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2nd International Conference on

Driver Distraction and Inattention

Abstract Booklet

SAFER
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

IFSTTAR

Introduction

It has been estimated that up to 80 percent of crashes and 65 percent of near-crashes involve inattention as a contributing factor, and that distraction is a factor in about a quarter of these. Distraction and inattention are therefore significant road safety problems, around the world.

The contribution of distraction as a factor in road trauma is likely to increase as more distractions, inside and outside the vehicle, compete for driver attention. As the role of distraction and inattention in crashes and near-misses has become clearer, countermeasure development has been intensified. Simultaneously, there has been an increased focus on the fundamental science of attention in modern neuroscience research.

This conference, which follows from the highly successful First International Conference on Driver Distraction and Inattention (held in Gothenburg in 2009; www.chalmers.se/safer/driverdistraction-en; the papers from the first conference are available at this website), aims again to bring together stakeholders from these different fields. All papers submitted for this conference are peer-reviewed by two experts in the field.

Driver distraction and inattention are complex, multi-dimensional, problems. Consequently, management of them requires concerted action by multiple stakeholders – vehicle designers, traffic engineers, road and transport safety authorities, the police, the media, motoring clubs, equipment manufacturers and suppliers, standards organizations, road safety bodies, driver trainers, academics and others.

The 2nd International Conference on Driver Distraction and Inattention aims to bring participants up-to date on recent developments in the field, to bring into the spotlight developments in research from neighbouring disciplines that have an important bearing on the problem, and to showcase new and emerging technologies, products and other countermeasures which have significant potential to prevent or mitigate distraction and inattention. It will be a key event for anyone working on these topics.

Michael A.Reagan, PhD	Trent W. Victor, PhD
IFSTTAR	SAFER Vehicle and traffic Safety Centre at Chalmers
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KEYNOTES

Opening speaches by:
- Carl von der Esch, State secretary to the Minister for Infrastructure
- Anne-Marie Hermansson, Vice President, Chalmers University of Technology

Keynote speakers:
- Prof. John D Lee, University of Wisconsin-Madison, USA
- Prof. David Strayer, University of Utah, USA
- Dr Richard Hanowski, Virginia Tech Transportation Institute (VTTI), USA

Dinner speaker:
- Anders Eugensson, Volvo Car Corporation, Sweden

KEYNOTE ABSTRACTS

Attention in context

Prof. John D Lee
University of Wisconsin-Madison, USA

Driver distraction has received considerable attention and the increasing computerization of cars will further raise its prominence. The attention paid to driver distraction has generated a substantial volume of research, which has produced both clear and ambiguous findings. These ambiguous findings can be reconciled through a more systematic consideration of context. Driving context consists of layers of constraint that range from the momentary interaction with surrounding vehicles to long-term social influences. Such layers of constraint suggest the unit of analysis to define distraction might range from the driver to the car, traffic, and even society. Context and the unit of analysis have important implications for theory development, data analysis, design, and policy.

Cognitive Distraction and its Neural Basis

David L. Strayer, Nathan Medeiros-Ward, & Jason M. Watson
University of Utah, USA

Keynote speaker: David L. Strayer

Driver distraction is a significant source of motor vehicle crashes. This article focuses on cognitive sources of distraction stemming from the use of a cell phone while driving. We present converging evidence establishing that concurrent cell phone use induces a form of inattention blindness, wherein drivers fail to notice information directly in their line of sight. Although the vast majority of individuals cannot perform this dual-task combination without impairment, a small group of "supertaskers" can, and we discuss the neural regions that support this multi-tasking ability.

There are many sources of driver distraction. Some "old standards" include talking to passengers, eating, drinking, lighting a cigarette, shaving, applying make-up, and listening to the radio (Stutts et al., 2003). However, the last decade has seen an explosion of wireless "nomadic" devices that have made their way into the automobile enabling a host of new sources of driver distraction (e.g., sending and receiving e-mail or text messages, communicating via cellular devices, watching movies, using the internet etc.). It is likely that these new sources of distraction are more impairing than the old standards because they are more cognitively engaging and because they are often performed over more sustained periods of time.

The Naturalistic Study of Driver Distraction

Keynote speaker: Dr Richard Hanowski
Virginia Tech Transportation Institute (VTTI), USA

Naturalistic driving research is a method for studying driver behavior and driving performance as it occurs in the real world. In naturalistic driving studies, vehicles are instrumented with data collection equipment, including video cameras, and operated by research participants in their typical, day-to-day operations and under real-world driving pressures. Data collection can last for weeks, months or one year or more and no experimenter is present during data collection. Unique to this method is the ability to record, with great precision, driver behavior (e.g., engaging in non-driving tasks while driving) and driving performance (e.g., vehicle control errors) in the critical seconds leading up to crashes, near-crashes and other safety-related events. Naturalistic driving research has provided new insight into driver safety issues, including "driver distraction." This keynote presentation will highlight the naturalistic driving method, an in situ research approach, and how it has been used to investigate driver distraction. Two U.S. Department of Transportation-funded driver distraction studies will be described and key findings highlighted (both studies were directed at commercial vehicle operations). Video data will be presented to illustrate the naturalistic method and results. As the naturalistic driving method collects data in the full context of driving, the results from these studies helped solidify a scientific basis for countermeasures aimed at preventing and mitigating driver distraction. The real-world implications and applications from the study findings will be discussed with regard to education, policy and human-machine interface (HMI) design.

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1-O: Cell Phone Use While Driving A Truck or Bus: Not all Sub-Tasks are Created Equal

[1]Jeffrey Hickman, [1]Richard Hanowski, and [2]Albert Alvarez

[1]Virginia Tech Transportation Institute
[2]Federal Motor Carrier Safety Administration

Contact: Jeffrey S. Hickman, Ph.D.
Virginia Tech Transportation Institute Center for Truck and Bus Safety
3500 Transportation Research Plaza Blacksburg, VA 24061
Fax: 540-231-1555
Voice: 540-231-1542

Distracted driving in commercial trucks and buses has become a significant safety issue, in part, because of high-profile crashes and a recently published report on the dangers of driving a commercial truck while distracted (Olson et al., 2009). This naturalistic study found that talking/listening on a hand-held or hands-free cell phone while driving did not increase the odds of involvement in a safety-critical event. This finding was not restricted to commercial truck and bus drivers. Klauer et al. (2006) found that talking or listening on a hand-held phone did not statistically elevate the odds of being involved in a safety-critical event in a naturalistic study with light vehicle drivers. However, the results from these naturalistic studies are in opposition to results found in simulator, epidemiological, and test track studies that suggest talking/listening on a cell phone while driving does increase risk. One possible explanation for this discrepancy may be the failure of some of these studies to classify phone use into discrete cell phone sub-tasks.

2-P: Driver Cell Phone Usage Comparison of a State Cell Phone Law Versus a Fleet Cell Phone Policy Using Naturalistic Data

[1]Jeffrey S. Hickman, [1]Richard J. Hanowski, [1]Matt Camden and Albert Alvarez[2]

[1]Virginia Tech Transportation Institute
[2]Federal Motor Carrier Safety Administration

Contact: Jeffrey Hickman, Ph.D.
Virginia Tech Transportation Institute 3500 Transportation Research Plaza
Blacksburg, VA 24061 (540) 231-1442
jhickman@vtti.vt.edu

The current study used a naturalistic data set to assess the relationship between fleet cell phone policies and State cell phone laws and commercial motor vehicle (CMV) drivers use of a cell phone while driving. This research analyzed naturalistic data from commercial trucks (3-axel and tractor trailer/tanker) and buses (transit and motor coaches) over a one-year period. The data sets included 195 different truck and bus fleets comprising 13,431 trucks and buses. These 13,431 trucks and buses accounted for 230,912 safety-critical events and 211,177 non-events. The odds of a truck and bus driver using a cell phone while driving under a fleet cell phone policy were 0.83 times less, compared to no fleet cell phone policy. The data showed that a State cell phone law did not significantly impact truck and bus drivers‟ likelihood in using their cell phone while driving compared to a State that did not have a law prohibiting cell phone use. Moreover, CMV drivers were far more likely to obey a specific fleet cell phone policy than a State cell phone law. It may be premature to indicate that State cell phone laws are ineffective in reducing crashes; rather, the laws may be ineffective in dissuading truck and bus drivers from using cell phones while driving. This also suggests that State cell phone laws should be made more like fleet policies in terms of enforcement and consequences for violations, by having sufficient "teeth" (e.g., primary law, significant fine/points) that may impact driver compliance.

Keywords: distraction, naturalistic driving, odds ratio, cell phone, fleet policy, state law, commercial vehicle

5-P: An Investigation Into the Effect of Distracter Tasks on the Perception of Vehicles at Junctions

Ya Mi, David Crundall

University of Nottingham, Nottingham, UK
Contact: Room B03, School of Psychology, University of Nottingham, University Park, Nottingham, NG7 2RD.
lpxym@nottingham.ac.uk (Ya Mi)

The present research investigates how concurrent spatial, verbal and central executive distractions interfere with vehicle perception and driving behaviour. **Experiment 1** used static pictures of t-junction containing either motorcycle or a car, or no approaching traffic, participants complete the experiment four times under control condition, verbal distraction condition, spatial distraction and central executive distraction condition. The tests of within-subjects contrasts show significant differences between the control condition and verbal distraction but not spatial distraction condition. **Experiment 2**, participants view the pictures and decide whether it is safe to pull out under the four conditions. There was a significant main effect of vehicle and location. **Experiment 3**, participants were asked to drive a driving simulator after a leading vehicle under the four conditions. Participant's performance was most impaired under spatial distraction condition in all of the three measurements. The results suggest that the visuospatial-sketchpad is not critically involved in the decision to detect or pull out at junctions but is heavily involves in driving.

Key words: Driving; driving simulator; working memory; dual-task; distraction

6-O: Older Drivers' Engagement in Distracting Activities - A Face-to-Face Interview

Julia Fofanova, Mark Vollrath

Department of Engineering and Traffic Psychology, Technische Universität Braunschweig, Gaußstraße 23, D-38106 Braunschweig, Germany
phone: +49 (0)531 / 391- 3615
j.fofanova@tu-bs.de

The prevalence of older drivers' engagement in distracting activities while driving is largely unexplored. Therefore face-to-face interviews with the objective to explore the extent to which older drivers engage in distracting activities while on the road were conducted. We assumed that if older adults are aware of their difficulties in sharing attention between various tasks, they will probably be less inclined to combine driving with other not driving related activities.

The anonymous self-report data on demographics, rated frequency, duration, severity of distracting behaviors, as well as on accidents caused by the distracting activities was collected from N = 420 drivers (26 - 83 years) during a three-month period. The interviews were conducted during the daytime at the supermarket parking places direct after the driving trip. The drivers were asked about their engagement in certain distracting activities while driving during the last half an hour of their driving trip.

Middle-age drivers were significantly more likely to report engaging in certain distracting activities than older drivers. None of older drivers reported engaging in clothing/body care (e.g. grooming, make-up) or using a mobile phone. The two most frequently undertaken activities in both age groups were 'using the in-car devises' (e.g., radio tuning) and 'interaction with passengers'. With regard to the duration of interaction with the passengers older drivers were significantly more talkative than middle-age drivers.

The most frequently reported distracting behaviors that resulted in self-reported accidents were, 'self-initiated tasks' (e.g. daydreaming, singing), 'interaction with passengers', and 'outside distractions'. No age difference was found with regard to the number of reported accidents caused by distracting behaviors within the previous five years.

Our conclusion is that older drivers' reluctance to engage in distracting tasks while driving is a process of self-regulation. The study is one of the first to derive knowledge about German older drivers' reported engagement in a range of distracting activities.

7-O: Calibration and Distracted Driving: Theory and Implications

William J. Horrey

Liberty Mutual Research Institute for Safety

71 Frankland Road
Hopkinton, MA 01748 USA 508-497-0237
william.horrey@libertymutual.com

In recent years, there has been a proliferation of studies pertaining to distracted driving—one that largely parallels the explosive growth of the devices themselves. These studies typically examine the impact of distracted driving on various measures of performance or other outcomes (see Regan, Lee, & Young, 2009 for a review). Not surprisingly, when drivers divide their attention between multiple tasks, their performance on one task or the other suffers (e.g., Caird et al., 2008). While the impact of distractions on driving performance is well documented in such studies, the examination of upstream factors (or precursors) to distraction has lagged. That is, far less is known about why and under what conditions drivers are willing to expose themselves to distracting activities while driving. Clearly, this represents an important in-road for potential interventions or mitigation strategies.

With respect to precursors to distraction, one important consideration is how a driver perceives their own ability to perform while driving or, more importantly, their own abilities while performing multiple (and potentially distracting) tasks. Accurate perceptions of driving ability have been thought to positively influence driving behavior, resulting in reduced propensity towards risk taking (Deery, 1999). With respect to in-vehicle tasks, drivers may engage in distracting activities simply because they do not realize that their performance is degraded or they may be overconfident in their skills and their ability to deal with distractions while behind the wheel (Wogalter & Mayhorn, 2005). That is, poor calibration to (perception or awareness of) distraction effects may influence drivers' decisions or their willingness to engage in distracting activities while on the road, not to mention the role of calibration in drivers understanding, agreement and trust in automated systems aimed at supporting the driver (e.g., Donmez et al., 2007).

There have been a few studies that suggest that drivers' are not well-calibrated to distraction effects (Lesch & Hancock, 2004; Horrey et al., 2008). In the current presentation, we will describe and discuss calibration and distraction while highlighting some results from earlier work and from other domains and applications. We will also discuss some of the remaining uncertainties and knowledge gaps concerning the role of calibration in decisions regarding distraction as well as its implications for performance, more generally. In doing so, we will present a theoretical framework that is currently being developed in an effort to guide research efforts in this domain, allowing one to account for discrepancies in driver calibration and, more importantly, design and elaborate on research aimed at mitigating the potentially adverse effects. Finally, we will present some preliminary results from some work that is planned for late 2010/early 2011 from this framework.

10-O: A Viable Alternative Music Background as Mediated Intervention for Increased Drivers Safety

Warren Brodsky[1], PhD, and Micha Kizner, MMusEd

[1] Music Science Lab, Department of the Arts
Ben-Gurion University of the Negev, POBox 653, Beer-Sheva 84105, Israel
Tel: 072-7-6461443
wbrodsky@bgu.ac.il

While it may difficult to assess music as a contributory risk factor for distraction (and subsequent road accidents), on the most basic of levels, listening to music while driving requires one to process sounds and often words, and many drivers find themselves singing the melody and/or tapping along to the rhythm. Research has reported ill-effects of: momentary peak levels in loud-music that can disrupt vestibulo-ocular control; loud music that can cause a decrease in response time to unexpected rear break lights; especially arousing music that can significantly impair driving performance; and quick-paced music that can cause an increase in cruising speed as well as boost traffic violations (including lane weaving, disregarded red traffic-lights, and collisions). Clearly, the greater the music complexity the larger the effects of risk for distraction and inattention to driving-related tasks. It is indeed worrying that drivers underestimate the effects of music, and do not perceive their decreased ability to spot hazards; the more involved drivers become with the music, the more detrimental music-generated distraction may be on their capacity to observe and control the vehicle. Shinar (2007) stated that the advent of new invehicle sources of distraction in the form of entertainment systems "is a good reason to focus on their contribution to driver interactions and distraction, and on the potential methods to deal with their effects" (p. 556). Therefore, whereas most previous studies relate to the former clause (i.e., a research focus on the contribution of music to driver distraction), it seems warranted that efforts arise that target the later clause (i.e., towards developing methods to deal with the ill-effects of music). This was the goal of the current study. First, we move beyond epidemiologic efforts, and promote a proactive strategy towards mediated intervention: we designed, recorded, and produced an 8-item 30-minute experimental music program to serve as an optimal listening environment for driver safety. Then, after demonstrating proof of concept, we conducted two field tests in a naturalistic on-the-road environment, in an effort to investigate the feasibility of employment. In the first field study we compared driver's preferred music CDs (brought from their home) to the experimental music. The results indicated that their preferred driving music was rated higher in 'enjoyment' but also caused greater levels of mental involvement – a sign of cognitive distraction. The second field study explored repeated exposure involving ten trips with the experimental program staggered over one month. The results indicated that drivers remained only 'moderately' aware of the background, and consistently reported 'high' levels of perceived driving safety with positive mood states. We recognize that cars are here to stay, and in-car listening will forever be part of vehicular performance. Therefore, we feel that future research should begin to invest in exploring what music types (styles and genres) offer increased traffic and road safety through viable alternative music backgrounds.

13-P: Examining Whether Mental Resource or Response Competition Causes Spatial Cell Phone Conversations to Impair Driving Performance

Kerstan S. Cole
Sandia National Laboratories, Albuquerque, New Mexico
PO Box 8500 Albuquerque, NM 87185-0830

Keith S. Jones
Texas Tech University, Lubbock, Texas

The goal of this research was to investigate the effects of mental resource and response competition on driving performance during spatial cell phone conversations. Background: Cellular phone conversations clearly impair driving performance (Gugerty, Rakouskas, & Brooks, 2004; Kass, Cole, & Stanny, 2007; McKnight & McKnight, 1993; Strayer, Drews, & Johnston, 2003; Strayer & Johnston, 2001). What is less clear is what mechanisms cause these impairments. Method: An experiment was developed to compare the response and resource competition explanations of dual-task impairments observed during concurrent cell phone conversations and driving. During this experiment, participants drove a simulator while completing a spatial task that required response selection and a spatial task that did not require response selection. Results: The results indicated that participants'average braking response times were slower, their average headway was greater, their average speed was higher, and they were involved in more collisions with a lead vehicle during the condition that did not require response selection compared to a single-task driving condition. Additionally, participants' average braking response times were slower, their headway and lane position varied more, their average speed was higher, and they were involved in more collisions during the condition that did require response selection, compared to the condition that did not require response selection. Collectively, these results mean that both resource and response competition both have the potential to impair driving performance.

Keywords: Driver distraction, cell phone conversations, multiple resource theory, response competition

17-P: Modelling and Predicting the Visual Demand of In-Vehicleinformation Systems

Gary E. Burnett and Nirwan Sharma, University of Nottingham, Nottingham,

Michael A. Pettitt, Everything Everywhere Ltd, Aldmondsbury, Alan Stevens, Transport Research Laboratory

This paper describes the development of a novel method in which the visual demand of in-vehicle information systems (IVIS) can be predicted, based on the modelling of usersystem interactions. The approach requires no use of participants or functioning equipment and comparisons between alternative user-interfaces can be made both rapidly and early in the design process. The method is fundamentally an extension of the GOMS Keystroke-Level Model (KLM), such that primitive activities with IVIS are described in a systematic fashion (e.g. moving hand from steering wheel to IVIS control, scanning display for target item). Whilst a traditional KLM enables the prediction of task times for skilled users, our new approach assesses visual demand by considering a time-line of vision and non-vision periods (drawing on the established occlusion protocol). Additional assumptions have been generated which consider the requirements for vision with IVIS tasks. This paper explains the use of the method and summarises the validity work that has been conducted to date. An emphasis is placed on original data concerning the inter-analyst reliability for the method. It is concluded that the method is both valid and reliable, especially for tasks with a logical sequence of activities (e.g. menu-driven interactions with IVIS). Current work is considering how the method can be developed further to consider a wider range of IVIS tasks.

Keywords: dual-task, heart rate, work load, driving simulation, LCT

18-P: Driver Behaviour and Task-Sharing Strategies when Using a Portable Music Player

Kristie L. Young, Eve Mitsopoulos-Rubens,
Christina M. Rudin-Brown, & Michael G. Lenné

Monash University Accident Research Centre (MUARC)
Building 70, Clayton, Victoria, 3800, Australia
Phone: +613 9905 1258
kristie.young@monash.edu

This study examined the effects of performing scrollable music selection tasks using a portable music player (iPod Touch™) on simulated driving and task-sharing strategies, as evidenced through eye glance behaviour and secondary task performance. Nineteen young (18-23 yrs) and 18 middle-aged (26-48 yrs) drivers completed the PC-based MUARC Driver Distraction Test (DDT) while performing music selection tasks on an iPod Touch, whereby drivers were required to search for a target song in long vs. short scrollable lists. Drivers' eye glance behaviour was examined using FaceLab. Results revealed that performing the music search tasks while driving increased the amount of time that drivers spent with their eyes off the roadway and decreased their ability to maintain lane position. However, there was also evidence that drivers attempted to regulate their behaviour when distracted by decreasing their speed and taking a large number of short glances towards the device. Few differences were found across young and middle-aged drivers in terms of the effect of the song selection tasks on driving performance or task-sharing strategies. Overall, the results suggest that using portable music players while driving can have a range of safety-critical effects and strategies for managing this issue are discussed.

Keywords: Driver distraction; Portable music player; iPod; Eye-glance behaviour

20-P:The Effect of Car-Following on Lateral Guidance During Cognitive Load – a Study Conducted in The Multi-Driver Simulation

Dominik Mühlbacher and Hans-Peter Krüger,

Julius-Maximilians-University, Würz-burg, Germany

Several studies report improved lane keeping as one effect of cognitive secondary tasks while driving. However, in many of these studies a car following paradigm was used for the distracted driver. Therefore, the aim of the present study was to identify if the effects of cognitive load depend on car-following. In the multi-driver simulation, four platoons of four subjects (N=16) drove a country road course two times. The po-sitions within the platoon differed by the number of preceding vehicles (0 - 3 preced-ing vehicles). In one run, drivers had to perform a cognitive secondary task while driving. Despite the fact that driving with the secondary task was negatively rated and had no effects on velocity or headway behavior, when considering lateral control, the introduction of the secondary task corresponds with positive effects: Drivers showed greater lane keeping precision (measured by variability of lateral position and the number of lane departures). It seems that the driver's position influences these ef-fects: Whereas the secondary task has only little positive effect on lane keeping of the first driver in the platoon formation (the driver without car following situation), drivers in positions 2 to 4 (the drivers with car-following situation) benefit from the secondary task in a higher extent. Implications of this effect are discussed.

21-O: Automated Deadman´s Device Operation?

Nina Jellentrup & Frederike Feldmann

German Aerospace Center, Institute of Transportation Systems, Lilienthalplatz 7, 38108, Braunschweig Germany

Since years human factors is well-established in automotive and aircraft engineering as a result of severe accidents caused by the so called human error. Therefore many executing operations have been replaced by technical systems. In consequence the human operator is increasingly responsible for the supervision of technical systems and excluded from the active control process. This in turn leads to the well known out of the loop phenomenon. But in cases of malfunctions, system failures or critical situations the driver is in demand to be in the loop of the task and to be able to take over directly. While the importance of the human reliability grows with the level of automation the knowledge and practise of the user decrease as the interaction with the system is reduced to monitoring operations.

Workplaces in the railway domain have also transformed to less physical work but more cognitive supervisory tasks. The integration of human factors in railway engineering is not yet common practise in continental Europe although the railway domain is aware of risks due to automation like a reduction in alterness and vigilance. To countermeasure consequences of automation the so called deadman´s device was established to maintain the train driver´s vigilance and to force him being permanently held in position. The driver´s condition is detected by requiring a confirmation at timed intervals of 30 seconds. If no confirmation occurs the train will be stopped automatically.

Peter (1980) already required in his dissertation („Kann die Sicherheitsfahrschaltung SIFA die Dienstfähigkeit von Triebfahrzeugführern gewährleisten?“) a revision of the deadman´s device. He showed that also in states of high fatigue and little attention a driver is still able to affirm the deadman´s device and retain his individual affirmation rhythm. The problem of his results was that they were obtained in a car drivingsimulation. For this reason an interdisciplinary team of the Institute of Transportation Systems in the German Aerospace Center conducted a train simulator study to analyse the deadman interaction behaviour in a real train driving environment. In the railway laboratory RailSET valid human factors studies for train drivers can be run without risk for life and do not interfere with real railway operations. The results of this study will show if non train drivers are able to get trained to an individual rhythm after a relative short amount of training. First of all a learning session of several minutes was given to get an impression of train driving and to become familiar with the operator control actions and duties. After this first learning period the real study with several subunits was conducted. The analysis of the train logging data is still in progress.

Keywords: Rail human factors, automation, deadman´s device, vigilance, human error,simulator studies.

22-O: Conversing while Driving: The Importance of Visual Information on Conversation Modulation

Jannette Macieja, Mark Vollratha

Department of Engineering and Traffic Psychology; Technische Universität Braunschweig, D-38106 Braunschweig, Germany

Multiple studies have shown an increased accident risk due to telephoning while driving. On the other hand, driving with passengers leads to a decreased accident risk. One explanation is a conversation modulation by passengers in cars which leads to a different conversation pattern which is not so detrimental to driving as that when phoning. A driving simulator study was conducted in order to examine this conversation modulation more closely and to find out more about the factors involved in this modulation, especially the visual information available to the passenger. In a within-subject design, we systematically compared the conversational pattern of 33 drivers and passengers in different in-car settings (passenger as usual, passenger without front view or passenger without view of the driver) with a hands-free cell phone and with a hands-free cell phone with additional visual information either about the driving situation or the driver. Participants were instructed to have a naturalistic small-talk with a friend. Results of the drivers´ speaking behavior showed a reduction of speaking while driving. Compared to a conversation partner on the cell phone, a passenger in the car varies his speaking rhythm by speaking more often but shorter. Further analyses showed that this effect is also be found with a cell phone when providing the conversation partner additional visual information either about the driving situation or the driver. This latter finding supports the idea that conversation modulation is not triggered by being in the car but by the visual information about the driver's state and the driving situation.

23-P: A Field Test of Eye Tracking Systems with One and Three Cameras

Christer Ahlstrom[1], Katja Kircher[1] & Per Sörner[2]

[1]Swedish National Road and Transport Research Institute (VTI), Linköping, Sweden
[2]SmartEye AB, Gothenburg, Sweden

Driver state monitoring by eye tracking is an increasingly used method to assess driver distraction and sleepiness. The aim of this study is to compare a 1-camera eye tracking system with a 3-camera system in a field setting and evaluate how the choice of eye tracker impacts (a) the quality of the recordings and (b) behavioural performance indicators. Eighteen drivers drove an instrumented vehicle on a motorway for about 90 minutes while their gaze patterns were recorded with the two systems in parallel. The results show that neither quality nor performance indicators deteriorate over time. Tracking is available for 96 ± 6 % of the time for the 3-camera system and 77 ± 22 % for the 1-camera system, and both the frequency and the duration of lapses are considerably higher in the 1-camera system. The 3-camera system provides better vertical accuracy and increased horizontal availability. These properties cause performance indicators calculated from the two systems to deviate. For example glance durations are 0.76º ± 0.34º for the 3-camera system and 0.60º ± 0.48º for the 1-camera system. When comparing the output from the systems, it becomes clear that not all differences can be explained by the larger coverage of multiple cameras. In conclusion, the 3-camera system shows better performance with respect to data availability, working environment and accuracy. In many applications it is sufficient to use one camera, but special focus on the handling of lapses is essential.

Keywords: Eye tracking, comparison, distraction, eye movements, quality, field study

25-P: Distraction and Inattention in the Driver Model Library

Jeroen H. Hogema, Marieke H. Martens, Emiel M. Ubink

TNO, Soesterberg, The Netherlands

Contact: Jeroen.hogema@tno.nl, TNO, PO Box 23
3769 ZG Soesterberg The Netherlands

The Driver Model Library (DML) is a cross-platform plug-in for traffic simulations, providing driver behaviour and decision making. The DML is based on a multi-agent cognitive framework which models the individual driving tasks (such as navigation, overtaking, gap acceptance, etc.) and the influences on those tasks as separate agents. It can be used in combination with several traffic simulation models. The framework includes a resource management system, allowing stressors that affect driving performance and safety to be modelled, such as fatigue. In order to accurately model driver behaviour and performance, the DML will need to account for driver distraction and inattention. In this paper we will describe how data and theories on driver distraction and inattention can be implemented, using the resource system in the DML.

Keywords: Driver distraction, driver model, resources, task hierarchy, attention model

27-P: Assessing Intrinsic "Blind Spots" in Attention to Dynamic Streams of Sensory Events.

Derek N. Eder, University of Gothenburg,

Vigilance and Neurocognition Laboratory, Göteborg Sweden

In dynamic, feature rich sensory environments, incoming inputs could easily overwhelm the brain's capacity for effective intake and action were it not for reflexive mechanisms which protect the integrity of information processing. These mechanisms include the inhibition of the transmission of sensory signals (sensory gating) and their neglect from consciousness (attentional blindness) as well as a temporary neglect of the spatial location of the sensory stimulus (inhibition of return). While these mechanisms offer a great deal of robustness and flexibility in our interaction with the environment, they also entail intrinsic "blind spots" in attention which, given the wrong circumstances, encourage error and accident.

These phenomena represent intrinsic changes in the efficiency of sensory processing of serially occurring events. In this context, the sensory event is not defined by the elemental transduction of physical energy by the sense organs - the constant hum of the engine or the steady "flashing" of the broken white lane markings are relegated by the brain to the status of background noise demanding little or no active attention. Rather the sensory event is defined functionally by the detection of sensory inputs which, through evolutionary adaptation, learning or conscious motivation, may be well worth paying attention to. Early on in chain of sensory signal processing, specialized detectors for qualities including novelty, threat potential, and relevance to behavioral intentions sift through all raw signals. These processes are designed for speed and not accuracy or discrimination and operate well beneath (and before) conscious perception. Sensory events detected at these early stages serve to engage other processing systems throughout the central nervous system in order to optimize the reception and evaluation of incoming information, trigger protective reflexes and facilitate effective behavioral responses (1).

In environments where the presentation of information is under automated control, as in vehicle instrumentation and warning systems, design informed by cognitive neuroscience may be optimized to the needs and capacities of the driver. This paper illustrates several aspects of the temporal dynamics of the capture or neglect of visual attention in an experimental laboratory setting.

30-O: Assessment of drivers' attentional performance using the Attentional Networks Test for Vigilance (ANTI-V)

Javier Roca[1], David Crundall[2], Cándida Castro[1],
María Fernanda López-Ramón[1] & Juan Lupiáñez[1]

[1]Universidad de Granada (UGR).
[2]Accident Research Unit, The University of Nottingham.

Contact author: Javier Roca. Address: Dpto. de Psicología Experimental y Fisiología del Comportamiento, Universidad de Granada, CampusCartuja, s/n, 18011 Granada, Spain. Phone: +34958240663. E-mail: jroca@ugr.es

A crucial strategy for preventing attention-related accidents is to analyse the basic cognitive mechanisms underlying driver distraction and inattention. Recent advances in the study of the human attentional system have shown thefeasibility of obtaining a quick and easy measure of the functioning of the three attentional networks with Michael Posner's neurocognitive model of attention (i.e., alerting, orienting and executive control networks). Some computer-based tasks, such as the Attentional Networks Test (ANT) and the Attentional Networks Test for Interactions (ANTI), have been developed for this purpose and their application in driving research is currently being analysed.

Although some previous research found a relationship between the ANT task (e.g. the global RT) and both a driving-related attentional test (UFoV–Useful Field of Vision) and a performance measure in a driving simulator (Manitoba Road Test), the role that each specific attentional network or the interactions between them might play while driving is still unknown. It would therefore be of great interest to investigate the specific relationships between the alerting, orienting and executive control scores and some well-established measures of driver attention and performance.

This work summarises a series of studies that aim to achieve two main objectives:
1) To improve the ANTI task with an additional measure of tonic alertness or vigilance (the ANTI-V task), which could be of particular interest in the study of driver distraction and inattention. This first objective was achieved previously in an experimental sleep-deprivation study in our labs, showing that the vigilance measure of the ANTI- V task could be considered as a valid index of vigilance.
2) To analyse the applicability to driving research of this new attentional task, which measures alertness (both phasic and tonic or vigilance), attentional orientation and executive control functioning. The attentional scores of the ANTI-V have been used as predictors in a regression analysis, looking for relevant associations with some measures of driver attention and performance, such as the computer-based Deceleration Detection Flicker Test (DDFT) and a driving simulator-based Hazard Perception Test (HPT).

The results obtained so far reveal that some of the ANTI-V scores reveal interesting relationships with both the Deceleration Detection Flicker Test (DDFT) and the driving simulator-based Hazard Perception Test (HPT) Therefore, the ANTI-V can be considered a sensitive instrument to measure the functioning of the attentional networks and may help us to discover the basic mechanisms underlying drivers' attentive performance and thus to prevent distractions.

31-P: The Ratio of the Second Digit to the Fourth Digit and its Relationship to Driver Distraction

Meaghan L. Rutledge, Julia D. Irwin and Eugene Chekaluk

Macquarie University, Sydney Australia

Address correspondence to Julia Irwin, Department of Psychology, Macquarie University, NSW 2109, Australia; email: julia.irwin@mq.edu.au

This study investigates how gender and testosterone (as measured by the 2D:4D ratio) affects driving performance under distracting conditions. The 2D:4D ratio is a widely accepted marker for masculinisation through prenatal androgen exposure, in particular testosterone, such that, on average males have a lower ratio than females. Documented effects of testosterone include; decreased susceptibility to distraction, increased ability to focus attention, faster cognitive processing speed and reaction times. Simulated driving performance of young male and female drivers was examined, whilst they were actively distracted by conversational tasks that were either cognitive or emotional in content. The cognitive task involved answering mathematical and spelling questions and the emotional task involved discussing moral dilemmas. Under emotionally distracting conditions it was the gender of the drivers that determined the number of errors that were made, with female drivers making more errors than the male drivers, particularly in regard to maintaining lane position. However, under cognitively distracting conditions it was the 2D:4D ratio that was significantly correlated with driving errors, such that, the lower the ratio (i.e. higher exposure to prenatal testosterone) the fewer driving errors were made – this was most noticeable in regard to situations requiring a fast response to potential hazards. Significantly, these results relating to digit ratio were independent of the gender of the driver.

33-O: Analyzing the Relationship between Behavioral Measures of the Attentional Networks Performance and Self-Report Data of Attention-Related Driving Errors

María Fernanda López-Ramón[1,2], Cándida Castro[1], Javier Roca[1], Rubén Ledesma[2], Juan Lupiañez[1]

[1] Universidad de Granada, Spain (UGR)
[2] Universidad Nacional de Mar del Plata, Argentina (UNMdP)
[3] Consejo Argentino de Investigaciones Científicas y Técnicas (CONICET)

Contact author: María Fernanda López-Ramón. Dpto. de Psicología Experimental y Fisiología del Comportamiento, Universidad de Granada, Campus

Driving is a complex activity that demands attention from competing tasks. The diversion of attention, or driver distraction and inattention, can produce errors and may cause failures in performance while driving.

Based on Posner´s theoretical framework, several tests were created for obtaining behavioral measures of the functioning of the attentional networks: alerting, orienting and executive control and their interactions (e.g., the ANTI test, and the ANTI-V test, that additionally measures vigilance).
However, an approach that combines self-report data about the propensity to attentionrelated driving errors and the behavioral measurement of the three Attentional Networks performance of drivers is still missing.
Therefore, this research aims to explore the relationship between the behavioral measures of the attentional functioning (measured by ANTI and ANTI-V behavioral tasks) related to self-report data of personal proneness to distractibility while driving (assessed by the Driver Behavioural Questionnaire [DBQ] and the Attention-Related Driving Errors Scale [ARDES]).
Preliminary results obtained with ARDES questionnaire and ANTI task suggest that the group with greater propensity to experience attention-related errors may be more at risk when driving. That is, their attentional performance showed a slowdown in the overall functioning of the attentional networks (that can also be considered as an attentional measure of vigilance) and less endogenous preparation for high priority warning signs. But the results also showed that they are less at risk in situations in which they can deal with response conflict in the presence of valid cues (e.g., traffic signs). It can be inferred that the group prone to commit attention-related errors shows a particular combination of attentional networks functioning that could, in some situations, compensate their deficit with a better response conflict.

36-0: What to Expect at Intersections? – Driver's Expectation and the Influence of Gaze and Driving Behaviour

Dipl. Wirtschaftspsych. Julia Werneke and Prof. Dr. Mark Vollrath

TU Braunschweig, Department of Traffic and Engineering Psychology, Gaußstraße 23, 38106 Braunschweig, Phone: +49-531-391-3643, Email: julia.werneke@tu-bs.de

Accident studies in Germany found that lack of information was the main reason for the drivers' error leading to the accident. Looking only at intersection accidents this percentage lies above 90% (Hoppe, Zobel, & Schlag, 2007; Vollrath, Briest, & Drewes, 2006). In-depth surveys of bicycle-car accidents have found that inappropriate expectations about the situation and improper attention allocation by the drivers are important for this kind of error (Räsänen & Summala, 1998; Summala, Pasanen, Räsänen, & Sievänen, 1996). One typical situation is a right turn where the driver has to yield to cars from the left-hand side. Here, the driver focuses his attention mainly to the road on the left and does not take the two-way cycle track into account. If at this point of time a cyclist comes from the right-hand side on the cycle track and crosses the road, the driver will probably not notice him. It seems that drivers learn where to direct their attention to, and thus tend to allocate their attention primarily to certain areas of the intersection, neglecting others. The question arises how different characteristics of this intersection situation influence the drivers' expectations, and thus their gaze behaviour.

This was examined in a driving simulator study where different aspects of a give way T-intersection were varied. According to the SEEV model (Wickens et al., 2001), the event rate (Expectancy) and the Value of information are important on the role of expectations and the process of attention allocation in dynamic environments. In the study, the T-intersection situation was varied by traffic density (Expectancy) and number of important objects (Value). At two intersections the traffic density was either low or high with either one or two task-relevant objects: cars (approaching from the left-hand side) and with or without pedestrians (standing on the right-hand side). At these four intersection types, the main driving task was turning right. 40 subjects (26 male, 14 female) participated in the study. The drivers ranged in age from 19 to 55 years (SD = 11.9 years). Gaze behaviour, vehicle and subjective data were recorded.

According to the SEEV model (Wickens et al., 2001) at intersections with only cars coming from the left-hand side, the drivers will allocate their attention mainly to that side in order to avoid a collision. At the same time the drivers will neglect the right-hand side of the intersection as they do not expect task-relevant objects there. With additional pedestrians on the right-hand side of the intersections, both areas contain high task-relevant information for the drivers, so they will shift their attention between these two areas. With regard to the traffic density, in the high density situations the drivers' attention will be more grabbed to the cars, as compared to the situations with lower traffic density. The results of the study will contribute to a better understanding of the drivers' expectations at intersections and how these expectations influence the drivers' attention allocation and driving behaviour.

37-P: Can Talking on the Phone keep the Driver Awake? Results of a Field-Study using Telephoning as a Counter-measure Against Fatigue While Driving

[1]Nina Jellentrup, [2]Barbara Metz, [3]Siegfried Rothe

[1]German Aerospace Center, Institute of Transportation Systems, Braunschweig
[2]Interdisciplinary Center for Traffic Sciences (IZVW) at the University of Wuerzburg
[3]Daimler AG, Böblingen

In recent studies, negative consequences of distraction while driving, especially of telephoning are highlighted and discussed. Besides negative short term effects of telephoning, also other, more positive effects are thinkable. Fatigue is an important risk factor especially in the field of driving platoon. Long distance drives under monotonous conditions lead to diminished attention and alertness. Then asked, drivers report that they actively apply countermeasures against fatigue in monotonous driving situations. One of the countermeasures that are mentioned is engaging in conversation either with the passenger or on the phone.
The presented field study investigated whether talking on the phone can help to improve drivers' condition during monotonous rides. The participants drove for 3 hours in the morning and 3 hours in the afternoon on a test track with a mean speed of 40 km/h. During the drives, the participants received phone calls after defined time intervals. With the help of physiological recording methods (EEG and eyelid measures), CAN-Bus-data, reaction times and psychological questionnaires, the condition of 18 subjects was measured. The analysis shows that the drivers were more alert and awake during the telephone conversation and up to twenty minutes afterwards. The alpha spindle rate diminished and data of eyelid-behaviour showed a decline in the relative blink duration. The results support the subjectively reported impression that talking on the phone is a possibility to stay alert in monotonous driving conditions. The reported findings are discussed in the light of a prospective application in vehicles.

38-P: Distribution of Visual Attention during Distraction: Influence of Demands of the Driving Task and of the Secondary Task

Barbara Metz and Hans-Peter Krüger

Interdisciplinary Center for Traffic Sciences (IZVW) at the University of Wuerzburg, Roentgenring 11, 97070 Wuerzburg (Germany)

Newer studies report that drivers tend to engage with secondary tasks anytime without considering demands of the driving task. On the other hand, it is reported that driver adapt their interaction with secondary tasks to the demands of the current driving situation. One possibility of how this can be done is to adjust the distribution of attention between driving and the secondary task in accordance with the demands of the current driving situation.

An experiment is presented in which the influence of task difficulty of the secondary task as well as of the driving task is investigated. The experiment took place in the driving simulator with N=16 drivers. The participants solved two visual secondary tasks that differed subjectively and objectively in difficulty. Each experimental drive consisted of sections that differed in their situational difficulty (short term demands of driving). Furthermore, long term demands of the driving task (in the experiment fog vs. no fog) were manipulated. Results show, that in the easier task a higher proportion of button presses can be performed without looking at the display. Regarding the influence of the driving task, both, long and short term demands influence how much attention is directed to the road during distraction. In more demanding situations, a higher proportion of attention is directed to the driving task than in less demanding situations. The presented results support the assumption that drivers adapt their interaction with visual secondary tasks to the demands of the driving task.

40-P: Validating Driving Simulators for Distraction Research

Richard a. Donkor, Gary e. Burnett and Sarah Sharples

Human Factors Research Group, Faculty of Engineering, University of Nottingham, Nottingham, UK NG7 2RD.

Richard a. Donkor: epxrd1@nottingham.ac.uk Tel: +44(0)115 95 14040

Driving simulators are increasingly used as tools for conducting human factors research. However, it is unclear whether drivers behave in a simulator as they would in the real-world; (issues of validity) and how this relates to the design of a simulator (issues of fidelity) and an individual driver's motivations. In our work, we are developing short, standardised scenarios which can be used by researchers as an additional component to a simulator study to a) establish how realistic drivers were overall in their performance/behaviour, and b) to identify participants who behaved in an unsuitable manner in the simulator, e.g., due to inappropriate motivations. An exploratory study specific to driver distraction is described, in which 40 participants drove for five minutes on a rural road within a fixed-base simulator. The initial scenario included a stretch of straight road driving (low primary task demand) and curved road driving (high primary task demand). At fixed points along both stretches of the road drivers were requested to conduct a series of visual search tasks using an in-vehicle display.

41-O: The Critical Tracking Task – A Useful Tool to Assess Driver Distraction?

Tibor Petzoldt, Hanna Bellem & Josef F. Krems

Chemnitz University of Technology, Germany

The significant increase in the use of driver information systems renders the assessment of their distraction potential an important issue in transportation research. Easy to use methods like the LCT or the PDT have been developed to tackle this problem. A task that, as of now, has only received attention as a potential IVIS surrogate, is the Critical Tracking Task (CTT). The CTT is a simple tracking task that requires operators to stabilize a dynamic, instable element on a computer screen. The task has been criticised in its function as an IVIS surrogate, as the continuous monitoring and input which it requires are rather uncommon in most IVIS. However, continuous monitoring and input are requirements of the driving task itself. Therefore, our goal was to assess the potential the CTT has as a method to measure the distraction demand of in-vehicle tasks. Our experiments, employing artificial as well as real IVIS tasks suggest that the CTT is indeed capable of quantifying the distraction elicited by IVIS.

43-P: Driver Secondary Tasks in Germany: Detailed Analysis of Face-to-Face Interviews

Anja Katharina Huemer, Mark Vollrath

TU Braunschweig, Department of Traffic and Engineering Psychology,
Gaußstraße 23, 38106 Braunschweig, Germany.
Anja Katharina Huemer: a.huemer@tu-braunschweig.de

To understand the impact of secondary tasks on road safety it is necessary to know what kind of tasks drivers are doing in which situations. To this aim, drivers were face-to-face interviewed in 2009 on German motorway service areas as well as in the city of Braunschweig about their secondary task engagement in the last 30 minutes of driving. Drivers were asked to report on different secondary tasks groups that were identified in former studies on the safety impact of driver secondary task occupation. As drivers gave detailed descriptions of their secondary tasks, typical patterns of task execution can be described for specific secondary task groups as passenger related tasks, device manipulation or distractions from outside the vehicle. Thus, a detailed and comprehensive picture of what people do at the wheel emerges. This can be used to develop more specific countermeasures.

Keywords: Driver distraction; secondary tasks; face-to-face interviews; qualitative analysis; task patterns

44-P: Assessing Driver State – Neurophysiological Correlates of Attentional Shift During Real Road Driving

Andreas Sonnleitner [1,2],Michael Simon [3],*
Wilhelm E Kincses [1], Michael Schrauf [1,4]

[1]Daimler AG, 71034 Böblingen, Hanns-Klemm-Straße 45*
+49 7031 4389 875, andreas.s.sonnleitner@daimler.com
[2]Heinrich-Heine-Universität Düsseldorf
[3]Eberhard-Karls-Universität Tübingen
[4]Universität Regensburg

In order to investigate ecologically robust parameters in the EEG as correlates of driver attentional shift, we conducted a real road driving study with N=40 participants which performed two different secondary tasks (i.e. visuomotor and auditory). Due to safety considerations, adaptive cruise control was activated all the time and participants were not allowed to overtake. The visuomotor task consisted of a Landolt-rings task presented on an extra display. In the auditory task, the participants were instructed to detect predefined words during the presentation of an audio book and had to answer a question with regard to the content at the end of every chapter.
In the EEG, alpha spindles show a significantly higher occurrence rate during the auditory secondary task and a significantly lower rate during the visuomotor secondary task as compared to driving only. For alpha spindle duration we could find significantly shorter alpha spindles during the visuomotor secondary task as compared to the auditory secondary task and to driving only.
The results give strong evidence that alpha spindles stand for active inhibition of visual information processing. The balanced appearance over the cortex indicates one central origin of these alpha spindles, which accordingly to prior findings is supposed to be the thalamo-reticular system.
As compared to alpha band power, the measures of alpha spindle rate and alpha spindle duration were less prone to artifacts and the effects were more pronounced, which allows for a more accurate classification of different attentiveness levels while driving in real traffic.

Keywords: Alpha spindles; alpha rhythm; real road driving; EEG; driver monitoring; distraction; secondary task; visuomotor; auditory

45-P: Legislation has Minimal Impact on Drivers' In-Vehicle use of Nomadic Devices

Samantha L. Jamson, University of Leeds, UK

Nomadic devices are portable technologies that drivers are able to use as means of navigation, entertainment or communication. Behavioural studies indicate that using nomadic devices while driving can result in cognitive and manual distraction leading to poorer vehicle control and reduced attention to critical events. Legislative attempts have been made to impose restrictions on the use of some devices while driving, translating to either a total ban (as in the case of hands-held mobile phones) to limiting the level of interaction (e.g. not entering or changing a destination in a navigation system). In this study, over 1500 drivers across Europe were surveyed and using their country of residence as a proxy for the stringency of legislation, their propensity to own, use and engage in risky interactions with nomadic devices was modelled. Whilst the results varied depending on the nomadic device, the relationship between legislation and use was not always straightforward. Mobile phone legislation, which is relatively simple and well promoted, was clearly understood and adhered to; however, more complicated or less advertised legislation such as that pertaining to navigation devices and music players was poorly comprehended and, where present, generally not complied with. The study highlights the need for drivers to be presented with clear legislation, supported by educational and enforcement campaigns.

46-P: Impact of Simulated Forward Collision Warning System While Driving: an Event Related Potential Study

Fort Alexandra[1], Collette Boris[1], Bueno Garcia Mercedes[1], Deleurence Philippe[1], Bonnard Arnaud[1], Fabigoule Colette[2]*

[1] Laboratory of Ergonomic and Cognitive Sciences for Transport (LESCOT) - French Institute of Science and Technology for Transport, Development and Networks (IFSTTAR), Bron, France
[*]IFSTTAR – LESCOT 25 avenue François Mitterrand 69675 Bron Cedex alexandra.fort@ifsttar.fr +33 (0)4 72 14 25 80

[2] USR 3413 SANPSY (Sleep, attention and neuropsychiatry), National Center for Scientific Research University Bordeaux Segalen, Bordeaux, France

Rear-end collisions represent about 30% of all car crashes and generate a significant economic cost for society. Driver inattention has been identified as the most important contributing factor in rear-end collisions. One possible countermeasure is the use of systems that warn drivers of potential collisions. The main objective of this study is to assess the impact of such a warning system on the processing of a relevant driving visual cue while taking into account the attentional state of the participants.

For this, we designed a laboratory experiment during which we recorded behavioral data and brain activity (event related potential, ERP) following the detection of a visual target preceded or not by an auditory alert. Participants had to perform this visual task either alone (simple task) or with a concurrent problem-solving task (dual task). Behavioral and electrophysiological data contribute to revealing (1) that there is a behavioral gain induced by the alert and (2) that this gain is at least linked with a time-saving aspect at both the sensory and cognitive stages of neural information processing. Nevertheless, this impact depends on the attentional states of the participant.

In conclusion, we observed an impact of the warning system at both behavioral and brain levels. In addition, our results suggest that this impact has to be tested according to the attentional state of the driver. The main innovation in this work has been the use of ERP measures enabling a better understanding of how this kind of system acts on the information processing.

47-O: Effects of Electronic Billboards on Drivers

Tania Dukic, Christopher Patten, Christer Ahlström

Ph.D. VTI, Researcher Human Factors
Post adress: Box 8077, 402 78 Göteborg
Tel: +46-31 7502606 E-mail: tania.dukic@vti.se

Most driver distraction research focuses on distractions from inside the vehicle, but drivers are also distracted by objects outside the vehicle. Major roads are increasingly becoming sites for advertising billboards and there is only limited research on the potential effects of this advertising on driving performance and possible consequences for road traffic safety.

The Swedish Transport Administration (STA) recently approved the installation of a dozen roadside electronic advertising billboards (EB) for a trial period along a four-lane motorway with heavy traffic running through central Stockholm, Sweden. The STA required that the luminance of the EB be dramatically reduced to moderate their conspicuity in relation to the surrounding environment and especially to ambient lighting conditions. The method of picture conveyance was also regulated to avoid rapid picture frame changes that might be seen as animations as well as attention-grabbing flashes between pictures.

The aim of this study is to investigate the effects of these billboards on driving performance and primarily visual distraction. A total of 41 drivers participated in the by driving an instrumented vehicle past four of the EB during daylight for half of the group and during darkness for the other half. Dependent variables are primary task measures (velocity, lateral position, distance and velocity headway) and eye-tracking measures (glance frequency and duration, total glance time etc.) and subjective data from questionnaires pertaining recollection and awareness.

Expected results include investigating the relationships between visual behaviour patterns and driver performance when passing the EB. Possible implications for road traffic safety and EB will also be discussed.

48-P: The Risk of a Safety-Critical Event Associated with Mobile Device Use as a Function of Driving Task Demands

Gregory M. Fitch and Richard J. Hanowski
Virginia Tech Transportation Institute

Previous research has shown that using a cell phone while driving is associated with an increased risk of involvement in a Safety-Critical Event (SCE). However, examination of cell phone use by its constituent subtasks revealed that complex subtasks (e.g., texting and dialing) were associated with an increased risk, while talking/listening on a device was not. The current study investigated the risk of involvement in an SCE associated with using a mobile device as a function of driving task demands. Data from Naturalistic Driving Studies (NDSs) involving commercial motor vehicle drivers (CMVDs) and light vehicle drivers (LVDs) were re-analyzed. The NDS datasets were partitioned into low, moderate, and high task demand subsets using criteria from the workload literature. Odds ratios for mobile device use and its subtasks were then computed. In low task demands, only dialing was associated with an increased risk for LVDs. In moderate task demands, cell phone use (collapsed across subtasks) was associated with an increased risk for CMVDs. In this condition, texting and dialing was associated with an increased risk, while talking/listening was not. Furthermore, talking/listening on a hands-free phone, or CB radio, was associated with a decreased risk. In high task demands, cell phone use (collapsed across subtasks) was associated with a decreased risk for both CMVDs and LVDs. However, cell phone use in this condition primarily consisted of talking/listening, which on its own was associated with a decreased risk. Overall, the risk related to talking/listening on a mobile device was not found to increase in the three driving task demand conditions examined. Furthermore, unlike LVDs, CMVDs' mobile device use was lowest in high task demands, suggesting that CMVDs may regulate their mobile device use differently from LVDs as the driving task demands vary.

Keywords: Driver Distraction, Cell Phone, Workload, Visual Distraction, Cognitive Distraction, Manual Distraction

49-P: Effects of Aging and a Cognitive Competing Task on the Setting of the Saliencerelevance balance in visual search

[1]C. Gabaude, [1,2]J.E. Cerf, [1]C. Jallais, [1,2]E. Douissembekov, [1]D. Letisserand, [1]L. Paire-Ficout and [2]G.A. Michael

[1]Université de Lyon, F-69622, Lyon - IFSTTAR, LESCOT, F-69675, Bron, France

[2]Département de Psychologie Cognitive & Neuropsychologie, Institut de Psychologie, Laboratoire d‟Étude des Mécanismes Cognitifs, Université Lyon 2, Lyon, France

Goal-directed and stimulus-driven processes interact during the deployment of attention while driving. Using road elements localization, we investigate the issue of the salience/relevance balance (SRB) in visual search by seeking to understand the influence of age, task demands and scene presentation conditions. Twenty-four older drivers (mean age = 71.3) and 24 younger experimented drivers (mean age = 35.4) were asked to localize as quickly as possible a target on a fixed driving scene (a pedestrian, a vehicle, a traffic light or a roadmarking). Pictures of intersections were segmented in 9 sections and showed randomly under three different presentation conditions: original (scenes presented in their original form), partly jumbled (the target appeared in its original position, but the remaining sections were jumbled), or fully jumbled (all locations were jumbled, ensuring that the target was not in its original position). Half of the trials were administered while executing a competing task of semantic judgment (dual task), and the remainder without (single task). Eye movement strategies were analyzed. Two indices, Normalized Scanpath Salience and Normalized Scanpath Relevance were developed to compare data from salience maps and from relevance maps to visual scanning pathways. Results provide evidence for the existence of adjustments of SRB and the need of available attentional resources for such a setting. Furthermore, we show that, despite the greater driving experience of elderly drivers, there is a deleterious effect of the competing cognitive task on the organization of their visual search, which is not compensated by a relevance-oriented adjustment.

50-P: Semi-Autonomous Advanced Parking Assistants Andtheir Effects on Surveying the Surrounding Environment in Real Traffic

Ingo Totzke, Felix Schwarz, Dominik Mühlbacher & Hans-Peter Krüger*
Center for Traffic Sciences (IZVW), University of Wuerzburg,
Roentgenring 11, 97070 Wuerzburg (Germany),

**Ingo Totzke Tel: +49-931-3182175, Fax: +49-931-3182616*
Email: totzke@psychologie.uni-wuerzburg.de

Several studies have shown the positive effects of Advanced Parking Assistants (APA) on driver comfort and parking performance. However, to what degree the use of a semiautonomous APA system that utilizes automatic steering, but does not control speed by accelerating or braking, influences a driver's visual attention (i.e. surveying the surrounding environment) and is a possible danger to road safety has not yet been discussed. In this study, N=11 subjects parallel parked in real traffic with or without a semi-autonomous APA system; a total of nine parking maneuvers were done in a residential area. A staged situation, in which an oncoming vehicle passed the test vehicle during its first backward motion, was integrated into one of the nine maneuvers. Prior to parallel parking, drivers were acquainted with the test vehicle and instructed how to use the APA system. In this study, drivers' glance behavior and judgments as well as observations by an in-vehicle experimenter were measured. No significant detrimental effects of the APA system on surveying other relevant "points-of-interest" while searching for and entering a parking space can be found. Drivers report to have paid as much attention to parking with the APA system as without the APA system. They are able to name as many features of the vehicle that passed by in the staged situation as the drivers without the APA system. No contact with other vehicles, passers-by or obstacles occurs in real traffic. The implications of this study and some methodological aspects are discussed.

Keywords: crash, driver distraction, Inattention, large truck, passenger vehi-

51-P: Driver Distraction in an Unusual Environment: Effects of Textmessaging in Tunnels

[1]Christina M. Rudin-Brown, [1]Kristie L. Young, [2]Christopher Patten, [1]Michael G. Lenné, and [3]Ruggero Ceci*

[1]Human Factors Team, Monash University Accident Research Centre (MUARC), Clayton, VIC, Australia Contact author: Christina M. Rudin-Brown Building 70, Wellington Road, Clayton, VIC, 3800, Australia email: missy.rudin-brown@monash.edu Phone: ++613 9905 1879, Fax: ++613 9905 4363*

[2]2VTI, Borlange, Sweden

[3]Swedish Transport Administration

Text messaging while driving can be distracting and significantly increases the risk of being involved in a collision. Compared to freeway driving, driving in a tunnel environment introduces factors that may interact with driver attentional resources to exacerbate the effects of distraction on driving safety. With planning and design of the 18 km Stockholm Bypass tunnel ongoing, and because of the potentially devastating consequences of crashes in long tunnels, it is critical to assess the effects of driver distraction in a tunnel environment.

Twenty-four participants (22 to 50 years) drove in simulated highway and tunnel road environments while reading and writing text messages using their own mobile phones. As expected, compared to driving alone, text messaging was associated with decrements in driving performance and visual scanning behavior, and increases in subjective workload. Speeds were slower, and marginally more variable, in the tunnel environment compared to the freeway; however, the difference in speed was largely due to drivers adopting the fastest speeds when most distracted (when reading and writing texts) and in the freeway environment. Only the effects of text messaging on lane position were influenced by road environment, with drivers adopting a more central lane position compared to baseline when most distracted in the tunnel. Collectively, results imply that driver distraction in tunnels is associated with similar driving decrements as freeway driving; however, the potential consequences of these decrements in tunnels remain significantly more serious. Drivers should be advised to refrain from text messaging, especially when driving in tunnels.

56-P: Distracted Cycling: The Use and Risks of Mobile Phones and Portable Media Players among Dutch Cyclists

Maura Houtenbos and Charles Goldenbeld , SWOV Institute for Road Safety Research, Leidschendam, The Netherlands

Address correspondence to Maura Houtenbos, SWOV Institute for Road Safety Research, PO Box 1090; 2260 BB Leidschendam, The Netherlands
maura.houtenbos@swov.nl

Objective

To determine the extent to which cyclists are distracted by mobile phones and portable media players and to assess the risks associated with these distractions.

Background

Most research has focused on the distraction of car-drivers and less so on the distraction of cyclists. Cyclists, however, also seem to be using more and more electronic devices while taking part in traffic

Method

An internet survey was conducted among 2554 cyclists.

Results

About seven out every ten cyclists at least occasionally use devices and about one in every six cyclists use devices during every bicycle trip, which appears to consist mainly of music listening. Younger cyclists use devices more often, tend to consider device use as less dangerous and adapt their behaviour less when using devices. Cyclists have 0,3 crash per year, which are most often crashes without contact with other road users. Phone use and listening to music are mentioned with similar frequency as behaviours preceding a crash. The relative risk of a bicycle crash is 1,4 times higher for cyclists who use devices every trip to listen to music and to make or answer a call than for cyclists who never use any devices at all while cycling.

Conclusion

The results of the study provide an indication of the increased crash rate due to listening to music and using the phone while cycling; a problem that should be taken seriously.

Keywords: devices, traffic safety, distraction, bicycling

57-P: Frustration and Distraction: How Frustration Reduces Sensitivity to Hazards and Impairs Visual Search in Hazardous Driving Situations.

Peter Chapman and Jodie Walton
University of Nottingham

Contact: Dr Peter Chapman,School of Psychology, University of Nottingham, Nottingham NG7 2RD, UK. Email: peter.chapman@nottingham.ac.uk

In order to drive safely through potentially hazardous situations it is necessary that drivers adopt an efficient visual search strategy and have an ability to detect emerging dangerous situations. This paper explores the possibility that internal distractions such as frustration and anger can disrupt visual search and prevent drivers from detecting hazards in the road environment. In the current study a group of 40 young drivers watched a series of 11 hazard perception videos. While watching the videos their heart rate, skin conductance, and eye-movements were recorded and they made a continuous hazard assessment on a sliding scale. Before eight of the clips drivers had to solve a series of anagrams. In some case these anagrams were relatively easy while in other cases the anagrams were impossible although this was not clear to the driver. We predicted that failing to solve the impossible anagrams would create feelings of frustration that would carry over to the subsequent hazard perception clips. The results confirmed this prediction, with drivers being less sensitive to hazards after failing to solve anagrams. Frustration was also associated with an increase in skin conductance but a reduction in the frequency of electrodermal responses to specific hazards. The eye movement data showed that frustration was linked to shorter fixation durations while viewing subsequent driving. The results support the idea that even small degrees of frustration and anger can decrease the efficiency of visual search and increase the danger of failing to detect driving hazards.

59-O: Drowsiness Detection by Thoracic Effort Signal Analysis with Professional Drivers in real Environments

[1]Noelia Rodríguez Ibáñez, [2]Miguel Ángel García González,
[2]Juan Ramos Castro, [2]Mireya Fernández-Chimeno

[1]Research Department, FicoMirrors Pol. Ind. Can Magarola,
C/ Rec de Dalt,08100 Mollet del Vallès (Barcelona), SPAIN
Tel: +34 93 561 00 00 E-mail: noelia.rodriguez@ficosa.com

[2]Grup d'instrumentació Electrònica I Biomèdica. Departament d'Enginyeria Electrònica Universitat Politècnica de Catalunya

Drowsiness is one of the main causes of vehicle accidents. A recent NHTSA study showed that 20% of crashes and 12% of near-crashes were caused by drowsy drivers[i] . The morbidity and mortality associated with drowsy-driving crashes are high, perhaps because of the higher speeds involvedii combined with delayed reaction time[iii].

Biomedical variables related to autonomic nervous system provide direct information of the driver physiological state, instead of an indirect indicaction of the participant's behavior. Therefore, they may be especially useful to collect detailed information of the drowsiness cycle and anticipate risking[iv] situations while driving.

The aim of this work is to detect drowsiness in drivers by the analysis of the variability of respiratory signal measured with a thoracic band in real driving conditions.

This paper presents a research developed in order to achieve a measurement of drowsiness in real drivers, and to find patterns in thoracic effort signal that allow characterizing the drowsiness cycle by registering data in real vehicles and driving simulator. One hundred hours of real vehicle tests in real environment[v] have been recorded. The participants in the test were professional drivers (11 male, 2 female) with ages between 26 and 56 (x= 35,5; σ= 8,9) and no clinical conditions. The tests were carried out in two different routes: highway and mountainvi, to analyze the driver behavior with different concentration level[vii].

Previously to these real vehicle tests, 72 hours of driving simulation test[viii] [ix] have been made to adjust measurement procedures. The subjects in the driving simulator test were 17 male and 19 female in different conditions: sleep deprived (6 male and 8 female), fatigued (4 male and 5 female) and awake (7 male and 6 female).

The thoracic effort signal was measured in all cases using an inductive band located at the middle trunk above the diaphragm. Thoracic effort signal was analyzed with an algorithm based on the quantification of the respiratory rate variability normalized by the basal respiratory rate variability of each particular subject in normal conditions.
These results were compared with a binary gold standard signal that classified the state of the driver during the test defined by combining the percentage of EEG vertex waves[x] [xi] and the annotations of an external observer from the analysis of gestures and behavior of the participant.

60-P: The Influence of Cognitive Distraction on Driver Behaviour at Signalised Intersections

Robert Kaul and Martin Baumann

DLR German Aerospace Center, Braunschweig, Germany
Contact: Robert Kaul, Institute of Transportation Systems, DLR German Aerospace Center, Lilienthalplatz 7, D-38108 Braunschweig
E-mail: robert.kaul@dlr.de, Tel: +49531 295 3469, Fax: +49531 295 3402

The signal change from green to yellow is a central critical event of traffic lights at signalised intersections. Due to yellow onset of traffic lights the driver is suddenly in a situation with different action alternatives. To avoid incorrect decisions, thus driving errors and accidents, it is necessary that the driver understands the current traffic situation. Cognitive distraction of the driver can impair the understanding process, underlying the driving behaviour. To investigate the influence of cognitive distraction and their underlying mechanisms on driver behaviour at signalised intersections an experiment was conducted. In an urban traffic scenario it was varied whether the ego vehicle followed a lead car or not (car following vs. no lead car) when approaching a traffic light. Furthermore, the participants had to solve a cognitive demanding secondary task (no secondary task vs. secondary task). First analyses show that the existence of a lead car crossing the intersection causes drivers to cross the intersection more often. Furthermore, if the ego vehicle is following a lead car the quality of solving the cognitive secondary task is higher. A possible interpretation of this result is that cognitively distracted drivers tend to reduce the demand of the traffic situation by using simple heuristics, such as follow the lead car, as basis for their driving decisions, especially as cognitive distraction impairs top-down control of action selection.

Keywords: decision-making, action selection, yellow onset, driving heuristics, car following

61-O: Visual Distraction, Driver Performance, and the Risk of Rear-End Crashes at Intersections

**Martin Baumann and Robert Kaul*

DLR German Aerospace Center, Institute of Transportation Systems
Lilienthalplatz 7, D-38108 Braunschweig

**Contact author: Tel: +495312953429, Fax: +495312953402,*
martin.baumann@dlr.de

The performance of drivers is highly influenced by how well they know what is currently going on around them and how well they anticipate the future behaviour of other road users. A prerequisite for this is that the drivers apply the appropriate visual search strategies in a given traffic situation and therefore allocate visual attention in accordance with the requirements of the current traffic situation. In a recent in-depth accident analysis conducted within the EU project ISi-PADAS (Muhrer & Vollrath, 2010) it was found that a substantial proportion of rear-end crashes occur in urban areas in low demanding traffic situations. It seems plausible to assume that one reason for this kind of accidents is that the drivers in the rear vehicles had the wrong expectation that the lead vehicles will continue driving with the current speed, were inattentive and were therefore not prepared to a sudden braking manoeuvre of the lead car. According to the SEEV-Model (e.g., Horrey, Wickens, & Consalus, 2006) the allocation of visual attention to a visual information channel is determined by four factors: i) by the salience of information in a visual channel, which is related to the conspicuity of information or events that occur within that channel, ii) by the effort to access information from this channel, iii) by the expectation of the person that there will be new information in that channel, and iv) by value or importance of the piece of information perceived in that channel.

Given the supposed role of expectation in the causation of such rear-end crashes we examined how expectation is determined by certain situational variables. According to the SEEV-Model expectation is mainly determined by the frequency with which relevant events are observed in a given channel. The more events the more visual attention is allocated to this channel. On the other hand it seems reasonable to assume that the allocation of attention is less determined by the frequency of events in a certain channel but rather from the predictability of the events in a channel. That is, many predictable events in channel cause less attention allocation than a single but unexpected event.

In a driving simulator experiment, also conducted within ISi-PADAS, we compared the effects of event frequency and event predictability on the allocation of visual attention. 20 participants took part in this experiment. They had to drive in an urban area with a lead car changing either frequently its speed or not at all on a straight section before a crossing, braking either predictably at the crossing (stop sign) or unpredictably (priority sign) at the crossing, and simultaneously performing a visual secondary task with either high frequency or low frequency stimulus presentation. Drivers' gaze behaviour was recorded while driving. The results show drivers allocation of visual attention is mainly determined by the predictability of the lead car's behaviour demonstrating the importance of the driver's ability to predict events as major determinant of driving behaviour.

62-P: Attentional Perturbations Encountered in Driving: Experimental Evaluation of Cognitive Factors

[1]J. Hoel, [2]C. Boujon, [3]L. Granjon, [1]P. Van Elslande

[1]INRETS-MA - Chemin de la croix blanche 13300 Salon de Provence - FRANCE
[2]Université d'Angers - Maison des Sciences Humaines, 5 bis Boulevard Lavoisier 49045 Angers – France
[3]Gipsa-lab – Domaine universitaire 38402 Saint Martin d'Herès - France

The study of attentional perturbations in driving continues to intensify, especially with the growing implementation of information and communication systems in vehicle. Van Elslande, Jaffard, Fouquet and Fournier (2009) distinguished attentional perturbations according to the task which is in competition with the driving task: inattention, attentional competition and distraction.
The study had two mains objectives: evaluate what is directly attributable to a failure of attentional processes and test whether a factor internal to individuals, such as the working memory capacity, modulates the inter-individual differences in attention.
Participants performed two tasks: a visual search task adapted from Lavie and Cox (1997) and an Operation Span task (OSPAN) assessing Working Memory Capacity (WMC). The visual search task, and more precisely the variable "distractor compatibility", allows us to distinguish the attentional competition and the distraction. With OSPAN task, we have two groups: high spans and low spans. As Lavie (1995), results showed that the perceptual load in a visual search task determines the ability to ignore the distractor. It means that whatever the nature of the distractor (e.g. attentional competition or distraction), the perceptual load reduces his effect About individual differences, we showed a non significant trend toward an interaction of span group, load and compatibility, suggesting that perceptual load would reduce the effect of distractor especially for low spans. The main interest of those results is to be transposable to every day life, like in driving.

63-O: Processing of Eye Tracking Data from Naturalistic Driving Data

[1]Christer Ahlström, [2]Trent Victor, [3]Erik Steinmetz, [2]Claudia Wege
christer.ahlstrom@vti.se

[1]Swedish National Road and Transport Research Institute (VTI), 581 95 Linköping, Sweden
[2]Volvo Technology Corporation, 405 08 Göteborg, Sweden
[3]SP Technical Research Institute of Sweden, 501 15 Borås, Sweden

Driver inattention is a large contributory factor in crash causation, and whether or not drivers' eyes are off theroad when something unexpected happens can often be the difference between a harmless event and one that turns into a crash. Naturalistic driving studies have shown that crash-relevant events are strongly associated with a preceding period of large eyes-off-road times, but the data does not necessarily prove the opposite – that large eyes-off-road-times are strongly predictive of crash-relevant events. Until recently, the latter statement has not been possible to investigate. Modern eye tracking technology does, however, make promises of automatic encoding of eye movements. The challenges posed by naturalistic driving studies are however much larger compared to when eye trackers are used in simulators or controlled field experiments. Challenges include automatic calibration and dealing with the difficulties associated with blocked or misaligned camera views, glasses, night time conditions, backlighting etc. It is thus inevitable that naturalistic data are sometimes faulty or corrupt. The aim of this paper is to describe how naturalistic eye tracking data can be treated and how some of the problems can be circumvented. Especially, practical issues and algorithmic details regarding quality control will be highlighted. The workflow can be summarized in the following steps:

1. Automatic quality control at the trip level: A number of performance indicators such as percentage of data loss, percent road centre and standard deviation of radial gaze are calculated for each trip. If these performance indicators fall below certain thresholds the trip is marked as a low quality trip. If the trip is of long duration it is divided into 10 minute segments. The segmentation is done in order to avoid excluding an entire trip that is only partly corrupted. This step is used to coarsely sort trips as either useful or corrupt.

2. Manual quality control at the trip level: The thresholds in the previous step have been set to only accept really good trips. This approach will inevitably exclude some good trips and this is why we have a manual quality control as well. A 2D histogram of the data in each trip is created and an observer deter mines if the trip should be classified as useful or corrupt. The observer's deci sion overrides the automatic quality procedure.

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3. Noise reduction at the subtrip level: Smoothing as well as interpolation of missing values is achieved with a weighted penalized least squares ap proach. The weight is based partly on the reliability of the signal and is mostly governed by physiological constraints.

4. Drift compensation: The driver is changing position from time to time and the tracking equipment sometimes drift or tracks erroneous facial features. This causes a complicated drift in the tracking data that can either show up as very low frequency changes or sudden jumps. The sudden jumps have been detected with a state estimator based on a change-in-mean model and, after the jumps have been removed, the low frequency drift has been estima ted with a Whittaker smoother.

5. Onroad estimation: The driver has been assumed to look at the road when the gaze/nose direction resides inside a circle with 15/20 degree radius. Since the driver should be allowed to look at the road, curves (as measured via the GPS-position trace) have been compensated for by allowing the circle to grow according to the road ahead. To reduce the effect of noise, the deci sion whether the gaze/nose direction resides within the onroad area uses hys teresis with the lower thresholds 10/15 degrees.

The resulting onroad signal will be compared with manually annotated video recordings in order to validate the algorithms. This work is in progress but will be reported here.

64-O: Investigating Driver Distraction: The Effects of Video and Static Advertising a Driving Simulator Study

Dr Mark Chattington
Transport Research Laboratory, United Kingdom

Roadside advertising is a common sight on urban roads; with the purpose of drawing the attention of passing travellers to the displayed product/service. This represents a source of distraction for road users. Previous research has demonstrated roadside advertising has a detrimental effect on a driver's ability to control a vehicle; increasing mental workload and affecting eye fixation behaviour. This study was designed to assess the relative level of distraction caused by roadside billboard advertising with reference to advert:

- type (static vs. video adverts);
- position (placement relative to road);
- exposure time (duration over which advert is visible).

Method
The study was conducted using TRL's driving simulator, and its non-intrusive integrated eye tracking system. Two simulated driving routes (13km in length) were created and 48 participants, mixed by age and gender, were recruited to drive each route in both directions. The simulated routes were built to appear representative of the London hinterland, included features such as traffic light controlled junctions; urban buildings and moderate traffic density with various vehicle types included (see Figure 1). Each route contained seven adverts plus additional blank advertising boards. Selecting suitable advertising content was challenging, as it was vital to ensure the advertising used was approximately similar in its capacity to distract drivers. A range of static and video billboard type adverts were selected. To ensure the adverts shown to drivers were suitable, Thirty-four participants (16F; 18M) across a wide age range completed the content validation study prior to the simulator trial.

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Key findings and conclusions
The simulator study revealed numerous differences in behaviour across the experimental factors, comparing behaviour when passing static adverts; participants in the study:

- Spent longer looking at video adverts;
- Glanced at video adverts more frequently;
- Tended to show greater variation in lateral lane position with video adverts;
- Braked harder on approach to video adverts;
- Drove more slowly past video adverts.

Result indicated video adverts caused a significantly greater impairment to driving performance when compared to static adverts. A possibly counterintuitive result indicated drivers went slower past the video adverts, which could be considered to indicate safer driving. However, visual behaviour analysis suggested participants were slowing to view the video adverts. This combined with greater variation in lane position and harsher braking suggests an overall impairment to driving ability when viewing video adverts. The increases observed, particularly at the short duration exposure time are consistent with an increased tendency to drift to the offside lane or nearside kerb, increasing the risk of a collision. When compared to other impairments tested on the simulator, cannabis has been shown to increase variation in lane position by 35% whilst trying to write and send a text message caused this measure to increase by 91%. Qualitative data collected as part of the trial, examining participants' subjective opinions, support the vehicle control findings in that participants were aware their driving wasmore impaired by the presence of video adverts than with static adverts.

69-O: Measure, Adapt, and Manage – the AKTIV Approach on Driver Attention

Dietrich Manstetten

Robert Bosch GmbH - Corporate Sector Research and Advance Engineering
Dept. CR/AEY, P.O. Box 30 02 40, 70442 Stuttgart, Germany
Email: dietrich.manstetten@de.bosch.com

Contributing authors: Klaus-Peter Kuhn - Andreas Proettel - Ann Sokoll - Peter Frank (Daimler AG) Stefan Mayer - Michael Schadeck (Audi Electronics Venture GmbH) Daniel Heyes - Walter Schwertberger - Gunnar Tigges (MAN Nutzfahrzeuge AG) Harald Berninger - Thomas Schramm (Adam Opel GmbH) Stefan Lüke - Waldemar Schrinner (Continental Teves AG & Co. oHG) Michael Dambier - Wolfgang Krautter (Robert Bosch GmbH)

Whether it be «Active Hazard Braking», «Integrated Lateral Assistance», «Intersection Assistance» or «Pedestrian and Cylist Safety» – to reach its full effectiveness on traffic safety an innovative driver assistance system has to be optimally adapted to the current actions and capabilities of the driver. Therefore, within the framework of the German project initiative AKTIV (Adaptive and Co-operative Technologies for Intelligent Traffic, partly funded by Federal Minstery of Economy and Technology) the six industrial partners Daimler, Audi, MAN, Opel, Continental, and Bosch worked on the tasks

- to measure the driver's attentional level by means of
  1) analyzing driving parameters at pedals or steering wheel
  2) interpreting the operational behavior at other vehicle systems
  3) detecting head orientation and gaze direction using interior cameras,
- to adapt the warning strategies of different driver assistance systems to the measured level of attention,
- to manage the driver's attention by offering different degrees of automation in longitudinal and lateral control.

The presentation gives an overview of the work and results reached within the project during the years 2006 to 2010. It describes experiments performed in driving simulators and on test tracks to answer specific questions on driver reaction times and to reach a consistent data base for the development of the measurement algorithms. It outlines the principles of the algorithms using different technologies and shows results concerning their measurement quality. It illustrates how the generated information was used to adapt the display concepts and warning strategies of specific assistance systems, e.g., an emergency braking system and a signal light assistance. It illustrates information on the vehicle demonstrators built-up within the project and shows video material demonstrating the performance of the systems. Finally, it gives an outlook to future research demand in the field of analyzing the driver focussing on the recognition of the driver's intention in urban traffic environment.

71-O: Driver Distraction and the U.S. Department of Transportation: A Multi-modal Approach

[1] *Christopher Monk, [2]Ralph Craft, [3]Stephanie Binder

[1]*Federal Highway Association
[2]Federal Motor Carriers Safety Administration
[3]National Highway Traffic Safety Administration

*6300 Georgetown Pike (HRDS-30), McLean, VA 22101, (202) 493-3365
Chris.Monk@dot.gov

Driver distraction is a major focus area at the U.S. Department of Transportation. The Secretary has convened two Distracted Driving Summits, which provided a platform for researchers, advocates, manufacturers, and the public to come together to discuss this important topic. However, the interest in this topic did not begin or end with the Summits – in fact, many of the modes have research programs in distraction. This presentation will provide a summary of and preliminary results for some of the research efforts in three modes – Federal Highway Administration, Federal Motor Carriers Safety Administration, and the National Highway Traffic Safety Administration.

The FHWA is concerned whether roadside information in digital form may be a source of distraction for drivers, and is currently concluding an on-road eye-tracking study to determine if drivers spend too much time looking at digital billboards. In addition, the FHWA will initiate a new research project in 2011 that will explore the distraction potential of new information sources in the right of way. The results from these studies will help inform FHWA policy for roadside signage and guidance for MUTCD signs.

FMCSA has been active in limiting the use of wireless communication devices among commercial vehicle drivers. In September 2010, the agency published a final rule banning texting. This ban imposed sanctions, including civil penalties, for drivers who fail to comply with this rule. The rule was effective on October 27, 2010. Currently, the agency, along with the Pipeline and Hazardous Materials Safety Administration (PHMSA), is considering a rulemaking to limit or restrict the use of devices or certain activities by: (1) commercial motor vehicle (CMV) drivers operating in interstate commerce and (2) drivers of CMVs containing a quantity of hazardous materials.

In April of 2010, NHTSA put out the Driver Distraction Program Plan, which outlines the entire agency's efforts in driver distraction. One project is that of manual entry tasks (Initiative 1.7). This project used a driving simulator to investigate the distraction potential of several manual entry tasks (e.g., navigation entry, texting) for several phone interfaces (analog, Smartphone). The results of this study are expected to show the relative difference in distraction potential among the selected tasks. These results can then be used for policy decisions.

72-P: When Emotions Disturb the Localization of Road Elements: Effects Of anger and Sadness

[1]Jallais Christophe, [1]Gabaude Catherine, [1]Paire-Ficout Laurence

[1]IFSTTAR (French Institute of Science and Technology for Transport Development and Networks) - LESCOT (Laboratory of Ergonomic and Cognitive Sciences for Transports), 25 Avenue François, Mitterrand, 69675 BRON Cedex – France

Contact: christophe.jallais@ifsttar.fr

This research aims to study the effects of negative moods (sadness and anger) on the visual search of road elements. We used a modified version of the jumble scenes paradigm to provide evidence for the effect of such moods on driving-related schemata which appeared to be guiding visual search. It seems that participants previously induced in sadness are less relying on their schemata than other participants. Negative mood also promotes the use of a detail-oriented processing of information. Moreover, Sadness increases irrelevant thought, and decreases the attentional resources leading to inattention. Previous studies suggested that negative moods should be disentangled according to the arousal dimension (exciting versus calming) rather than according to the valence (the hedonic value) dimension. The results reported here revealed that all groups used their visual schemata to localize road elements. Participants induced in anger were slower to locate road elements than participants induced in sadness and in neutral mood. Further analyses revealed that participants of the anger group did not use their driving schemata to localize road signs, suggesting that the information processing is different between the localization of road signs and road users under anger mood. The sadness group made more errors in their detections, confirming that sadness leads to irrelevant thoughts and inattention.

Keywords: Perception, emotions, feelings, driver behaviour, Damasio, The

73-0: Design and Evaluation of an Innovative Virtual Instrument Cluster for Automotive Dashboards

Michael Tybel, Iñigo Garcia, Nerea Aguiriano, Alfonso Brazález
CEIT, Paseo de Manuel Lardizábal 15 - San Sebastián (Spain)
+34 943 212800 (Ext. 2136) Email: mtybel@ceit.es

The rapid technological advancement, particularly in the area of electronics and telecommunications, has had a massive impact on modern cars over the last decade. At the same time, portable computers, smart phones and tablets have brought us a big step closer to ubiquitous computing. These and other common automotive devices, such as route guidance or hands-free speaking systems, have transformed the workplace of the driver considerably and are demonstrably source of distraction.

Now, many car manufacturers have established a sophisticated HMI solution in their middle and upper class models that help drivers controlling vehicle functions in an intuitive way. Those systems are typically based on a secondary screen placed inside the centre console. Recent hybrid (e.g. Ford Fusion) and full electrical (Chevrolet Volt or Nissan Leaf) cars are going one step further and extend the HMI experience by introducing a digital instrument cluster. This trend has progressed into conventional models now and will become state of the art in the near future.

Digital instrument cluster erase the limitations of traditional analog dashboards and are going to change the driver workspace essentially. However, a dynamic configurable instrument cluster with all its possibilities and innovative functions means a new experience for most drivers. Since the primary task of the driver is always driving, innovative systems must not only be evaluated regarding their particular functional performance, but regarding the overall driving performance, especially in terms of safety. Their design and implementation create new requirements that are not studied sufficiently yet.

The ITS and Simulation department at CEIT has developed a 100% configurable digital instrument panel and integrated it into a full immersive truck and bus simulator. This Virtual Instrument Cluster (VIC) is OpenGL rendered and uses a high definition TFT screen to display all vehicle information to the driver. Thus, any information can be displayed in multiple ways (color, size, shape, location, etc.), at any moment. The freedom of layout allows to significantly improve the interaction between vehicle and driver, by making it more efficient, more functional and personalized. That is, for example, when only the important information is displayed at any time, while irrelevant data remains hidden. In addition, several profiles can be implemented to suit the individual taste and driving style. Moreover, external devices (phone, music player, GPS) and new innovative ADAS (e.g. night vision, blind spot detection or Intelligent Speed Adaption System - ISA) can be integrated natively in the instrument cluster.

The VIC developed by CEIT integrates additionally RGB LEDs between cluster and windscreen in order to provide a color based ambient light that utilizes the peripheral vision of the driver. In doing so, the HMI is able to show a passive and gradual indication without distracting the driver.

This paper presents a virtual instrument cluster that introduces an innovative advisory ISA system. The overall HMI performance with focus on driver distraction is evaluated through driving experiments performed in a full immersive truck simulator. As result, a general guideline for digital instrument cluster design is developed.

75-0: Driver Visual Distraction due to a Secondary task Without Visuomotor Component

*[1, 2]*Lehtonen E., [2]Lappi O.b, and [1]Summala H.*

*[1]Traffic Research Unit, Institute of Behavioural Sciences,
University of Helsinki, Finland
[2]Cognitive Science, Institute of Behavioural Sciences,
University of Helsinki, Finland*

**Contact: esko.lehtonen@helsinki.fi +358-9-191 29421,
Traffic Research Unit, Box 9 Institute of Behavioral Sciences,
FIN-00014 University of Helsinki, Finland*

One behavioural index of the visual anticipation of potential oncoming vehicles, obstacles and road alignment is the time spent on fixating the «anticipation point»: the furthermost point in a visual scene where the road ahead is visible, and where potential oncoming traffic will first appear from.

In two on-road studies where a total of 22 participants have driven on a low-standard rural road in an instrumented car equipped with an eye-tracking system we have been able to show that:

(a) Drivers spontaneously orient toward the anticipation point (typically by brief glances whereafter the gaze immediately returns to the road).
(b) This orienting behaviour depends on executive working memory: a purely cognitive secondary task without explicit visuospatial or motor components (a demanding mental arithmetic task, intended to simulate the demands of an intensive conversation) significantly reduces the use of the anticipation point.

It has been shown previously that cognitive secondary tasks can lead to reduction in looking at the speedometer and mirrors, as well as of safety-critical visual scanning at street crossings. We have now extended this research and shown that the reduction of visual orientation to the environment also occurs with respect to the anticipation of hazards and road curvature.

This result has implications for the design and recommendations concerning the use of in-vehicle information systems (such as satellite navigators and cell phones): to avoid safety-compromising driver distractions it is not sufficient to design in-vehicle devices so as to require no visuomotor interaction (speech-based interfaces, hands-free). Cognitive demands of tasks also need detailed empirical analysis in order to understand their potential to distract the driver.

76-P: Emotion in Motion: Comparing the Effect of a Range of Distractions on Driver Behaviour

Nick Reed and Cyriel Diels

TRL Wokingham RG40 3GA UK
Contact: nreed@trl.co.uk, cdiels@trl.co.uk

Objective
To investigate the relative levels of impairment to driving performance caused by a range of different potential distractors that drivers may encounter when performing the typical driving duties of European drivers.

Background
A driver‟s mental state can affect vehicle control. This is understood for known impairments such as alcohol, drugs and sleepiness. Drivers may be less aware of how situations in everyday life may affect their vehicle control. Four studies were completed using a validated test route on a driving simulator to investigate.

Method
A series of driving simulator studies were completed by 74 participants. The driven route tested response times, behaviour in traffic, and lateral/longitudinal control. The conditions tested were the effects of preferred and non-preferred music; pre-drive stress or relaxation; engaging sports commentary; arguing children; and passengers on driver behaviour.

Results
An intriguing pattern of results emerged with some of these routinely experienced situations causing impairments comparable to that of alcohol to the UK legal limit. Some interesting gender differences were observed.

Conclusion
Some of the experimental conditions caused impairments comparable to that of alcohol to the UK legal limit. Different situations were found to either facilitate or impede performance, suggestive of both stimulative and distractive effects. Beneficial effects of improved response times appeared to be negated by smaller safety margins. Gender differences in impairment were also observed.

Application
This paper provides an overview of these studies and sets them within the context of other comparable research in this area.

78-P: Consideration of External Factors for Driver Attention Classification

Fabian Friedrichs, Peter Hermannst¨adter, Bin Yang

Chair of System Theory and Signal Processing,
University of Stuttgart, Pfaffenwaldring 47
70550 Stuttgart, Germany
phone: +49 711 685-67354, fax: -67311
{fabian.friedrichs, peter.hermannstaedter, bin.yang}@lss.uni-stuttgart.de

This article aims on considering external influences to improve the detection accuracy of driver state classification systems. Such factors are road condition and curvature, cross-wind, construction sites and vehicle speed. Driver warning systems aim to reduce drowsiness-induced road-crashes as a major cause of severe accidents by analyzing the diving performance using standard equipment sensors. The systems notifying them about their performance or issue a warning to fatigued or inattentive drivers proposing them to have a break. Special controlled driving experiments have been conducted in order to isolate single disturbing factors. Recorded data have been analyzed for their correlation with the driving behavior. The relationships between environmental factors and measures for the driving performance are discussed. Compensating external influences under real driving conditions is an even more challenging task than the detection of sleepiness patterns under ideal conditions. The detection and consideration of external factors is one of the keys to optimize the performance and improve generalization of driver state classification systems. The presented work shows the relevance of considering external influences and proposes solutions for the individual influences. We show the potential to further investigate this topic and validate the results with a larger set of experiments.

81-O: What ARDES actually measure?
Driver inattention vs. engagement in distracting activities

Montes, Silvana; Ledesma, Rubén; Valle, Virginia; Poó, Fernando; and Nucciarone, María Isabel
Universidad Nacional de Mar del Plata / CONICET
Funes 3250, Mar del Plata (7600), Argentina 54 223 4752266
smontes@conicet.gov.ar

Background
The Attention-related Driving Errors Scale (ARDES) is a self-report measure developed to assess individual differences in driver inattention. ARDES was conceived to measure driver inattention as a personal proneness factor, and the validation study suggested preliminary evidence of validity in this regard. Nevertheless, the original study did not keep records of an important factor: the differences in the level of drivers' exposure to distracting activities while driving. The purpose of this study was to determine if errors that ARDES assesses could be explained in terms of driver exposure to distracting activities rather than by an inattention-trait as had originally been hypothesized.

Method
Participants were 201 Argentinean drivers drawn from a non-probabilistic sample. Drivers responded the ARDES, a modified version of the Dissociative Experiences Scale (DES-M) and a self-report on personal involvement in distracting activities. DES-M was administered as a measure of personal sources of inattention (e.g., psychological abstraction). An index of distracting activities (IDA) was computed. IDA measures the number of distracting activities in which drivers reported having been involved in the previous two weeks (Cronbach's Alpha= .76).

Results
The ARDES correlated positively with the DES-M ($r=.50$, $p< .01$), and negatively with the IDA ($r= -.16$, $p<.05$). The correlation between DES and IDA was also weak and negative ($r= -.18$, $p<.01$). A multiple regression analysis suggested that ARDES scores are significantly predicted by DES (Standardized beta=.46, $t=7.9$, $p<.01$), but not by IDA (Standardized beta= -.08, $t=-1.4$, $p>.05$).

Discussion
According with results ARDES assesses an internal disposition to commit attention related errors which appear to be unrelated to distracting activities. The weak and negative correlation between ARDES and DAI suggests that inattentive drivers could counterbalance their inattentiveness by being less involved in distracting activities.

Keywords: driver inattention, distracting-activities, self-report measurement, individual differences

82-P: A Refined Measurement Model for the Attention-related Driving Errors Scale

Rubén D. Ledesma, Silvana A. Montes, Fernando M. Poó, María F. López-Ramón, and Virginia Valle

CONICET-Universidad Nacional de Mar del Plata, Argentina
Contact: Rubén Daniel Ledesma
Río Negro 3922, Mar del Plata (7600), Argentina
rdledesma@conicet.gov.ar, tel 54 223 4716015

Objective
The aim of this study was analyze the internal structure of ARDES (Attention-related Driving Errors Scale) by using Confirmatory Factor Analysis (CFA). Background: We propose a novel measurement model consisting of three correlated factors measuring driving errors at different levels of the driving task: navigation (strategic level); maneuvering (tactical level); and control (operational level).

Method
We analyzed data from the original validation study (n=301) and from a new replication sample (n=201). Both samples are comprised of drivers drawn from the general population of the city of Mar del Plata, Argentina. As is usual in CFA, we evaluated parameter estimates in relation to model predictions and assessed the goodness of fit for different models. Relationships with external variables and mean differences due to traffic accident history were analyzed.

Results
The proposed three-factor model showed satisfactory goodness-of-fit indices. The three factors were strongly related and showed similar patterns of association with external variables. A measure of attention-related errors in everyday life proved the best predictor for the three factors. Only errors at the maneuvering level were related with self-reported road crashes and tickets.

Conclusion
Responses to ARDES items can be interpreted via three interrelated factors that, taken collectively, point to a second-order factor measuring overall inattention while driving. Even though the three factors seem to share a common basis, they appear to have different effects on road safety; therefore, there is reason to maintain the distinction between the three categories of errors. Further studies providing complementary evidence of validity are needed.

Keywords: driving, driver inattention, measurement, self-report

83-O: Assisting drivers with a "Visual Distraction Alert System"

[1, 2]Claudia Wege and [1, 2]Trent Victor

[1]Volvo Technology Corporation, Götaverksgatan 10, 405 08 Gothenburg, Sweden

[2] SAFER, Sweden
E-mail: claudia.wege@volvo.com

This research presents an evaluation of driver performance and drivers' visual behaviour while being assisted with a "Visual Distraction Alert System" which helps them coordinate their interaction in distracting tasks. The present study focuses on the influence of different features of a visual distraction alert system: its functional transparency as well as the system's reliability. The system's functional transparency is varied in different types of real-time feedback alerting drivers. This feedback is based on off-road eye glances when being engaged in realistic distracting secondary tasks. The system reliability differs according to the degree of predetermined false warnings being issued.56 participants sent text messages while driving on a two-lane highway road in a Volvo FH12 truck simulator. All participants were professional truck drivers, driving at least 30 000 km/year.Key findings include the fact that real-time feedback on drivers' off-road glances influences their interaction with the text message, thus altering driver's distraction. With system assistance present, drivers maneuver the truck safer, as is indicated by better lane keeping performance, and use shorter glances away from the roadway compared to baseline, as indicated by gaze measures. When drivers engage in distracting tasks, the "Visual Distraction Alert System" causes them to look forward on the road 40% more – resulting in enhanced safe driving.

86-O: Would The Dominant Role of Bottom-Up Control of Visual Attention or the Deficit of Topdown Control Explain the Low Conspicuity of the Motorcycle for Car Drivers?

*[1]*Joceline Rogé, [1]Evgueni Douissembekov and [2]Fabrice Vienne*

[1]Laboratoire Ergonomie et Sciences Cognitives pour les Transports, Institut National de la Recherche sur les Transports et leur Sécurité, 25 avenue François Mitterrand, 69675 Bron, France.
[2]Laboratoire Exploitation, Perception, Simulateurs et Simulations, INRETS/ LCPC, 58 boulevard Lefebvre, 75015 Paris, France.

**Contact: Joceline Rogé, joceline.roge@inrets.fr, 33 (0)4 72 14 24 19*

In several cases of collision between a car and a motorcycle, the car driver failed to detect the motorcyclist in time to avoid the collision, despite the fact that the driver's visual field was not obstructed in any way. Motorist's cognitive processing of information regarding motorcycles might explain these collisions. In order to test this hypothesis related to the low cognitive conspicuity of motorcycles for car drivers, forty-two car drivers including motorcyclist-motorists and non-motorcyclist-motorists carried out a motorcycle detection task in a car-driving simulator. The lack of motorcycle visibility might also be related to their physical characteristics, i.e. their low sensory conspicuity for car drivers. We have studied the effect of improving the colour contrast between motorcycles and their background (road surface) on the ability of car drivers to detect these vulnerable road users when they arrive from different parts of the road.

Statistical analyses of the motorcycle visibility distance indicate that, in specific conditions, a high level of colour contrast enhances motorcycles' visibility and that the motorcyclist-motorists detect oncoming motorcycles at a greater distance than the nonmotorcyclist-motorists. The analyses of the participants' ocular data recorded during the driving task lead to the conclusion that the ocular behaviour of the two groups is different. The results related to sensory conspicuity and cognitive conspicuity of these vulnerable roadusers for car drivers are discussed using visual attention theories.

88-O: Visual-Cognitive Abilities and Performance in Dual Task Driving

[1]Matthias J. Henning1, [2]Nils B. Kroemer, and [1]Josef F. Krems

[1]Chemnitz University of Technology,
[2]Technische Universität Dresden

Although driving is highly automated, it is a complex task that relies critically on visual information. It is regarded as a skill that almost everyone can acquire to a level that is satisfactorily, although there are known differences in visual-cognitive abilities (e.g., Inspection Time, Deary, 2000). Using a dual-task paradigm in a driving simulator, we investigated how individual differences in visual-cognitive abilities relate to glance duration and how these differences translate to driving and secondary task performance. In Experiment 1 (N = 28), high visual-cognitive abilities was associated with lower glance duration to the mirror ($r = -.45$, $p = .015$). Memorizing visuospatial content (Hedge's $g = 1.06$) led to a larger effect, especially compared to phonological content (Hedge's $g = 0.29$). Experiment 2 (N = 51) replicated the interrelation of visual-cognitive abilities and glance duration to the mirror with a more complex driving situation using multilevel analysis. However, the content effect could not be replicated. Further, visual-cognitive abilities were positively correlated with driving performance ($r = .43$, $p = .002$) and secondary task performance ($r = .45$, $p = .001$). Inspection time (IT) explained incremental variance for glances to the secondary tasks when there was high visual competition. An in-depth analysis of visual demanding situations revealed varying strategies of drivers with lower visual-cognitive abilities: deceleration, neglecting of secondary task, collision, etc. Our results lend support to a speed of information processing account and suggest that visual-cognitive abilities and more specifically IT are crucial for analysis of dual task performance in visual demanding situations.

89-O: How does Automated Driving Affect Attention and Distraction?

Oliver Carsten, Frank Lai and Natasha Merat

Institute for Transport Studies
University of Leeds, Leeds LS2 9JT, UK
Tel +44 113 343 5348, Fax +44 113 343 5334
o.m.j.carsten@its.leeds.ac.ul

This work examined how Advanced Driver Assistance Systems will affect safety — to what extent automation leads to inattention and distraction and the role that level and type of automation plays in such phenomena. The investigation made use of the University of Leeds Driving Simulator and consisted of three types of driving scenarios: manual driving, semi-automated driving (either automated lateral control or automated longitudinal control was provided) and fully automated driving (i.e. both lateral and longitudinal control was supported). Forty-eight drivers participated in the experiments. Participants' uptake and performance on secondary tasks were studies. Secondary tasks were implemented method was used to determine if task performance is affected by automation.

One set of the secondary tasks involved a number of entertainment and information activities as well as grooming and food. Participants were free to choose as many activities as they wished and were free to engage in a chosen activity at will. Task engagement fit the expected pattern with the highest rate being in the fully automated condition. However, there were considerable differences between the two forms of semi-automated driving.

Another set of secondary tasks, Twenty Questions, was non-visual and system-paced, involving deductive reasoning and creativity. Participants' performance in each driving condition was observed. Results showed that performance with the secondary task resulted in impaired driving performance, due to the increase in resources required by this task. Drivers' management of the secondary task and driving performance was found to be worst in the semi-automated conditions, where it was perhaps not clear to drivers whether they or system were in charge.

Findings from this study suggest that previous theory on levels of automation is insufficient to predict behaviour and task performance. Instead, a proper understanding of which aspects of the driving task are being substituted is needed.

90-O: Simultaneous use of In-Vehicle Technologies: What is Happening in Real-Life Situations?

[1]*Marta Pereira, [2]Marie-Pierre Bruyas, [3]Clemens Kaufmann, [4]Virpi Britschgi, [5]José Luis Diez Gil, [6]Aleš Zaoral

[1] ISEC. Alameda das Linhas de Torres, 179, 1750-142 Lisboa, Portugal
[2] INRETS. 25 AvenueFrançois Mitterrand, Bron, France
[3] FACTUM OHG, Danhausergasse 6/4 1040, Austria
[4] VTT, P.O.Box 1000, FI-02044, Finland
[5] CTAG, Calle A, 249-250, Spain
[6] CDV. Líšeňská 33a 63600 Brno,Czech Republic

*Tel: +4937153138669; email: marta-sofia.pereira@psychologie.tu-chemnitz.dei

The growing availability of in-vehicle technologies (IVT) increases the likelihood of having more than one such system inside a car. Systems may then be activated or run simultaneously in certain moments. Based on results from a qualitative Focus Group study, the present work offers a discussion on the simultaneous use of in-vehicle functions, and examines present and future solutions to manage the distinct sources of information.

Knowing what drivers think about a system or how they interact with it, is not only important for newly designed products, but also for technologies in the current market. These technologies need to be studied over time, especially if other elements capable of influencing the nature of the driving task, are installed inside the vehicle. Their integration needs to be studied continuously to assure that researchers, manufacturers and policy makers know what is really happening inside vehicles, allowing the development of solutions that are effective and well accepted by drivers.

The present work describes the results of Focus Group discussions conducted within the framework of the INTERACTION project (2009-2012) across six European countries: Austria, Czech Republic, Finland, France, Portugal and Spain. The main aim was to understand why, when, where and how a driver interact with Cruise Control, Speed Limiter, Navigation System and Mobile Phone. The same methodology was applied across all countries. Sessions lasted from between two to three hours and were composed of two parts, each one promoting the discussion of one system. Two sets of sessions were defined: one to collect opinions of Cruise Control and Speed Limiter users, and the other to discuss about Navigation System and Mobile Phone. Between five to eight drivers were present in each session. To collect a broader spectrum of opinions from different drivers, groups were differentiated by age and driving experience. A total of 233 drivers (65 females; 168 males) participated in the Focus Groups. As the objective was also to gain opinions from long-term users, all participants owned the above-referred IVT for at least one year.

Results reveal motives linked with the use of the systems and their effects on driving behaviour. They confirm the simultaneous use of these technologies by drivers. Participants also stated that sometimes information provided by one system improves the use of another in-vehicle technology. Activating Cruise Control or Speed Limiter was reported to allow drivers to engage in secondary activities, particularly in interacting with Navigation System and Mobile Phone. The simultaneous use of Navigation System and Mobile Phone was also confirmed, even when systems are not connected to each other and do not share the same voice output. A discussion is made on the relation between reported benefits of Cruise Control and Speed Limiter and the fact they might facilitate dual task situations. Furthermore, special focus is given to the joint use of Navigation System and Mobile Phone and the willingness of drivers to not connect both systems in certain moments even when they have a technical solution to do it.

91-O: Capture and Control in Visual Attention

Maria Nordfang

University of Copenhagen – Department of Psychology
Øster Farimagsgade 2A, 1353 København K, Denmark
maria.nordfang@psy.ku.dk
+45 35 32 48 63

One of the greatest challenges for the cognitive sciences is to understand how we distribute our limited processing resources. General consensus exist that two types of factors are the primary influences of attentional allocation – the physical properties of the stimuli and the goal of the observer. The interplay between these so-called bottom-up and top-down factors are crucial for which information gets selected and fully processed. Yet the mechanics of, how strong salient signals influence processing and selection of relevant information, has been under debate for at least the last 20 years.
A new series of experiments were designed to test to which degree we are able to select relevant visual information under the influence of salient but irrelevant features. Subjects were tested in a laboratory setting. The task was to report as many letters as possible from briefly presented displays. On some trials a salient element was present. By detailed analysis of the accuracy data it was possible to investigate how the attentional allocation according to task relevance was influenced by the elements' saliency.
I will discuss some of the major theories of visual attention in the field of cognitive science today, such as Guided Search (Wolfe, Cave, Kyle, & Franzel, 1989; Wolfe, 2006), Theory of Visual Attention (Bundesen, 1990) and the development of complex saliency map models following the lines of Itti & Koch (2000). By introducing empirical evidence from the novel experiments described above, I will show how new data point towards a redefinition of how we think of stimulus-bound and task-driven attentional allocation. This new theoretical development has implications for the existing theories of visual attention, by providing a new insight into the basic mechanisms of how we distribute and allocate our attention. I will discuss how attentional allocation relate to naturalistic tasks, such as driving, and I will suggest a new theoretical approach, that can move us closer to an understanding of which visual information drivers perceive in the diverse and complex traffic situations.

92-P: Development and Validation of a Driver Distraction Impact Assessment Test

Hallett, C., Regan, M. A., and Bruyas, M-P.

French National Institute for Transport and Safety Research (INRETS), Lyon, France
Contact: Charlene Hallett (PhD student, Cognitive Psychology)
Tel: +33 04 72 14 26 18, Email: charlenehallett@hotmail.com

There is evidence that driver distraction and driver inattention are leading causes of vehicle collisions. While both driver distraction and driver inattention have been widely studied, there is varied understand of what these terms mean, how they relate to each other, and what mechanisms underlie them (Pettitt, Burnett, & Stevens, 2005; Regan, Hallett, & Gordon, 2010). Driver inattention has been defined as "insufficient, or no attention, to activities critical for safe driving" (Regan, et al. 2010, p. 18). Driver distraction, which has been asserted to be a sub-category of driver inattention, has been defined as: "The diversion of attention away from activities critical for safe driving toward a competing activity, which may result in insufficient or no attention to activities critical for safe driving" (Regan, et al. 2010, p. 19).

The work to be reported in this paper derives from PhD research currently underway to develop a valid, cheap, quick to complete and easy to administer test that will be able to reliably measure the impact of driver distraction on activities critical for safe driving when a driver engages in a secondary task, such as text messaging, conversing or manipulating invehicle systems. In order to develop such a test several crucial factors must be addressed. Firstly, before one can measure driver distraction, one must define it, determine what mechanisms are involved and determine how it can be measured. Secondly, activities critical for safe driving must be identified, as the test must incorporate a representative range of scenarios in which driver distraction has been shown to impact on driving activities that are most critical for safe driving performance. Thirdly, this test should be able to measure the degree to which a secondary activity, which diverts attention away from activities critical for safe driving, impacts on activities critical for safe driving. Fourthly, the test should be sensitive to the different patterns of interference brought about by different types of distraction (visual, auditory, internal). Lastly, the test should have high predictive validity in order to predict which competing activities are most likely to compromise driving performance and driving safety. The test being developed should, ideally, be able to determine a level of degradation of each activity critical for safe driving, beyond which the level of impairment on driving safety and performance induced by the secondary activity is unacceptable.

This paper will firstly review the limited previous work undertaken in developing driver distraction impact assessment tests. Following that, the aims of the research program, research activities completed to date, and research activities that will be undertaken to complete and validate the driver distraction impact assessment test will be reported.

94-O: Definition and Taxonomic Description of Driver Inattention and Driver Distraction

Regan, M.A. and Hallett, C.

French National Institute for Transport and Safety Research (INRETS), Lyon, France
25 avenue Francois Mitterrand BRON-cedex 69675 FRANCE
Contact: Michael Regan Tel: +33 04 72 14 23 21 Email: michael.regan@inrets.fr

There is converging evidence that driver distraction and driver inattention are leading causes of vehicle crashes and critical incidents in many countries. However, as applied psychological constructs, they have been inconsistently defined and the relationship between them remains unclear. Striking is the number of papers that purport to measure the impact of inattention (including distraction) on driving performance which are devoid of any definition of the construct being investigated. The current lack of precision and consistency in definition of driver distraction and driver inattention can have important consequences; it can make the interpretation and comparison of research findings difficult, or even impossible; and similar studies may be measuring slightly different constructs and measuring different outcomes. Additionally, different definitions can lead to different taxonomies for coding and classifying crash data, resulting in different estimates of the role of distraction and inattention in crashes, near-crashes, and incidents.

In this paper, we describe a taxonomy of driver inattention, developed by the authors, in which driver distraction is defined and distinguished from other forms of driver inattention. In doing so, we review exiting definitions and taxonomies of driver distraction and driver inattention, attempt to characterise driver distraction and driver inattention, and provide examples of the different forms of driver inattention proposed. In addition, we distinguish between different types of internalised thoughts, including daydreaming, that have potential to distract drivers and compromise driving performance. With further validation (currently being carried out by the authors), the taxonomy has the potential to become an international standard for the classification and coding of driver inattention in crashes and critical incidents.

95-P: Development of Attentional Workload Metrics to Assess Driver Distraction

David H. Weir and Kevin W. Chao

Dynamic Research, Inc., Torrance, CA, USA

Objectives
Objective measures of driver attentional workload useful in the evaluation and assessment of in-vehicle visual-manual secondary task devices in dual task driving conditions are developed and presented.

Background
Objective measures of driver attentional workload in dual task situations have long been sought. Typical measures involve a single response or performance variable, but composite measures involving more than one variable can be more effective figures of merit. The complexity of driver behavior issues and variability in measures of behavior and subjective ratings complicate efforts to derive composite metrics, and this can be minimized with appropriate experimental procedures and the use of robust correlation methods.

Method
The experiments were done in a driving simulator. The primary task was driving on a straight road at a specified speed. Secondary tasks included navigation destination entry, radio tuning, critical tracking task, and generic touch screen entry. Objective measures included steering inputs, vehicle motions, and secondary task entries and entry errors. Subjective ratings included ease of performing the primary task and overall mental workload. The objective and subjective measures were correlated and weighted to develop composite workload metrics.

Results
The attentional workload metrics provide objective estimates of the mental effort and attention required by the dual task. A metric can be chosen for application based on the objective measures available.

Conclusions
The resulting WE models for visual-manual task can provide objective measures of attentional workload and distraction. They can be used to compare dual task conditions or to continuously monitor driver attentional workload.

96-O: Timing Matters: Visual Behaviour and Crash Risk in the 100-Car On-line Data

[1,2]T. Victor, et al

[1] Volvo Technology Corporation, Sweden
[2] SAFER, Sweden

97-P: Are Children more Distracting than Technology? Using Naturalistic Data to Explore Rear Seat Child Occupants as a Source of Driver Distraction

Christina M. Rudin-Brown, Sjaan Koppel, and Judith Charlton

Monash University Accident Research Center (MUARC), Clayton, VIC, Australia

Contact: Christina M. Rudin-Brown
Building 70, Wellington Road, Clayton, VIC, 3800, Australia
email: missy.rudin-brown@monash.edu
Tel: ++613 9905 1879, Fax: ++613 9905 4363

While the use of in-vehicle technology such as mobile phones has consistently been found to contribute to driver distraction, there are other sources of distraction that may be overlooked in the literature, and that may impair driver performance to a similar extent. It is of benefit to study these factors and, where possible, to identify or develop effective countermeasures. There is anecdotal evidence that children can be a significant source of distraction for drivers; however, the nature and prevalence of distraction related to child vehicle occupants is, as yet, unclear. The collection of naturalistic observational data during vehicle trips is an effective means to investigate child-driver interaction in vehicles and to more systematically quantify the relationship between rear seat child passengers and driver distraction.

Analysis of video data from journeys undertaken by 12 families with young children revealed that children accounted for 12 percent of all potentially distracting activities, with drivers in this study interacting with rear seat child occupants 12 times as often as they did with mobile phones, and six times as often as all in-vehicle technology combined.

An international collaborative, follow-on study of children's behavior in vehicles is introduced; the broad aims of the project are to objectively document and describe how children behave within their CRS, within vehicles, and how they interact with drivers. The project is a world first in its design, using naturalistic driving methods and covert video-recording techniques to observe child occupant and driver behavior during normal, day-to-day trips. Study outcomes will be used to improve occupant and driver safety through improved CRS design, targeted messages for parents and children, and other countermeasures to limit driver distraction.

Notes

Notes

Co-Organisers:

SAFER Vehicle and Traffic Safety Centre at Chalmers
PO Box 8077, SE-402 78 GOTHENBURG, SWEDEN
www.chalmers.se/safer

IFSTTAR
The French institute of science and technology for transport, development and networks
25, Avenue François Mitterrand - Case 24 F - 69675 Bron Cedex, FRANCE
www.ifsttar.fr

Conference website:
www.chalmers.se/ddi2011

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