationalisable inattention detection and classification and should be seen as a theoretical starting point for the eventual goal of developing an operational inattention detection algorithm.

This work was supported by the Danish Road Directorate.

Foley, J. P., Young, R. A., Angell, L., & Domeyer, J. E. (2013). Towards operationalizing driver distraction. Paper presented at the Proceedings of the 7th International Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design.

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Modelling the effect of cognitive load on driver reactions to a braking lead vehicle: A computational account of the cognitive control hypothesis

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The recently proposed 'cognitive control hypothesis' suggests that the performance of cognitively loading but non-visual tasks such as cell phone conversation selectively impairs driving tasks that rely on top-down cognitive control while leaving automatized driving tasks unaffected. This idea is strongly supported by the existing experimental literature and we have previously outlined a conceptual model intended to account for the key underlying mechanisms. The present paper offers a more explicit account of these mechanisms in terms of a computational simulation model. More specifically, it is shown how this model offers a straightforward mechanistic explanation for why the effect of cognitive load on brake response time reported in experimental lead vehicle braking studies appears to depend strongly on scenario kinematics, in terms of the initial time headway. Moreover, it is shown that this relatively simple model can be fitted to empirical data obtained from a meta-analysis of existing lead vehicle braking studies.

The full paper is available in the DDI2017 e-Proceedings.

Dynamic Anticipation of Driving Scenarios

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Keywords: anticipation, situation comprehension, representational momentum, cognitive distraction

Anticipation in dynamic traffic situation is the supposition to ensure safe driving and prevention of conflicts and accidents. Predicting future events increases the time and space for adequate action which has a positive impact on driving performance (e.g. Fitch, Blanco, Morgan, & Wharton, 2010; Jackson, Chapman, & Crundall, 2009). Anticipation in driving is a competence that is based on high level cognitive processes and includes the perception of characteristic cues and the identification of stereotypical traffic situations (Stahl, Donmez, & Jamieson, 2014). However, this process can be impaired by a variety of influencing factors like visual or cognitive distraction (e.g. Baumann, Petzoldt, Groenewoud, Hogema, & Krems, 2008). In order to develop driver assistance systems that support anticipation and help to avoid the deteriorating effect of distraction on anticipation of driving events knowledge about the underlying cognitive processes is required. A cognitive model of anticipation is presented that is based on situation comprehension (e.g. Baumann & Krems, 2009; Durso, Rawson, & Girotto, 2007). Based on Endsley's (1995) theory of situation awareness that proposes that situation awareness consists of the perception of situational elements, their understanding and the projection of the future development of the situation, Baumann & Krems (2009) and Durso et al. (2007) added to this theory by proposing that situation awareness is constructed and maintained by comprehension processes analogue to text comprehension. One major process involved is the activation of knowledge stored in long-term memory triggered by the perception of situational elements. These activation processes result in a situation model that represents the driver's current understanding of the situation but also includes relevant well-learned expectations about the future development of the situation. But in addition to this expectation-based anticipation of events there is also evidence of more sensory-based processes that support the short-term prediction of events. The phenomenon of representational momentum (Freyd & Finke, 1984) represents a promising paradigm to investigate the effects of combined sensory-based (bottom-up) and experience- and expectation-based information (top-down) in updating of the representation of the situation. Representational momentum describes the systematic error to overestimate position changes along a trajectory of an occluded object in direction of movement that is influenced by previous knowledge (Reed & Vinson, 1996). This effect seems relevant in driving for instance while focussing the road in front of the own car and observing successively rear traffic in order to anticipate future states of traffic participants behind the own car.

A series of experiments is conducted using the paradigm of representational momentum in dynamic traffic situations showing that drivers tend to overestimate position changes along the driven road in direction of movement. The increase of velocity and landmarks each led to stronger forward displacements. Additionally the effect of cognitive distraction on the size of this displacement effect is investigated in various situations. This shift in representation of one' own position in direction of movement might be a relevant aspect of human anticipation in dynamic situations and important in terms of the interpretation of effects of cognitive distraction on driving performance.

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Stahl, P., Donmez, B., & Jamieson, G. A. (2014). Anticipation in Driving: The Role of Experience in the Efficacy of Pre-event Conflict Cues. *IEEE Transactions on Human-Machine Systems*, *44*(5), 603–613. doi:10.1109/THMS.2014.2325558

Session 2B – Driver characteristics

Analysing the inability to focus on the driving task in young males, un-experienced and offender drivers

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Keywords: Impulsivity, Risk Perception, Risk-taking, BART, Offenders, driving experience, Sensitivity to reward, sensitivity to punishment, offender status

Adult men, young people and inexperienced drivers are an issue in road accident data. Age, experience and gender appear to be determining factors in accident rates. Young men are more likely to be involved in risky behaviours because they perceive less risk in situations like driving under the influence of alcohol or talking on the phone while driving. Experienced drivers are more capable of detecting road hazards than inexperienced drivers. Offender drivers show significantly higher levels in driving angrily, seeking sensation, and being aggressive and impulsive. Impulsiveness has a cognitive/attentional dimension, defined as the inability to focus on the tasks at hand and cognitive instability involving thought insertions and racing thoughts.

In this study, we analysed the relationship between experience, risk perception, sensitivity to punishment, sensitivity to reward, impulsivity, and driver profile (offender or non-offender). These constructs have so far been studied in a relatively diffuse form, as an impulsivity and risky decision-making paradigm (Balloon Analogue Risk Task, BART), a measurement of self-reported perceived risk (Domain-Specific RiskTaking Scale-Spain, DOSPERT) and a measurement of sensitivity to punishment and sensitivity to reward (Sensitivity to Punishment and Sensitivity to Reward Questionnaire, SPSRQ-20). The aim of this study was a better understanding of the variables that could be relevant in reducing the accident rate.

A sample of 220 drivers, offenders and non-offenders, aged between 18 and 60 years, from driving schools, training centres and universities, was gathered for this study. The main results demonstrated that inexperienced drivers show a risk-underestimation pattern, with higher impulsivity and higher insensitivity to punishment. This pattern was also found in both young and adult male participants. Regarding non-offender drivers, driving experience is related to increased risk perception. Adult men perceive less risk than women in different situations. It seems that factors such as age, gender and driving experience are more closely related to impulsivity in the BART task, since no differences were observed between offenders and nonoffenders with regard to impulsivity. Finally, offenders showed less sensitivity to punishment compared to non-offenders. This may be due to an adaptation to punishment from authorities. Non-offenders are less exposed to these punishments, making them more sensitive to it.

Driver distraction is an under-reported cause of road accidents: An examination of discrepancy between police officers' views and road accident reports

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Police records represent the primary source of data on the role of driver distraction in crashes. It is commonly assumed that officers attending the crash scene tend to underreport driver distraction as a contributing factor in crashes. However, this assumption has never been explicitly tested. Thus, the goal of this study was to empirically estimate the presence of underreporting bias of driver distraction in police crash reports. We also explored whether such underreporting vary with respect to the age and gender of the driver. To this end, we presented police officers with hypothetical crash scenarios involving drivers from different age and gender groups. For each scenario, officers estimated the possible factors they believed to have contributed to the collision. We assessed the under-reporting of distraction-related crashes by comparing police officers' views with real crash reports. Our findings show that officers more often viewed distractive behaviours inside the vehicle as a cause of collisions than was evident in the crash reports. This difference was particularly pronounced with respect to mobile phone use as a cause of crashes. In contrast, officers' views and accidents records were similar with regard to the involvement of outside-vehicle distraction in crashes. Overall, the results substantiate claims that police reports do not provide reliable information on the role of driver distraction in crashes. In particular, the dangers of mobile phone use whilst driving have been severely underestimated.

The full paper is available in the DDI2017 e-Proceedings.

Special presentation

Participatory research with children: a pilot workshop on distraction in mobility

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Keywords: participatory research, children, design thinking, empowerment

The process of research and innovation has long been reserved to the scientific community, creating a gap between researchers and society at large. With the objective to bridge this gap and in accordance with the value of inclusiveness, an increasing number of science-based activities are addressing all societal actors in order to consider the values, needs and expectations of society. In line with the EC framework of Responsible Research and Innovation (Owen *et al*, 2012) that aims at engaging all societal actors in the coconstruction of innovative solutions, the Scientific Directorate at IFSTTAR supports participatory research initiatives, including those with children.

Finding the right answers to the challenges society faces is most likely when allowing for the joint participation of all parts of society. Interacting with children on research topics is not only meaningful to awaken their interest in science and to raise their awareness on a specific topic. Children can make a significant contribution to the research and innovation process by sharing observations through their unique lens and by inspiring researchers with their creative and fresh ideas. In order to give children a voice in the co-construction of society and to empower them through creativity and innovation, Imagineo runs design thinking workshops with children, following a bottom up approach and using tools that are tailored to the context of application. A collaboration between IFSTTAR and Imagineo has been established to promote and facilitate interactions between children and researchers through participatory research.

On the topic of distraction in the mobility context, two independent afternoon workshops (3 hours) have been carried out. A total of 24 children (12 girls, 12 boys) aged 9-12 participated in these science-based creativity workshops. The children were invited to contribute to the advances in research by sharing their observations, habits and ideas. They shared their point of view regarding the sources of distraction, its appearance and impact for different road user types, including themselves. They were accompanied in a creative process to generate ideas on innovative countermeasures that make mobility safer, more pleasant and yet playful.

At the example of distraction in mobility, the design thinking workshops could be confirmed as a promising approach to carry out participatory research with children. This experience supports the interest to further develop research involving children, both as an enrichment of the scientific process and as a way to empower children.

This work was supported by the Department of Science and Society (PEPS/Scientific Directorate) at IFSTTAR.

Owen, R., Macnaghten, P. and Stilgoe, J. (2012). Responsible research and innovation: From science in society to science for society, with society. Science and Public Policy 39, 751-760.

Session 3A - Distraction and automated driving

Effect of visual distraction on response time for lane change with partially automated vehicle

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The present study aims to clarify how visual distraction under partially automated driving affects the driver's subjective assessment for easy and comfort and the driver's response time in a lane change task when the driver needs to take control. We conducted an experiment on a test track using 21 participants. This experiment involved a car-following task with a lead vehicle. The study found that the response time to take control for changing lanes in the partially automated vehicle was affected by the visual task load. The participants became to perform the visual task more often with partially automated vehicle despite the complex visual load, then response time became longer. However, the second response time for the partially automated vehicle was significantly shorter than that for the manual vehicle. It is supposed that partially automated driving might reduce the driver's response time to take control due to trust in the systems.

The full paper is available in the DDI2017 e-Proceedings.

The effects of mental workload and duration of automated driving on driver behaviour

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Keywords: Automated driving, Mental workload, Duration, Driver behaviour

Vehicle automation is likely to have multiple positive effects such as increasing road safety, enhancing driving efficiency or time saving. However, automated driving is also expected to induce modifications on driver state and driver performance.

One of the main areas of interest in automated driving is the analysis of changes in mental workload on driver behaviour. Automation may induce both underload and overload (Young & Stanton, 2002) due to the driver is not responsible for most of the driving tasks but s/he is still necessary when there is a situation that the automation cannot handle. In addition, the changes in mental workload during automated driving may also be induced by the engagement in non-driving tasks. Nevertheless, these effects are not well-known yet (see for example, Neubauer, Matthews, & Saxby, 2012; Radlmayr, Gold, Lorenz, Farid, & Bengler, 2014). The current study aims indeed to examine the impact of different levels of mental workload on the driver behaviour during the automated driving as well as during the transition from automated to manual driving. Moreover, driver behaviour may be affected depending on the time spent on automated driving mode (Feldhütter, Gold, Schneider, & Bengler, 2016). Therefore, the impact of mental workload was analysed according to different time periods of automated driving.

A total of 57 drivers participated in this study conducted in a driving simulator. Half of participants were in automated driving mode during a 10 minutes period, whereas the other half of participants were in automated driving mode during 30 minutes. To evaluate the impact of the mental workload, participants performed a non-driving task presented in the human-machine interface with two levels of mental workload: low versus high mental workload. A baseline condition in which drivers were driving in manual mode and without performing the non-driving task was added in order to evaluate the effects of automation. Eye movements and driver performance data were recorded during the automated driving and during the transition between automated to manual driving to examine driver state and driver performance. We expect drivers to develop different visual strategies during the automated driving depending on the level of mental workload. Specifically, we hypothesised that participants under high mental workload condition would exhibit a poorer processing of the road environment compared to the low mental workload condition. In addition, high mental workload condition would produce a negative effect on driver performance, especially after the longer time exposure to the automated driving.

We expect our results to shed light on the driver state during automated driving based on relevant indicators as well as the take-over quality. Automated systems should ideally adapt the information they provide according to the drivers state and the present results can have implications for the design of humanmachine interfaces.

Feldhütter, A., Gold, C., Schneider, S., & Bengler, K. (2016). How the Duration of Automated Driving Influences Take-Over Performance and Gaze Behavior. Presented at the Kongress der Gesellschaft für Arbeitswissenschaft, Dortmund, Germany.

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Exploring the behaviour of distracted drivers during different levels of automation in driving

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Increased levels of automation in driving can reduce drivers' situation-awareness and cause erratic changes to workload and skills degradation following prolonged exposure. In addition, drivers (particularly those who are vulnerable to the onset of boredom/fatigue) may engage in non-driving related, and potentially distracting, secondary tasks. Understanding the behavioural cues associated with this change in driver-state can assist in the design and development of future driver monitoring systems that intervene in instances where a driver exhibits 'high' levels of distraction. The aim of this study was to explore the behavioural cues associated with distraction caused by a non-driving-related secondary reading task during manual, partially- and highly-automated driving in a medium-fidelity driving simulator. Results from thirty drivers show that highly-automated driving was characterised by reduced workload, increased secondary task times and longer in-vehicle glances, compared to manual and partially-automated driving. In contrast, partially-automated driving was characterised by high workload, poor secondary task performance and low levels of situation awareness. Furthermore, primary and secondary task performance immediately following take-over during partially-automated driving was significantly compromised. The results indicate that the same type of 'distraction' can elicit different behavioural cues depending upon the level of automation within driving. This information can be used to further the development of future driver monitoring systems.

The full paper is available in the DDI2017 e-Proceedings.

Session 3B - Driver distraction

When motion and color compete for selective attention, motion induces a stronger distraction

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According to some authors, a task-irrelevant but highly salient stimulus will always capture attention at first, regardless of the Attentional Control Setting (ACS) defined by observer's goals. In this way, motion stimuli are known to be particularly salient and therefore may be easily selected when necessary but act as powerful distractors when irrelevant. Nevertheless, previous studies investigating the capacity of irrelevant motion stimuli to override an ACS for color produced conflicting results. The aim of our study was to compare to what extent focusing on motion can prevent a distraction effect by color and vice versa, when both dimensions compete for attentional selection. In Task 1, participants performed a visual search task for a target defined as a color-singleton while having to ignore an irrelevant motion-singleton. In Task 2, the instructions were reversed. Our results revealed a distraction effect in both tasks, suggesting that an ACS for a particular dimension is not sufficient to prevent attentional distraction by an irrelevant one. Moreover, our results showed a larger distraction effect for motion-distractors than for color-distractors. Our results are discussed in regard to current models of attentional control.

The full paper is available in the DDI2017 e-Proceedings.

Do LED-advertising signs affect driver attention?

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With the purpose of investigating how LED-advertising signs (LED) affect drivers' attention compared to static signs and other kinds of distractors along roads, a new Danish empirical on-road study has been carried out by using an instrumented car equipped with a camera system to monitor eye movements. Speed behaviour was recorded by use of GPS and additionally a laser scanner was used for measurement of distances to vehicles ahead. In total, 16 different test drivers drove a test route making 228 drive pasts of different LED-advertising signs. The test drivers were not informed about the main purpose prior to the test drive. Eye track data verified whether the driver was glancing at the LED-advertising signs (the number of glances, glance duration and glance angles). Different algorithms for detection of driver distraction were used. Critical situations were identified and analysed in detail to uncover the identity of distractors. Driving in daylight were compared with driving in darkness.

Results showed that drivers' visual attention was diverted by LED-advertising signs. In more than every 10th drive past visual distraction occurred, e.g. cumulative glances of more than 2 sec. within a 6 sec. period, when the driver looked at the LED-advertising. In 4 % of the drive pasts visual distraction occurred together with a "safety buffer" less than 0 sec. The safety buffer reflects the time available to respond to a sudden critical event requiring immediate action in order to avoid an accident.

The full paper is available in the DDI2017 e-Proceedings.

Session 4A - Phone distraction

Factors influencing usage of extended functionalities on smartphone while driving

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Keywords: Distraction, Smartphone, Driving, Texting, Survey

Technological advances in mobile telephony multiply functionalities that can be used inside the vehicles. While this development offers prospects for improving safety and driving comfort (traffic information, navigation, etc.), it also raises problems of road safety linked to the risks of distraction and changes in driving behaviour, as it is well known now that phone manipulations impair the driving and increase the risk of having an accident.

To quantify such usages, a representative sample of the French population of 3,189 people was interviewed online, of whom 2,843 drivers were extracted (89%) and 1,081 drivers (38%) using their phone while driving at least occasionally. Results show that frequent use predominates over occasional one confirming the generalization of phone use while driving. 36% of drivers make phone conversations which still remains the most widespread use. However, 33% of the drivers declared using their phone for other functionalities: 27% of the drivers read messages or text, 9% navigate the internet or use applications. 8% of drivers declared having already taken a picture or a selfie and 7% used social networks while driving. Using GPS applications was also reported by 21% of the drivers. New contents appear that combine text, image and sounds, as well as static content becomes dynamic. New types of exchanges also emerge via instant messaging that facilitates group communications.

First analysis shows that having frequent phone conversations while at the wheel is correlated with none of the other usages, as well as the use of GPS applications. On the other hand, texting, sending emails, taking picture, browsing the Internet or using social networks are all correlated together. If those usages are much more frequent among the younger drivers, such phenomenon is better explained as a generational effect than as age effect.

Linear regressions highlight factors of influence such as age, mileage, but also phone dependence, perceived behavioural control over phone manipulations. Drivers with the most intensive usage also tend to report more violations and aberrant behaviour.

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The ESRA-project: Toward a joint European monitoring system on road users's safety attitudes

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Keywords: European survey, attitudes, behaviour, safety culture

The formulation of new road safety policy measures and the assessment of their impact requires thematic, temporal (trends) and spatial comparisons of road user behaviours. However, since the European road safety survey, SARTRE4 (2010) there is a lack of recent comparable and reliable data on road safety attitudes and behaviour within Europe. Therefore, in 2015, the Belgian Road Safety Institute launched the ESRA project (European Survey of Road users' safety Attitudes).

The overall aim of ESRA project is to provide scientific support to European road safety policy by generating comparable national data on the current road safety situation in Europe. More specifically ESRA captured national information on road users' opinions, attitudes and behaviour with respect to road traffic risks and compared these information access the involved 17 European countries. The first ESRA survey was conducted online using representative samples (N=1000) of the national adult populations. A common questionnaire was developed in English and translated into 20 different country-language versions. The subjects covered in the survey are, amongst others: "attitudes towards unsafe traffic behaviour", "selfdeclared (unsafe) behaviour in traffic", and "support for road safety policy measures". The ESRA questionnaire was inspired by the previous European project, SARTRE, and also includes some questions of the AAAFTS-survey (USA) "Traffic Safety Culture Index", which enables tentative comparisons with these projects. In total, data from more than 17,000 road users (of which 11,000 frequent car drivers) were collected. Hence, the ESRA survey provides comparisons on topics such as distraction and fatigue, speeding, safety feeling and risk perception, driving under the influence or the usage of seatbelt.

The results show that European people are aware of the risks related to distraction. Distraction is seen as the third cause of accident by Europeans after speeding and driving under the influence. Besides, European people have low personal and perceived social acceptability on distracted behaviours (e.g. checking social media, texting email or messages, using a hand held mobile phone) But, acceptability does not reflect self-declared behaviours. About 37% of European respondents declare reading text messages or email while driving or talking on a hand-held mobile phone. This European mean hides large variations between countries. While there only 22% to declare using a hand-held mobile phone while driving in the United Kingdom, this percentage raises to 73 % in Finland. Gender and age variations are also observed, even their range is much smaller than the country one. Finally, with regard to temporal evolution, distraction seems to be increasing as most European drivers (61%) agreed that they are more often confronted to distracted drivers than two years ago.

The ESRA project has shown the feasibility and necessity of a joint initiative for a European road safety survey based on the collaboration of national road safety institutes and universities. Currently the intention is to repeat this initiative on a biannual or triannual basis, retaining a core set of questions in every survey allowing comparisons and the development of time series of road safety performance indicators.

Texting distracted driving behaviour among European drivers: influence of social norms and risk perception

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Keywords: distracted driving behaviour, texting while driving, social norms, risk perception, inattention

Texting is becoming the most frequent way of non-personal communication, mainly among young people. (Newport, 2014). Following this social increasing trend, the number of people who text while driving is increasing, creating a new and growing problem in road safety (NHTSA, 2015). While driving, texting involves cognitive distraction, as well as long periods of both manual and visual distraction, which increase the risk of being involved in road traffic accidents (Olson *et al*, 2009).

The theory of normative social behaviour (Rimal & Real, 2005) provides a framework for understanding how risk taking combines with perceived acceptable behaviours (social norms) to shape driving distraction behaviours. The level of risk perception interacts with perceived social (descriptive norms) and personal (injunctive norms) acceptability influencing distraction driver behaviours such as texting (Carter *et al*, 2014).

This study examines how the risk perception of texting while driving, its personal and perceived social acceptability interact and affect this risky behaviour. In addition, the association of the self-declared behaviour with socio-demographic characteristics and with other traffic risk behaviours – like speeding or driving under the influence of alcohol/drugs – are also explored. The data are part of the ESRA survey (European Survey of Road users' safety Attitudes) (Torfs *et al*, 2016) and include representative samples of the national adult populations in 17 European countries. The ESRA survey was conducted online simultaneously in all countries in June/July 2015. In total, data from more than 17,000 road users (of which 11,000 frequent car drivers) were collected. The subjects covered in the survey are, amongst others, the self-declared unsafe traffic behaviours, its acceptability, the risk perception, and attitudes towards those behaviours. Different road safety topics are assessed: speeding, driving under influence of alcohol or drugs/medication, distraction, fatigue, and seat belt use.

First results show that 36% of the European drivers declare reading text messages or emails, and 27% declare sending text messages or emails while driving. These percentages are particularly high among drivers until 34 years old (56% and 48%, respectively). Logistic regression models show that men, young drivers, drivers with higher educational level, and drivers who drive more frequently are more likely to text while driving. Furthermore, both personal and perceived social acceptability increase the chances of the selfdeclared behaviour. On the other hand, the higher the risk perception, the lower the likelihood of texting while driving. In further analysis the aim is to explore the relationship among personal acceptability, perceived social acceptability, perception of risks and the actual behaviour in traffic. The connection between texting while driving and other traffic risk behaviours will also be explored. These results will also be presented in this paper.

This study found that texting while driving is more prevalent among young adult drivers and is strongly influenced by social norms and risk perception. The association with other risky driving behaviours suggests that there is a subgroup of drivers who are susceptible to engage in all types of risk behaviours in traffic.

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Session 4B - Driver distraction

Distraction effects of in-car music; the proof is in the performance

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Keywords: Driver Distraction, In-car Music, Car-aoke Singing, Steering-wheel Drumming

Drivers engage in a host of driving-unrelated tasks while on the road. Most frequently, drivers listen to music and sing-along with the words in a karaoke fashion (i.e., Car-aoke) and often sing background harmony. At times drivers accompany songs by pounding-out drum-kicks and fills on the steering wheel, floorboard, gearshift, or their own body. However, there is controversy over the utility of in-cabin music: Does background music facilitate via increased arousal leading to more focused concentration (Unal, Steg, & Epstude, 2012; Unal, de Ward, Epstude, & Steg, 2013; Unal Platteel, Steg, & Epstude, 2013), or cause distraction increasing risk (Brodsky 2002, 2015; Brodsky & Kizner, 2012; Brodsky & Slor, 2013; Hughes, Rudin-Brown & Young, 2013). Moreover, Unal and colleagues claim that drivers easily implement cognitive strategies to reduce task-demands on the road by blocking-out auditory distracters such as music and radio broadcasting. To shed light on the issue, the current on-going study investigates the secondary task (i.e., music engagement) under three simulated driving contexts: baseline stationary parked vehicle, low-demand driving, and high-demand driving. In Study I, 18 undergraduate young drivers recorded vocal performances of two songs at baseline; the vocal performances were analyzed and compared to vocal performances of the same songs recorded during simulated low-demand and high-demand driving tasks. The results indicated that as the perceptual demands of the primary driving task increased, vocal performances were more hampered with inaccuracies of intonation, rhythm, and tempo, as well as with errors of lyrics by word replacement or neglect. In Study II, 25 undergraduate young drivers will be recruited and record music performances of percussive accompaniment to two songs under three simulated driving contexts: baseline stationary parked vehicle, low-demand driving, and high-demand driving. It is expected that similar effects will surface, and further demonstrate increased levels of effect size than seen in Study I. In-car music may not necessarily be handled very well, nor can it be blocked-out by drivers during high-demand driving as previously reported. Singing and drumming with in-cabin music background clearly contributes to increased risk. Drivers should be made aware this driver behaviour, and learn to choose in-car music more wisely. Incar music should be re-considered by traffic scientists investigating human factors and driver distraction.

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Effects of driver's anger state on driving performance and attention

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Keywords: Anger, Event-Related Potentials, Visual N1, Lateral variations, Car simulator, Mind-wandering

Driver internal state, including emotion, can have negative impacts on road safety. Studies have shown that an anger state can provoke aggressive behaviour and impair driving performance. Indeed, it is known that negative emotions (Smallwood *et al*., 2009) are commonly associated with attentional disruptions and mind-wandering so that they may interfere with driving performance. In another hand, anger could lead to a positive impact on the alerting network efficiency (Techer *et al*., 2015) and so may become useful when driving with advanced driving assistance systems providing alerting cues. However, to our knowledge, no prior event-related potentials study has assessed the impact of anger on attention during simulated driving. Therefore, the aim of this study was to investigate the impact of anger on attentional processing and its consequences on driving performance. For this purpose, 33 participants completed a simulated driving scenario once in an anger state and once during a control session. This scenario consisted in a motorcyclefollowing task on a simulated straight rural road. A warning system informed participants about imminent motorcycle braking. Event-related potentials (ERP) were recorded so as to reflect attentional modulations that may be undetectable with behavioural data. Results indicated that anger impacted driving performance and attention, provoking an increase in lateral variations while reducing the amplitude of the visual N1 peak. The observed effects were discussed as a result of high arousal and mind-wandering associated with anger. This kind of physiological data may be used to monitor a driver's internal state and provide specific assistance corresponding to their current needs.

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Differences in calibration of skills in distracted driving situations

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Keywords: risky decision making, texting, driving, cognitive

The dangers of driver distraction are the topic of frequent reminders on television commercials, bumper stickers, and in general media coverage. However, it is still common see drivers texting while driving and crash statistics and observational studies corroborate this continued engagement. Two possible explanations for this risky behaviour are that drivers value the information in the message and therefore feel they cannot wait to respond—even in spite of the risks—and/or drivers do not have an accurate understanding of their driving abilities (i.e., have a poor calibration of their driving skills) and therefore might believe that they can tolerate the additional activities while driving. These two possible explanations and their potential interaction were examined together in a driving simulator study. Twenty participants (10 male, 10 female; Mage = 39) first responded to a questionnaire that quantified their propensity or capacity to delay a text messaging task (versus seeking immediate gratification). This delay discounting measure, applied in previous studies, was used to identify drivers who preferred a smaller hypothetical monetary reward if they responded to a text message immediately or a larger reward if they delayed responding to the message. The delay discounting measure utilized four different scenarios: either in sunny and clear weather or in a winter storm with a text message from their significant other (to induce a sense of urgency to respond to the message) presented either on the handheld phone screen or over the vehicle voice system. The point at which responding to the text message and monetary amount were equal in value (the indifference point), was calculated and used to group drivers into high and low discounters. Following the completion of this survey, participants completed six drives in a fixed-base driving simulator. The six drives consisted of two levels of ambient traffic (high and low) and three levels of distraction (control, cognitive n-back task, and texting task). The order of the drives was determined using a balanced Latin square design. During the drives, participants were prompted to verbally rate their driving performance. Lateral wind of varying strengths were also present, making it a challenge to maintain lane position. Measures of cognitive workload (peripheral detection task), driving performance, and task performance were collected. Upon completion of the drives, participants completed a second set of questionnaires to control for potential individual factors, such as impulsivity and personality. Data analysis is underway. Based on previous literature, we expect to see degraded driving performance in the distracted conditions as well as degraded performance in the peripheral detection task due to increased workload compared to the control condition. Further, we expect subjective ratings of driving performance to be inflated for most participants, but more so for those who value the message more. Findings will help inform the field of the factors and the interaction of factors that influence the decision to drive distracted.

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Session 5A - Human machine interaction

A Predictive Model of the Visual Demand Associated with In-Vehicle Touchscreens

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Touchscreen-HMIs are increasingly popular within vehicles. Understanding the likely visual demand of new designs is therefore important but typically requires time-consuming and costly testing with functioning prototypes. Theoretical modelling allows performance to be determined much earlier in the design cycle, but has seldom been applied to touch-screen interfaces in divided-attention contexts, such as driving. We describe a theoretical model of human performance – derived from empirical testing – that makes a priori predictions of the visual demand (total glance time, number of glances and mean glance duration) elicited by finger-touch pointing tasks in a driving context. The model integrates two well-established laws of human behaviour – the Hick-Hyman Law, concerning decision/search behaviour, and Fitts' Law, which considers the movement to acquire a visual target. The model also recognises that menus with greater depth will extend decision/search time and delay the time taken to achieve expert status. Preliminary validation work, comparing predictions for a real-world prototype touchscreen interface with empirically-obtained data, suggests that the model may provide an effective design and evaluation tool capable of making valuable predictions regarding the limits of visual demand/performance associated with in-vehicle interfaces, enabling designers to explore a wide range of possible designs before implementation, and permitting cost-effective redesign. Further work is required to refine the model, particularly in consideration of more complex tasks, involving multiple screen interactions.

The full paper is available in the DDI2017 e-Proceedings.

Exploring two interaction mechanisms for in-vehicle touch screens: Peripheral Vision and Muscle Memory

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There is a need to understand how in-vehicle touchscreens can be designed to minimise “eyes off road” time. We investigated the relative effects of two mechanisms shown to be relevant to visual behaviour when driving, but previously not considered together in the context of in-vehicle touchscreen use: peripheral vision (PV) and muscle memory (MM), i.e. motor learning. This study was designed to isolate and observe the effects of PV and MM on the time to press different sized buttons (small 6x6cm, medium 10x10cm, large 14x14cm) on an in-vehicle touchscreen. Twenty-five participants were seated in a driving simulator and were presented with a single, white, square button on the touchscreen on 24 successive occasions. For MM conditions, participants wore a pair of glasses that blocked their peripheral vision and for PV conditions they were asked to focus on the vehicle in front. Results show that task time was significantly higher during MM tasks at the beginning of each condition compared to task time for PV tasks. NASA TLX results showed that perceived workload was significantly higher during MM in comparison with PV conditions. Results suggest that for interfaces that utilise peripheral visual processing the learning effect is not evident and operation times are constant over time. This suggests that in-vehicle touch screens can be designed to utilise peripheral vision for making simple button selections.

The full paper is available in the DDI2017 e-Proceedings.

Understanding drivers' strategies for engaging with in-vehicle technology while driving: An interview study

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Keywords: Driver Distraction, Qualitative methods, In-vehicle technology, Individual differences.

Advances in technology have allowed more information to be brought into road vehicles for drivers to utilise. Navigation, communication, efficiency and infotainment systems are now commonplace in many vehicles. Much empirical research has focused on the ability of the driver to engage with these different technologies, taking measurements of their primary driving performance alongside secondary task performance, with an aim to quantify their distractive effects. Yet, qualitative research into the decisionmaking processes that drivers adopt when choosing to engage with these devices has been less widely explored in recent times. Where technology has been shown to have the potential to distract the driver, the reasons behind why drivers choose to risk their safety and engage with certain devices while driving requires further investigation.

Research to date has tried to uncover possible factors that correspond to engagement decisions, with mixed findings. Lerner et al (2008) conducted a focus group study into strategies for in-vehicle technology use and found that drivers did not attribute particular risk to mobile phone use while driving. Yet, these focus groups were conducted in America before an enforced ban on mobile phone use was incorporated in legislation. Young and Lenné (2010) has since shown that drivers do attribute a high level of risk to mobile phone use while driving but that their decision to engage with the device depended on how likely they were to get caught rather then the associated risks. Thus, it is evident that as technology continues to advance the perceptions drivers have towards their use while driving requires further analysis, with relevance to legislation and its regulation.

Semi-structured interviews were conducted in order to determine the current views on in-vehicle technology use, including built-in features, banned devices such as hand-held mobile phones and other nonregulated technologies such as portable devices. Drivers were recruited from across three different age groups: young (18-30yrs), middle (31-49yrs), and older (50-65yrs). Younger drivers have been shown to be more willing to engage with technology (Young & Lenné, 2010) and therefore the perceptions of technology use between drivers of difference ages was of interest. The drivers' engagement strategies and the factors that influence their decision to engage with devices were explored.

The findings from this study highlight the different perceptions that drivers from different age groups have towards their ability to engage with technologies while driving and how they perceive it to effect their driving performance. The role that legislation has on the perception of risk in relation to different technology use and how this alters engagement decisions while driving is of particular interest. The findings are reviewed with respect to a wider systems approach to mitigating against technological distractions behind the wheel.

This research was funded by the Engineering and Physical Science Research Council (EPSRC) grant EP/G036896/1 and industrial sponsor Jaguar Land Rover, under the Industry Doctoral Training Centre in Transport and the Environment.

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Session 5B - Vulnerable road users

Driver's emotional state and vulnerable road user detection

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Keywords: Anger, Emotional Intensity, Driving, Vulnerable, Road User, Coupled Measures

In 2014, slightly over 3380 deaths occurred on metropolitan French roads (Observatoire National Interministériel de Sécurité Routière [ONISR], 2015). For pedestrians and cyclists the percentage of fatal accidents increased by around 4, and 7% respectively since 2010. In addition, accidents involving pedestrians and cyclists are mostly caused by other road users as motorists, truck or bus drivers making pedestrians and cyclists vulnerable road users [VRU].

Previous investigations showed that VRU visibility for road users (drivers) was a crucial main issue. To address this issue, first of all, attention management to VRU while driving must be investigated. For example, Hole, Tyrrell, and Langham (1996) show that expectations and knowledge about a stimulus would modulate attention to it. However, recent research in the field indicated that driving is also influenced by emotion. Several studies highlighted a specific harmful impact of negative emotions on several processes involved during driving activity (Ellis, and Moore, 1999; Lemercier, and Cellier, 2008), especially for anger (Stephens, and Groeger, 2009; Stephens, Trawley, Madigan and Groeger, 2013)

Further, Rogé, El Zufari, Vienne, and Ndiaye (2015) found that a short film which delivered information to car divers about pedestrian, cyclist and motorcyclist vulnerability modified the intensity of negative emotions felt by motorists. In addition, among all emotions experienced during the film viewing, only anger intensity was positively correlated with a change in the visibility distance of VRU (i.e., road distance between a car driver and a VRU when the motorist claimed he has seen him). The greater is the distance, the more visible the VRU is for the driver (Rogé, Douissembekov, and Vienne, 2012).

Therefore, in our study, we only wanted to test the role of different anger intensities on VRU detection abilities. For this reason, we chose to set up a VRU detection task on a car driving simulator (in order to avoid real-life risky situations). Anger-elicitation was carried out using short film clips (see Schaefer, Nils, Sanchez, and Philippot, 2010). These films made no reference on driving or road safety and elicited different anger intensities. Film clips were watched by participants before we asked them to complete driving sessions in which they had to detect pedestrians and cyclists.

Furthermore, anger can also be characterized by specific physiological patterns that could be recorded (Kreibig, 2010). For these reasons, particular emphasis was placed in our study on emotional assessment in order to get as much feedbacks as possible on individual emotional state during and after driving. Thus, cardiac and ocular measures were recorded during the driving sessions while emotional self-assessments were carried out after each session to know in what extent all measures matched. By this way we were able to explore the relation between experienced emotional intensity and VRU detection abilities. It was also expected to highlight physiological and behavioural patterns linked with different anger intensities attempting at the same time to provide some answers about an optimum anger intensity likely to be beneficial for driving.

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Attention allocation of cyclists in interaction with other road users

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Keywords: Cyclists, system situational awareness, glance behaviour

When moving in traffic, each road user has to attend to a particular set of targets to gain the necessary information on how to continue on the intended path in an efficient, safe and predictable manner. This sharing and exchanging of mutually compatible information has been described as system situation awareness (Salmon et al 2012). Thus, each road user collects information from relevant sources, assuming that the information is system compatible and that other road users sample the share of information that is relevant to their progress.

In a semi-controlled field study the information sampling and integration process of 41 cyclists was studied. The participants were recruited into four rider type groups based on self-categorisation: fast cyclists, recreational/comfort cyclists, “normal” cyclists and cyclists using e-bikes. All cyclists rode a predetermined city route of 3 km twice, with and without listening to music or spoken text. Speed data, eye movements, verbal protocol, video recordings of the forward scene, of the rider’s face and of the rider as seen from a following bicycle were acquired. For a number of interaction scenarios experts will determine a minimum set of attentional allocation targets that belong to the cyclist’s share of the system situation awareness model. Data collection was completed in June 2016 and analyses will start in August. We will update the abstract with results well in advance of the conference.

For the mentioned interaction scenarios, the cyclists’ interactions with other road users will be categorised and analysed with regard to type of interaction, right of way, type of road users involved, rider type and whether the auditory entertainment was on or off. The analysis will take into account whether there was eye contact, how early it was initiated, whether the interaction was smooth or included unplanned evasive manoeuvres, etc. Eye movement data in combination with the verbal protocol will provide insight into the cyclists’ visual sampling behaviour and reasoning behind the sampling strategy. The expected outcome will be an analysis of whether and how the investigated factors contribute to how well a cyclist maintains his or her share of the system situation awareness, whether any systematic issues can be identified, and whether this can lead to improvement suggestions in different components of the traffic system.

By building on the notion that a functioning traffic system demands that all system components play their role in communicating relevant information amongst each other, it is possible to identify systematic problems, which will indicate where the system can be improved.

This work was supported by Stiftelsen Länsförsäkringsbolagens Forskningsfond.

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Cognitive conspicuity of cyclists for motorists: the effect of knowledge concerning risky situations?

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Keywords: attention, vulnerable road user, cyclist, conspicuity, car driver

In France, 14% of fatal accidents involved a pedestrian, 5% a cyclist and 24% a motorcyclist (World Health Organization, 2015). Collisions with passenger cars may be explained, at least in part, by the low visibility of vulnerable road users (VRU) for car drivers.

The low visibility of VRUs can be due to their physical characteristics (such as their visual angular size, eccentricity in relation to the point of gaze, contrast against the background, colour, etc.) that make them difficult to be distinguished from their environment (notion of low sensory conspicuity). According to Theeuwes, the momentary need for information could play a key role in the process of actively directing the observer's attention (Theeuwes, 1991). The observer could engage in active filtering based on knowledge related to the nature of probable stimulus inputs. These top-down processes can be put forward to explain, at least in part, the low visibility of VRU. Drivers' ability to detect a VRU could then depend on its cognitive conspicuity. This conspicuity is linked to the fact that the focus of attention is strongly influenced by the observer's expectations, objectives and knowledge. According to Crundall (2008), the detection of a motorcycle in the road environment is partly related to top-down influences (such as attitude, knowledge, skills and strategies) which lead to driving schemata concerning the interactions between car and motorcycle. The objective of this study is to see whether this model is relevant to the detection of cyclists by motorists. It is possible that, due to infrequent exposures to specific risky situations and based on their previous experience about what is likely to happen next, some car drivers might have incorrect expectations. It is also possible that car drivers misinterpret what they see or the location where the cyclist might show up. The corollary of these suggestions is that car drivers who also ride a bicycle (cyclist-motorists) could draw upon their riding knowledge or practical experience when they drive a car to help them detect cyclists and avoid collisions.

Therefore, the performance of two groups of motorists (not cyclist-motorists versus cyclist-motorists) has been compared in a task that consists of detecting cyclists during a simulated car driving. The scenarios included 16 (risky and not risky) situations that have been partly elaborated after an analysis of crashes in France and the observation of urban cyclists in their natural environment. The analysis of the number of collisions and the visibility distance leads us to conclude that cyclists properly identify the risky situations in terms of low conspicuity. In all driving situations, cyclist-motorists easily detected cyclists compared to the other group. These results raise the question of the effect of knowledge and lead us to suggest other possible explanations for the lack of cyclists' visibility.

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Session 6A - Special session

Development of a Rating System for HMI design to Reduce Driver Distraction

Driver distraction is a significant contributing factor to road trauma in many jurisdictions around the world.

Many new infotainment, communication and safety-related technologies are being incorporated into new vehicles entering the world market. Good ergonomic design of the human-machine interface (HMI) for these technologies reduces the potential for them to distract drivers from activities critical for safe driving. Not all technologies in new vehicles, however, are equal in terms of their potential to distract. The same technologies are often designed and implemented in very different ways by different vehicle manufacturers. The result of these different design choices is that some vehicle cockpits are more demanding of driver's attention than others, and hence are more likely to distract them from activities critical for safe driving.

In order to encourage all vehicle manufacturers to minimise distraction that may be caused by these technologies, a project has been funded in Australia to develop a prototype safety rating system for the HMI. The Victorian State Government is funding the project and VicRoads, the road transport authority in the Australian State of Victoria, is the project manager. VicRoads has commissioned the Australian Road Research Board (ARRB) to undertake the project on its behalf, including development of the prototype rating system and an assessment of the most feasible and effective implementation pathways. The project will be undertaken in close collaboration with the Australian New Car Assessment Program (ANCAP).

The ultimate aim of the proposed rating system is to encourage voluntary demand by Australian consumers for well ergonomically designed technologies in vehicles that minimise distraction and are safe and easy to use. This will require the development of suitable criteria, test methods and a system for rating the quality of the HMI in new vehicles entering Australia to minimise distraction. The Euro NCAP assessment and scoring assessment will replace the Australian NCAP assessment and scoring in 2018 and beyond. Thus, the project will also seek the support and collaboration of the European New Car Assessment Program (Euro NCAP).

The 5th International Conference on Driver Distraction and Inattention will bring together around 130150 experts on driver distraction from around the world – from government, industry and academia. The aims of this special session are to:

1. Introduce the Australian project to the international audience
2. Identify any other similar projects that might be being undertaken around the world, and opportunities for collaboration
3. Identify and discuss key technical and scientific challenges involved in developing a rating scheme for the HMI to minimise distraction
4. Identify any challenges and barriers that might exist to the development of a rating system from the perspective of industry and the NCAP community

The session will be introduced by Adj. Prof Mike Regan from ARRB, and will involve 4 short presentations followed by a general discussion:

1. Introduction to the Australian project, including a snapshot of the Victorian road safety context and key outcomes of recent work commissioned by VicRoads relevant to this project (Christopher Poulter, VicRoads, Australia) (Aim 1)

2. University of Utah distraction assessment research program (Prof. Joel Cooper, University of Utah, US) (Aim 2)

3. An NCAP perspective on the project – issues and challenges (Michael Paine, ANCAP, Australia) (Aim 4)

4. An automotive industry perspective on the project (Maria Beatriz Delgado, Applus IDIADA Group, Spain) (Aim 4)

A general discussion will follow, facilitated by Mike Regan, to expose issues relating to Aims 2 and 3.

The output of the workshop will be a short communique, prepared jointly by ARRB, ANCAP and VicRoads, that summarises the key issues deriving from the workshop, and recommendations deriving from it that will facilitate progression of the Australian project.

Session 7A - Driver characteristics

Visual demands of traffic signs in control drivers and drivers with reading impairment

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Keywords: Traffic signs, Readability, Eye-tracking, Dyslexia

Driving a vehicle places a high burden on the visuo-attentional system. One of the potential sources of increased visual demands while driving are traffic signs. Importantly, the design and content of traffic signs can be carefully considered to minimise the negative consequences of an excessive load, particularly among vulnerable drivers. In this context, the objectives of the current study are twofold. First, we analyse the effect on eye movements of two word-related factors (word frequency and word length) in a driving simulator showing 64 names of cities (e.g. “Barcelona”) on a sequence of overhead information signs during a motorway route. Participants were instructed to approach each sign at a constant speed (120 km/h) and read aloud the content as soon as they could correctly do it. Second, we compare gaze indicators of a group of control drivers and a group of participants with reading impairment (dyslexia) while reading the overhead information signs in the simulated driving task. Recent evidence on the neurocognitive bases on dyslexia suggests that their difficulties may be remarkably noticeable while driving, since the visuo-attentional system could be particularly impaired in dyslexic individuals. Previous results in our lab showed significant word frequency and length effects on correct reading distances and also that dyslexic participants had shorter reading distances. Now, we analyse eye-tracking data to clarify whether or not drivers have to invest more gaze time to read long and/or infrequent words on traffic signs and also whether or not adult participants with dyslexia, despite the potential use of compensatory strategies, have to dedicate further time to visually inspect traffic signs before being able to correctly read their content. The ultimate goal of the current study is to assess potential difficulties of dyslexic and non-dyslexic drivers and then propose measures based on cognitive human factors to improve the readability of traffic signs.

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How does distracted driving affect lateral position of older drivers?

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The objective of this research is the analysis of the lateral position of drivers, while talking on the cell phone and conversing with another passenger with focus on older drivers. To achieve this objective, a large driving simulator experiment was carried out, in which 95 participants from all age groups were asked to drive under different types of distraction (no distraction, conversation with passenger, cell phone use) in rural/urban road environment, in low/high traffic. In the next step, an appropriate modelling methodology has been developed, including first descriptive analysis in order to explore the large database. Then generalized linear models as well as generalized linear mixed models regarding lateral position were implemented in order to estimate the effect of the examined distraction sources as well as of driver and road characteristics directly on the lateral control and indirectly on driving behaviour and road safety. Results indicate that both conversing with a passenger and talking on the cell phone, while driving, lead to increased lateral position for all drivers especially in urban areas. Female drivers, in rural areas with high traffic, were found to have the worst lateral position, while being distracted (either conversing with a passenger or talking on the cell phone). Furthermore, older drivers talking on the cell phone achieved the highest lateral variability.

The full paper is available in the DDI2017 e-Proceedings.

The detrimental effect of mobile phone use on the driving competence of patients with neurological diseases affecting cognitive functions

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Drivers with brain disorders have difficulties in their driving competence (motor, visual, cognitive or perceptual) which may lead to increased accident probability. Alongside, driver distraction is an important cause of vehicle accidents. The interaction of brain disorders and driver distraction, which has not been adequately investigated so far, makes the assessment of their driving competence a very challenging task. The objective of this paper is the analysis and quantification of the effect of mobile phone use on the driving competence of patients with neurological diseases affecting cognition diseases, through a large driving simulator experiment carried out by an interdisciplinary research team of civil engineers, neurologists and psychologists. 34 Controls, 43 MCI, 28 AD, and 20 PD patients, all older than 55 years old, were asked to drive in urban and rural driving simulated environment and under three distraction conditions: no distraction, conversation with a co-passenger and conversation through handheld mobile phone. Their mean speed, their reaction time and accident probability in unexpected incidents were under investigation. The regression analyses (24 generalized linear models) indicated several interesting results. The findings extracted from the patient groups' regression analyses highlighted the detrimental impact of the mobile phone use on their reaction time and accident probability.

The full paper is available in the DDI2017 e-Proceedings.

Session 7B - Counter-measures

Driving distractions – What is wrong with us?

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Keywords: driver distraction, research, regulation, manufacturing, design, marketing

In this talk, I will briefly review the short history and current status of distraction research. I will discuss the recognized key deficiencies of the research discipline, foremost the lack of a useful definition of distracted driving. I argue that the lack of a proper and common definition in the research community has led to poor operationalization(s) of the construct, lack of standards, incommensurable points of view within the community, and even contradictory research findings. This in turn has led to insufficient and incoherent guidance to stakeholders, such as in-car user interface designers, as well as legislators and governmental organizations who are trying to regulate drivers' behaviours behind the wheel and the automotive manufacturers from bringing tempting but poorly designed secondary activities in the fingertips of the drivers. Bans and/or fees on the use of mobile devices while driving do not seem to work; the drivers are still willing to engage distracting activities while driving, as revealed by several polls in several countries (e.g., Finnish Road Safety Council, 2014). This highlights the need to develop safer means for the driver to conduct secondary activities while driving, but despite of good efforts (e.g., AAM, 2006; NHTSA, 2013), there are currently no reliable verification criteria or test method to verify that an in-car user interface is safe for use while driving. The automotive industry has taken the marketing advantage of the research results indicating how risky it is to use mobile devices while driving, but at the same time there are more and more in-car services and applications available on the embedded infotainment systems in our cars, of which distraction effects has not been sufficiently studied. The industry is demanding, and thus, some researchers are pushing for low-cost distraction evaluation methods, although several studies have indicated that the low-cost methods are often unreliable. At the same time a lot of financial resources are spent on developing other safety-critical systems in the car. This is understandable and a great thing, but one can ask why always, when it is about user interfaces, industry demands for quick, cheap and dirty methods. Autonomous selfdriving cars would be the ultimate solution for the problem but as long as there is even one human driver on the roads, the risks of driver distraction are among us. Furthermore, the way to the fully autonomous cars is paved with yet unseen risks, as the driver is partially relieved from the responsibility of driving, but only partially.

The talk tries to pinpoint areas of development, and suggests that all of us, researchers, automotive manufacturers, in-car user interface designers, as well as the government officers creating regulations, standards, and guidelines could do better work on this safety-critical area. The presentation concludes by highlighting some key proposals on how we could together proceed towards safer future.

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Research knows best, but how to communicate distraction measures practically in an industrial context

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Selection and comparison of human-factors related measures for evaluations of in-vehicle devices involves weighting of multiple criteria. It may result in a complex decision-making process for the practitioner, specifically in a time pressured industrial context. Visual information seeking has successfully been applied to reduce the complexity of datasets in healthcare and other fields. Information is presented visually and divided in 'Overview', representing the data by its characteristic criteria, and 'Details', which are presented on demand. This division reduces information load for the user and eases comparison based on characteristics. This project, first, aims to understand what criteria practitioners use to decide about the suitability of a measure for an in-vehicle evaluation. Secondly, criteria practitioners use to select measures are implemented in a new interface approach based on methods of visual information seeking to support users in the selection and comparison of human-factors related measures for in-vehicle evaluations. Overall, the interface exposes practitioners to new measures, enables them to rapidly compare measures, and obtain information to practically apply them.

The full paper is available in the DDI2017 e-Proceedings.

Stimulating Conversation: Engaging Drivers in Natural Language Interactions with an Autonomous Digital Driving Assistant to Counteract Passive Task-Related Fatigue

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Engaging in conversation has been shown to be an effective countermeasure to passive task-related fatigue. To investigate the effectiveness of a digital assistant to fulfil the role of conversational partner in counteracting driver fatigue, twenty participants undertook two 30-minute drives in a medium fidelity driving simulator, within a low-feature, monotonous driving environment – following a lead car at 68-mph in lane one of a UK-style motorway. All testing occurred between 13:00 and 16:30, when circadian and homeostatic influences naturally reduced participants' alertness. During one of the counterbalanced drives, participants engaged in natural language interactions with a state-of-the-art digital driving assistant, delivered using a Wizard-of-Oz approach. Results suggest that the digital assistant had a positive effect on driver alertness compared with the control condition (no assistant): there was a trend towards lower perceived sleepiness and significantly higher arousal after driving with the digital assistant. Objectively, interacting with the digital assistant improved lane keeping (lower SDLP) and attracted earlier responses to a hazard situation. There were also significant differences in eye activity when conversing with the digital assistant, revealed by fewer fixations directed towards the road centre and larger pupil diameter (suggesting increased arousal). The findings have implications for the design of future in-vehicle natural language interfaces.

The full paper is available in the DDI2017 e-Proceedings.

Session 8A - Driver monitoring

Detection of mind-wandering in driving: contributions of cardiac measurement and eye movements

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Keywords: Inattention; Driving; Mind-Wandering; Eye Movements; Heart Rate

In 2014 in France, there are still over 3,300 killed on our roads (ONISR, 2015). Many studies have highlighted inattention as a contributing factor for 25 to 50% of injury accidents (Mosedale *et al*, 2005; Galéra *et al*, 2012). Distraction can be defined as a diversion of attention away from critical activities to competitive ones while inattention can be defined as a state inducing endogenous shift of attention (Lemercier and Cellier, 2008).The term inattention gathers different states such as cognitive overload or Mind-Wandering (MW), defined as a shift in the contents of thought away from an ongoing task to self-generated thoughts and feelings (Smallwood and Schooler, 2015).

MW is a recurring phenomenon in driving, four drivers out of five declare being aware of MW on their last journey and feel being in this state for more than a third of the time (Berthié *et al*, 2015). According to Killingsworth and Gilbert (2010), this state represents nearly 50% of our daily life thoughts. It's therefore necessary to study this phenomenon to limit its impact on driving. During mind-wandering, drivers suffer from a perceptual decoupling corresponding to the capacity for the mind to flexibly disengage attentional processes from sensory input (Smallwood and Schooler, 2015). MW has many consequences on the driving activity. Being in MW would improve the risk to be considered responsible for a road accident (Galera *et al*, 2012). Conducted by He *et al*. (2011), the very first study confirmed the perceptual decoupling by revealing a change in the driver's visual scanning of the road during MW episodes. MW also leads to a decrease of speed micro-regulations and larger deviations in the vehicle's lateral position (Lemercier *et a*l, 2015). Several techniques have been used to identify MW episodes using eye gaze (Uzzaman and Joordens, 2011) and variability in lane position (Gabaude *et al*, 2012).

Thus, cardiac and gaze data have been recorded during simulated driving sessions. Participants were asked to (a) self-report their wandering thoughts when they were aware of it while driving and (b) thinking aboutinnovation in specific driving phases. The results obtained after analysis shown an increase in the gaze fixity during MW episodes. Different time-window have been set up to explore gaze behavior during inattention phase. It appears that the fixity rates is higher in the last second before the self-report (a). These results haven't been highlighted when drivers were thinking about innovation. Indeed, participants had to think about a topic on a longer time. This can explain a higher fixity rate before participants resolve the task than after on a wider time-window. These results could foster the gaze fixity rate as a MW objective indicator. Thus, this physiological indicator could be used to improve the detection of MW through data fusion and then warn drivers about their own state. Indeed, cardiac data collected here have not been analyzed yet but several indicators could be highlighted from this signal to improve our capacity to detect MW, this direction will also be explored.

This work was supported by IFSTTAR and the Valeo Innovation Challenge funds.

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Predicting when driver's state is going to become degraded

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Keywords: degraded state; drowsiness; prediction; machine learning

When driving, the state of the driver, and thus his/her performance, may change over time, depending on several factors. When the driver becomes drowsy or distracted, his/her state is considered as degraded and recommendations are usually to stop driving and rest. How to detect drowsiness, distraction, stress, cognitive workload etc. is a challenge which has been extensively addressed (Dong, Hu, Uchimura, & Murayama, 2011; Ranney, 2008). Nonetheless, when the driver is sleepy or distracted, it may be already too late. The present study focuses on the temporal prediction of decreased alertness, more specifically, finding when the degraded state is going to come. An experiment was conducted on a static driving simulator. Twenty one participants drove for 120 minutes under conditions optimized to induce drowsiness. Traffic and road type varied during the experiment in order to bring different drowsiness state (Larue, Rakotonirainy, & Pettitt, 2011). During the experiment, physiological and behavioural measurements were recorded which were selected according to the literature as good indicators of driver's state (Dong et al., 2011) such as the heart rate and variability, respiration rate, head and eyelids movements (blinking duration, frequency and perclos) and driving behaviour such as time-to-lane-crossing, speed, steering wheel angle, position on the lane. Data fusion of various features was used in order to be more robust (Samiee, Azadi, Kazemi, Nahvi, & Eichberger, 2014). The real state of the driver, namely the ground truth, was defined from video recording using the Trained Observer Rating (Wierwille & Ellsworth, 1994), which consists of classifying the driver state on a scale from 0 (alert) to 4 (very sleepy) every minute. An innovative model using artificial neural network was developed in order to predict every minute, in how much time the degraded state (moderately drowsy) is supposed to happen based on recorded measurements history. A feedforward neural network with one hidden layer has been used in order to fit an input-output relationship. For 80% of the validation and testing data, the absolute value of the error between the time to predict and the time predicted by the model is less than 6 minutes. The correlation coefficient R between the time to predict and the time predicted by the model is higher than 0.75. This study shows that with a controlled and very monotonous environment favourable to drowsiness in a driving simulator, it is possible to predict the dynamics of the occurrence of a degraded state of driver. Additional studies will be carried out under real conditions and/or in different vehicle automation levels (dynamic simulator).

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Short-term prediction versus detection of microsleep events

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Keywords: Sleepiness; Microsleep; Electroencephalography; Time-Frequency Analysis, Machine Learning

Maintaining attention under conditions of monotony, mental underload, and sleep pressure is critical for safe driving, especially during long distance highway rides. Despite deficient reactions and fluctuations in lane tracking performance, these conditions may result in unexpected, short attention lapses, so-called microsleep (MS) events. They are accurately detectable if short-term EEG processing and subsequent machine learning is utilized [1, 2]. It is asked if they are also predictable, i.e. if there are specific EEG patterns immediately before their occurrence.

EEG was recorded during overnight driving simulations in the lab. Each of 16 participants completed 7 driving sessions of 40 min duration each, between 1:00 AM and 7:40 AM. Visual observation of driver's behaviour by trained experts yielded 1,484 examples of MS events. In addition, 1,940 counterexamples of sustained attention (SA) were included for further analysis. Immediately before each MSE and each SA example, 8 sec long EEG segments were analyzed by the modified periodogram and in accordance to [3] by Choi-Williams distribution. For each segment, periodogram resulted in 161 signal features over all 7 channels (Fp1, Fp2, C3, Cz, C4, O1, O2). The second method resulted in 648 features over all 7 channels and over 6 ipsilateral and 5 contralateral channel pairs, in accordance to [3]. Support-vector machines (SVM) with Gaussian kernel function were empirically optimized in order to map signal features to the event type (MS or SA).
Processing periodogram features yielded mean classification accuracies of 98.9 ± 0.05 % and 87.5 ± 0.1 % for training and test data, respectively. Processing Choi-Williams distribution features yielded mean classification accuracies of 97.3 ± 0.07 % and 82.7 ± 0.1 % for training and test data, respectively.

In conclusion, the prediction of behavioral MS events is less accurate by approximately - 10 % compared to the detection case [4], where EEG segments contain pattern of ongoing MS events. Results support the hypothesis that MS events are triggered by subcortical processes and happen involuntarily. This is important for forensic considerations of MS events and the difficulties of the driver to be aware of upcoming MS events. Another conclusion concerns the time-frequency analysis performed by Choi-Williams distribution which did not improve results of spectral analysis per-formed by the periodogram method.

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Computer vision algorithms for detecting secondary tasks in naturalistic driving studies

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Keywords: computer vision; driver behavior; distraction detection; phone localization; machine learning; deep learning

Driver inattention and distraction are main concerns in road safety studies. In naturalistic driving studies, driver's videos are a valuable source of information and can only be used if annotated. The work presented here is a completely new framework for automatic video annotation. It is based on computer vision methods and focuses on driver distraction related to visual-manual secondary tasks: texting and phone-tothe-ear uses are automatically detected as well as hands on steering wheel and foot behaviour over pedals.
The database used to develop and validate image processing algorithms was recorded by LAB over a six months period. It includes several views showing: the driver face, the driver feet, the entire cockpit and the steering wheel.

The developed framework includes deep learning approaches and HoG+SVM algorithms. It provides driver behaviour indicators over time such as phone-to-the-ear conversation and texting on a phone. The algorithms performances are presented in this paper. Results are promising in different driving conditions. The next step will be to improve the processing time. The implementation of such processes will be a great opportunity to enhance data processing in future naturalistic studies.

The full paper is available in the DDI2017 e-Proceedings.

Observational study on driver secondary tasks in German cities

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Keywords: handheld cell phone, texting while driving, eating, drinking, smoking, observational study, prevalence, situational influences, driver characteristics

Distraction seems to become one of the major causes of accidents. In Austria, driver distraction is recorded as a causing factor in vehicle crashes by the police. Here, in 2014, distraction was the most common cause for traffic crashes, being responsible for 38% of all crashes (VVO, 2015). One of the major sources of distraction seems to be the use of smartphones while driving. While only about 30% of the German households had at least one smartphone in 2000, the percentage has risen to 90% in 2012 (Statistisches Bundesamt, 2013). This increase may also result in an increasing use while driving. However, it is argues that this may pose no real danger because driver are able to adapt their behaviour and use smartphones only when traffic is not very demanding and the driving situation is uncritical. As reliable information about distracted driving is still missing in Germany, the present study has two aims:

(1) To estimate the frequency of different distracting activities while driving in Germany.
(2) To examine whether drivers adapt their behavior to the traffic situation and whether the behavior depends on driver characteristics.

Observations were made at six locations in the city of Braunschweig, Germany between March and April 2015 and at six locations in Hannover, Germany, in May 2015. In Berlin, Germany, data was gathered at 18 locations between July and November 2015.

Overall, in 13.2% of all 11 837 observations drivers were engaged in any of the observed activities. The most frequent one was using the smartphone with 4.5%, followed by 2.9% smoking. Phoning was found in 3.9% of the observations with 2.2% with a handheld phone (which is not allowed in Germany) and 1.7% with a hands-free phone (which is allowed in Germany). Using the smartphone, either for phoning or for other activities, sums up to 8.4% of all observations.

The second question of this study was to which extent drivers adapt their behavior to the traffic situations. Overall, the frequency is a bit larger when standing (14.4%) than when driving (12.9%). Handling the smartphone, drinking and smoking is somewhat more frequent when standing then when driving. However, this pattern reverses for phoning (handheld and hands-free) and eating. Thus, there is some adaptation for some activities, but that is not large.

This study has shown that traffic observations are an effective means to gather large amounts of data about observable distraction while driving. However, the results are limited to city traffic in three major cities in Germany. Further extensions are necessary and on-going. The results show that it is necessary to increase the prevention efforts with regard to smartphone use in Germany.

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The Impact of Distraction on Driving Behaviour of Car Drivers in Urban Traffic. Results of a Simulator-Based Study

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Aim of this study was to evaluate the effect of different sources of distraction on driving behaviour. Six experimental conditions were included in three simulator tracks: (1) reading and writing texts, (2) talking on the phone (hand-held and hands-free), (3) eating and drinking. In total, 63 participants completed three experimental and one control track in the StiSim3 driving simulator. Simulator driving and self-reported data were gathered from all subjects, eye-tracking data for a part of the sample. Results, obtained by applying (generalized) mixed linear models, indicate that, compared with the other distraction sources, reading and writing of texts had most detrimental effects on the simulated driving (i.e. lower mean driving speed, increased reaction time and standard deviation of lateral position). The eye-tracking results are in line with this finding: percentage of gaze at relevant screen areas for text reading and writing was lower compared to control condition. Interactions were found with age and particularly gender, suggesting that females, and to some extent middle-aged drivers compared to young drivers, are more likely to engage in self-regulating activities than males when distracted. Finally, perceived effects of the different distraction sources were largely in line with actual driving performance.

The full paper is available in the DDI2017 e-Proceedings.

Virtual eye height and display height influence visual distraction measures in simulated driving conditions

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Glance behaviour towards in-vehicle visual displays is likely not only a result of the design of the display itself, but also influenced by other factors such as the position of the display and characteristics of the surrounding road scene. In the current study, it was hypothesized that both display position and simulator view will affect a driver's glance behaviour. A simulator study was conducted in which 25 participants drove in a highway scenario while performing three different tasks in a smartphone positioned at two different heights. Two different simulator views used: one corresponding to the view from the driver's seat of a truck and the other one corresponded to the view from the driver's seat of a car. A within-group design was used with simulator view, smartphone position, and task as factors.

Results showed that type of view and display position to some extent influenced glance behaviour as well as subjective ratings of driving performance. These results may have implications for eye glance measurement procedures as well as for guidelines relating to driver distraction, e.g. that simulated road scenes must correspond to the vehicle class that the device under test is intended for.

The full paper is available in the DDI2017 e-Proceedings.

Literature review on observational studies on cell phone use while driving

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Keywords: literature review, handheld cell phone, texting while driving, observational study, prevalence, situational influences, driver characteristics

Increased phone use while driving seems to cause an increase in distraction related accidents. In order to examine demographic and situational influences on phone use while driving, a literature review was conducted searching for observational studies concerned with driver secondary tasks. Forty-five publications were found containing 117 observation studies. One study used digital photographs for documentation of secondary tasks. All other relied on human observers.

In the US as well as in the United Kingdom yearly observations were made for a while. For the US, a steady increase in handheld phone use and in texting / manipulating devices while driving was found even though more and more states banned these activities in those years. Effects of gender were examined in twenty-seven studies. In Australia, New Zealand and in Europe mostly no gender differences were found. In the US, nine studies reported higher phone use for female drivers. Age effects on secondary task activities while driving were reported more often and were more consistently. The most common effect was that younger drivers used their phone more often than the other age groups. The presence of passengers decreases the frequency of secondary task activity. With regard to situational aspects, driver secondary task activity varied between weekdays and weekends, but the pattern was not consistent. Effects of the time of day were also frequently reported. However, again there was no consistent pattern. Only in two studies effects of weather were reported, indicating less phone use in non-clear weather. Street type and the area of observation were reported to have an influence on secondary task activity as well vehicle type. The movement status of the car (moving vs. stationary) was tested in one study, finding drivers to do more secondary tasks when standing except phoning, which was found to be more often while the vehicle was moving. Over all studies, about 2% of the drivers use a handheld phone. The percentage of hands-free phoning is somewhat smaller and lies below 2%. Texting on the smartphone lies at around 1%. The percentages for eating and drinking vary a lot with a median of about 2%.

Overall, the results from these observational studies show that this is a quite effective method to gather a large number of observations and to estimate the frequency of different, observable distractions. Moreover, quite a large number of possible influences regarding the drivers and the circumstances of the trip can be easily examined in order to better understand which drivers engage in secondary tasks under which circumstances. The large differences between different regions and studies show that it is necessary to obtain the information in the regions of interest, for example, for safety-related countermeasures.

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A Meta-analysis of In-vehicle and Nomadic Voice-recognition System Interaction and Driving Performance

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Keywords: Voice-recognition Systems; Meta-analysis; Driving Performance; Driver Distraction

Problem Importance. Voice-recognition systems lessen the visual-manual demands of a wide range of system interactions. However, the extent that voice-recognition systems integrated into vehicles or available in mobile phone applications affect driving performance is incompletely understood. A comprehensive metaanalysis of experimental studies is needed to guide design, guidelines, policy and research.

Search and Study Selection. A variety of search strategies were used, including the assistance of a librarian, to query PsycINFO, SPORTDiscus, Academic Search Complete, PubMed, Medline, TRID, Scopus and Google Scholar electronic databases with no limitations on publication year. Search terms included “driv*,” “performance,” “behavior*,” “voice*,” “speech*,” “voice*,” and “hands*”, which were combined with Boolean operators.

Independent and Dependent Variable Coding. To meet study inclusion criteria, drivers had to interact with a voice-recognition system while driving. Examples of voice-recognition tasks include dialing, initiating a call, texting, emailing or destination entry. Coded dependent variables included reaction time, detection, lateral position, speed and headway (see SAE, 2015 for definitions). Comparisons of voice-recognition systems with baseline driving and/or a visual-manual condition were also coded. Additional coding process details and statistical citations appear in Caird et al. (2014) and Simmons et al. (2016). Of 817 identified citations, 43 studies involving 2000 drivers and 183 effect sizes (*r*) were coded into the meta-analysis.

Results. Compared to baseline driving, driving while interacting with a voice-recognition system is associated with increases in reaction time to stimuli and events (*r* = .56). Interactions with a voice-recognition system had a smaller reaction time effect compared to interactions with visual-manual systems (*r* = -.23). Compared to baseline driving, drivers who interacted with a voice-recognition system detected moderately fewer targets (*r* = -.42), which was similar to visual-manual systems (*r* = .12). Compared to baseline driving, voicerecognition systems are associated with a modest increase in SDLP (*r* = .28) and a moderate decrease in SDLP compared to visual-manual systems (*r* = -.38).

Conclusions. Overall, the pattern of results across measures indicate that the negative impacts of voicerecognition system use on driving are larger in magnitude than anticipated, and the benefits of voicerecognition systems are smaller than expected. Implications of the results for voice-recognition system integration, mobile phone applications, and future research will be discussed.

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A Formal Approach for Allocation of Informational Elements: Displays and HUDs

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The automotive industry is undergoing a rapid change involving new and emerging technologies and many safety enhancement features such as Smartphone integration/mirroring technologies, internet applications for entertainment and social media, apps for information, as well many safety enhancement features. One outcome of this growing, in-vehicle interface usage is the need to organize and integrate this information as well as to allow drivers to handle vehicles safely and effectively with minimal distraction and inattention. This paper describes a methodological approach to designing a driver interface that maximizes utility and minimizes driver distraction and inattention: It first characterizes informational elements to achieve a priority ranking scale. We then show how this categorization can be used to evaluate the allocation of information elements to displays (cluster, centre stack, etc.) in the car. Finally, we focus our attention on the use of head-up displays that have the advantage that the information displayed on it is in the driving field of view and discuss several aspects of its organization based on the approach and methodology.

The full paper is available in the DDI2017 e-Proceedings.

What does current research tell us about why drivers engage with technological distractions: A Review

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There has been extensive research into driver distraction in recent years that has aimed to measure the behaviour and its resulting effects. This has assisted in determining the capabilities of the driver to engage with secondary tasks while driving. Yet, as evidenced by the large number of reported incidents relating to driver distraction, drivers are still choosing to engage with distracting technologies. The factors influencing why drivers engage with distractions is a complex issue that requires an insight into the drivers own subjective opinions and interior thoughts. Therefore, in order to determine why distraction occurs, methods that are able to capture the drivers' perspective and the surrounding context of the behaviour are required. It is identified that subjective research is key in obtaining this data. In order to gain an insight into the current understanding of subjective research, a document analysis and review was conducted.

31 papers utilising subjective methods to study driver distraction from the drivers' perspective were found, compiling 14,140 participants across eight countries. The studies were reviewed to determine the methods that were used, the key themes that have been identified and the recommendations subsequently made by the authors. It was evident that subjective data has the potential to provide detail on the factors and context surrounding why drivers engage with technologies, which cannot be derived from objective methods. Current trends in subjective research into driver distraction from in-vehicle technology are highlighted, alongside future recommendations.

The full paper is available in the DDI2017 e-Proceedings.

Phone manipulation at intersections with traffic lights: An observational study

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Keywords: Phone manipulation; Drivers; Pedestrians; Intersections

In 2013, road side observations by the Belgian Road Safety Institute (BRSI) showed that 3.2% of the observed drivers were manipulating their phones while driving; 2% were driving while talking on the phone and 1.2% were manipulating the buttons/screen. Since then, the penetration of mobile phones and smartphones in particular, has only grown across the entire population. A recent study by DEKRA in six major European cities, for instance, showed that almost 17% of the observed pedestrians are using smartphones (DEKRA Automobil GmbH, 2016). Distraction by mobile phone use has also become an increasingly important topic for road safety research (WHO, 2011).

We present an observational study on the manipulation of phones by car drivers, van drivers, pedestrians as well as cyclists. The observations will be made in July-August 2016 at intersections, controlled by traffic lights, in three major Belgian cities; Brussels, Liège and Antwerp.

Road users that are approaching the intersection are sampled visually and their behaviour is monitored until they leave the intersection. For drivers, this is operationalised as the moment when they pass the traffic lights. Pedestrians and cyclists are observed until they pass the lights at the exit of the pedestrian/cyclist crossing.

A basic distinction is made between two forms of phone manipulation: holding a phone against the ear and manipulating the buttons/screen (texting etc.), which requires visual attention. A second important distinction concerns whether the road user is arriving at the intersection on red or green lights. Irrespective of these distinctions, the main observations are whether the road user is manipulating his/her phone (a) when approaching the intersection, (b) when he/she is waiting for the lights to turn green, (c) when lights turn green and (d) when crossing the intersection.

Observers will classify road users with respect to gender and (broad) age categories. In order to study the relationships with traffic situations, it will be observed whether drivers, pedestrians and cyclists are respecting traffic lights. When phone manipulation is observed for road users that are waiting at red lights, it will be registered whether or not this results in an increased reaction time when lights turn green. Simultaneous car, van, pedestrian and cyclist traffic counts will allow to study relationships with traffic densities.

Multivariate analyses will provide an answer to two main research questions: (1) What is the prevalence of manual phone use across the different conditions? and (2) What are the observed effects with respect to red light violations and the interference with the traffic flow?

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Stephanie Binder memorial lecture

Real-time driving monitoring in the real world

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Road safety strategies for the past decade have focused on the “fatal five” behavioural issues: speeding, not wearing seat belts, drink and drug driving, drowsiness and distraction. Understanding these driver behaviours has not surprisingly been a research focus for many decades, with recent research focusing on real-time approaches to measurement. While in-vehicle technology is effective at addressing speeding and seat belt use, and alcohol interlocks show great promise to tackle repeat drink driving, drowsiness and distraction have been difficult to address using in-vehicle technology as the assessment tool. Perhaps for this reason, much academic and industry research over the past decade has focused on the measurement of these driver states. It is also likely that future in-vehicle real-time ADAS systems will address these states, based on historical and expected future relevance. An important question to consider, however, is what new driver states need to be understood with the emergence of semi-automated driving and how these states will be measured? In light of this, the demand for driver monitoring systems within the automotive industry continues to grow, in particular the demand for in-vehicle camera-based systems. Camera-based systems can be used to assess traditional driver states including distraction and drowsiness, whilst also capturing emerging driver states, such as “engagement”, as semi-autonomous vehicles appear on our roads. This paper presents data from a number of our research programs aimed at better characterising driver state in real-time in support of our product development and implementation in production programs.

Special Symposium

Priorities for research and countermeasures

During this plenary session the co-organisers of DDI 2017 will lead a discussion aimed at identifying key recommendations for research and countermeasure development. As in previous years, it will be an open discussion and all speakers will be asked to identify one or two key recommendations deriving from their presentations. Recommendations will be framed around the following areas – education and training, vehicle design, technology design, legislation, enforcement, driver licensing, data collection, research. A communique will be prepared after the meeting for distribution to participants.

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