6th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design
June 27-30, 2011

Monday, June 27, 2011

2:00 pm – 6:00 pm   **Early Registration**
Outside Grand Sierra Ballroom

6:00 pm – 8:30 pm   **Welcome Reception**
Montagna Restaurant & Decks

Tuesday, June 28, 2011

7:00 am – 4:00 pm   **Registration Open**
Outside Grand Sierra Ballroom

7:00 am – 8:30 am   **Breakfast Buffet**
Outside Grand Sierra Ballroom

8:30 am – 9:30 am   **NISSAN DISTINGUISHED KEYNOTE LECTURE**
Grand Sierra Ballroom A&B

Road Deaths and the Next U.S. Presidential Election (01)
Professor Donald Redelmeier
University of Toronto, *Canada*

9:30 am – 10:00 am   **BREAK**

Session 1 – Lectures
Driver Support Systems
10:00 am – 11:30 am
Grand Sierra Ballroom A&B

<u>Session Chair</u>: Maria Rimini-Doering

10:00 am   **Fully-Automated Driving: The Road to Future Vehicles (02)**
A. Hamish Jamson, Natasha Merat, Oliver Carsten, Frank Lai (University of Leeds – *UK*)

10:20 am   **Assessing Driver Behavioral Adaptation to a Rural Intersection Driver Support System (03)**
Michael Manser, Janet Creaser (HumanFIRST, University of Minnesota)

10:40 am   **Serialization of Vehicle Control at Intersections in Older Drivers (04)**
Erwin Boer (Entropy Control, Inc.), Diane Cleij (Delft University of Technology – *The Netherlands*), Jeffrey Dawson, Matthew Rizzo (University of Iowa)

11:00 am   **A Look in the (Driver's) Mirror: Use of Portable Electronic Devices While Driving by the Driver Safety Research Community (05)**
Neil Lerner, Emanuel Robinson (Westat)

11:30 am – 1:30 pm   **HONDA LUNCHEON & OUTSTANDING STUDENT PAPER AWARDS CEREMONY**
Sun Plaza Deck

Sponsored by
Honda R&D Americas, Inc.

Awards presented by
Mr. Charles Allen
Senior Vice President & General Manager
Honda R&D Americas, Inc.

The Honda Outstanding Student Paper Award winners will be announced at the luncheon

Session 2 – Lectures
Fatigue & Impairment
1:30 pm – 3:00 pm
Grand Sierra Ballroom A&B

<u>Session Chair:</u> Richard Young

1:30 pm   **Assessing Drivers' Fatigue State Under Real Traffic Conditions Using EEG Alpha Spindles (06)**
Michael Schrauf (Daimler AG; University of Regensburg – *Germany*), Michael Simon (University of Tübingen – *Germany*), Eike Schmidt (Bundesanstalt für Straßenwesen – *Germany*), Wilhelm Kincses (Daimler AG – *Germany*)

1:50 pm   **Microsleep Episodes and Related Crashes During Overnight Driving Simulations (07)**
Martin Golz (University of Applied Sciences Schmalkalden; Institute for System Analysis and Applied Numerics – *Germany*), David Sommer (University of Applied Sciences Schmalkalden – *Germany*), Jarek Krajewski (University of Wuppertal – *Germany*), Udo Trutschel (Circadian Technologies, Inc.; Institute for System Analysis and Applied Numerics – *Germany*), Dave Edwards (Caterpillar, Inc.)

2:10 pm   **Lateral Control in a Driving Simulator: Correlations with Neuropsychological Tests and On-Road Safety Errors (08)**
Amy Johnson, Jeffrey Dawson, Matthew Rizzo (University of Iowa)

2:30 pm   **Dexamphetamine and Alcohol Effects in Simulated Driving and Cognitive Task Performance (09)**
Marieke Martens, Ries Simons (TNO Human Factors – *The Netherlands*), Jan Ramaekers (University of Maastricht – *The Netherlands*)

Session 3 – Poster Session A
3:00 pm – 4:30 pm
Grand Sierra Ballroom C&D

Effects of Scheduling on Sleep and Performance in Commercial Motorcoach Operations (10)
Lora Wu, Gregory Belenky (Washington State University)

The Influence of Passenger-Driver Interaction on Young Drivers (11) Ryan Toxopeus, Robert Ramkhalawansingh, Lana Trick (University of Guelph – *Canada*)

Allocating Visual Attention: How Relevance to Driving Impacts Attention when Drivers are Distracted (12) Teena Garrison (Mississippi State University)

Self-Rated Distress Related to Medical Conditions is Associated with Future Crashes or Traffic Offences in Older Drivers (13) Petra Hoggarth (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury – *New Zealand*), Carrie Innes (Van der Veer Institute for Parkinson's & Brain Research; Christchurch Hospital – *New Zealand*), John Dalrymple-Alford (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury; University of Otago – *New Zealand*), Richard Jones (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury; Christchurch Hospital; University of Otago – *New Zealand*)

Impact of Cognitive Workload on Physiological Arousal and Performance in Younger and Older Drivers (14) Joonwoo Son (Daegu Gyeongbuk Institute of Science & Technology – *South Korea*), Bruce Mehler (Massachusetts Institute of Technology [MIT] AgeLab; New England University Transportation Center [UTC]), Taeyoung Lee, Yunsuk Park (Daegu Gyeongbuk Institute of Science & Technology – *South Korea*), Joseph Coughlin, Bryan Reimer (MIT AgeLab; New England UTC)

Making Auditory Warning Signals Informative: Examining the Acceptance of Auditory Icons as Warning Signals in Trucks (15) Johan Fagerlönn (Interactive Institute, Sonic Studio – *Sweden*)

Exploring Factors that Influence Vehicle Purchase Decisions of Older Drivers: Where Does Safety Fit? (16) Jenny Zhan, Brenda Vrkljan (McMaster University – *Canada*)

The Development of a Cognitive Skills Training to Support Driver Education: Experimental Validation of Theoretical Underpinnings (17) Tibor Petzoldt, Thomas Weiß, Josef Krems, Maria Bannert (Chemnitz University of Technology – *Germany*)

A Schema of Possible Negative Effects of Advanced Driver Assistant Systems (18)
Angela Mahr, Christian Müller (German Research Center for Artificial Intelligence – *Germany*)

Subjective Data Regarding Changes in Geometric Field of View During a Speed-Matching Task (19) Richard Goodenough, Johnell Brooks (Clemson University), Douglas Evans (DriveSafety, Inc.)

Driver Opinions of Simulator-Based Commercial Driver Training (20) Justin Morgan, Scott Tidwell, Myra Blanco, Alejandra Medina, Richard Hanowski (Virginia Tech Transportation Institute), Olu Ajayi (Federal Motor Carrier Safety Administration)

An Analysis of Driver Reactions to Tire Failures Simulated with the National Advanced Driving Simulator (NADS) (21) Robert Rucoba, Lee Carr, Robert Liebbe, Amanda Duran (Carr Engineering, Inc.)

Attentional Tracking of Multiple Vehicles in a Highway Driving Scenario (22) Martin Lochner, Lana Trick (University of Guelph – *Canada*)

Potential Benefits of a Concurrent Verbal Task when Feeling Fatigued Due to Monotonous Driving Conditions (23) Mark Chan, Paul Atchley (University of Kansas)

Developing a Driver-Centric Roadway Classification System with Multidimensional Scaling (24) Stacy Balk, Vaughan Inman, William Perez (Science Applications International Corporation)

Driving with Para-Central Visual Field Loss: Pilot Study (25) Matt Bronstad, Alex Bowers, Amanda Albu, Robert Goldstein, Eli Peli (Schepens Eye Research Institute, Harvard Medical School)

PERCLOS: An Alertness Measure of the Past (26) Udo Trutschel, Bill Sirois (Circadian Technologies, Inc.), David Sommer, Martin Golz (University of Applied Sciences Schmalkalden – *Germany*), Dave Edwards (Caterpillar, Inc.)

The Effect of Visual Clutter on Driver Eye Glance Behavior (27) William Perez, Mary Anne Bertola (Science Applications International Corporation)

Long-Term Effects of Hazard Anticipation Training on Novice Drivers Measured on the Open Road (28) Thalia Taylor, Kathleen Masserang (University of Massachusetts, Amherst), Anuj Pradhan (National Institute of Child Health and Human Development), Gautam Divekar, Siby Samuel, Jeffrey Muttart, Alexander Pollatsek, Donald Fisher (University of Massachusetts, Amherst)

Investigating HUDs for the Presentation of Choice Lists in Car Navigation Systems (29) Garrett Weinberg, Bret Harsham (Mitsubishi Electric Research Labs), Zeljko Medenica (University of New Hampshire)

Detecting Transfer of Training Through Simulator Scenario Design: A Novice Driver Training Study (30) Wade Allen, George Park, Scott Terrace, John Grant (Systems Technology, Inc.)

Cognitive and Psychomotor Correlates of Hazard Perception Ability and Risky Driving (31) Nebi Sümer (Middle East Technical University – *Turkey*)

Attention Factors Compared to Other Predictors of Simulated Driving Performance Across Age Groups (32) Richard Backs, Stephanie Tuttle, Davis Conley, Jr., Nicholas Cassavaugh (Central Michigan University)

A Driving Simulator Study to Examine the Role of Vehicle Acoustics on Drivers' Speed Perception (33) Natasha Merat, Hamish Jamson (University of Leeds – *UK)*

Driver Fitness in Patients with Cognitive Impairment and Glaucoma (34) Peter Rosen (University of California, San Diego; DrivingLab, LLC), Abiodun Akinwuntan, Jerry Wachtel (DrivingLab, LLC), Erwin Boer, Robert Weinreb, Felipe Medeiros (University of California, San Diego)

The United States Version of the Stroke Drivers' Screening Assessment Battery: A Report of Preliminary Findings (35) Abiodun Akinwuntan, Diana Gantt, Gina Gibson, Kurt Kimmons, Valerie Ross (Georgia Health Sciences University), Peter Rosen (Sharp Rees-Stealy Medical Group; University of California, San Diego), Jerry Wachtel (Veridian Group, Inc.)

<u>Wednesday, June 29, 2011</u>

7:00 am – 4:00 pm   **Registration Open**
Outside Grand Sierra Ballroom

7:00 am – 8:30 am   **Breakfast Buffet**
Outside Grand Sierra Ballroom

Session 4 – Lectures
Neurological Impairment & Fitness to Drive
8:30 am – 10:00 am
Grand Sierra Ballroom A&B

Session Chair: Tom Marcotte

8:30 am   **Driver Rehabilitation in Parkinson's Disease Using a Driving Simulator: A Pilot Study (36)**
Ergun Uc (University of Iowa; Veterans Affairs Medical Center of Iowa City), Matthew Rizzo, Steven Anderson, Jessica Lawrence, Jeffrey Dawson (University of Iowa)

8:50 am   **Longitudinal Two-Year Follow-Up of Updating and Flexibility Functions in Drivers with Parkinson's Disease: Preliminary Results (37)**
Maud Ranchet, Laurence Paire-Ficout (French Institute of Science and Technology for Transport, Development and Networks [IFSTTAR – INRETS], LESCOT; Université de Lyon – *France*), Emmanuel Broussolle (Université Lyon I; Centre de Neurosciences Cognitives [CNRS] – *France*)

9:10 am   **Using In-Vehicle Devices to Examine Exposure and Patterns in Drivers with Parkinson's Disease Compared to an Age-Matched Control Group (38)**
Alex Crizzle, Anita Myers (University of Waterloo – *Canada*), Brenda Vrkljan (McMaster University – *Canada*), Quincy Almeida (Wilfrid Laurier University – *Canada*)

9:30 am   **Translating Laboratory Measures to Real-World Outcomes: Application of the UFOV® Test in an Insurance Company Setting (39)**
Lesley Ross, David Vance, Karlene Ball, Leslie Cak, Michelle Ackerman, David Benz, David Ball (University of Alabama, Birmingham)

10:00 am – 10:30 am   **BREAK**

Session 5 – Lectures
Crash Risk & Driver Behavior
10:30 am – noon
Grand Sierra Ballroom A&B

Session Chair: James Foley

10:30 am   **Effect of Feedback on Performance in the Lane-Change Test (40)**
Vera Berthon-Donk, Marc Grosjean, Gerhard Rinkenauer (Leibniz Research Centre for Working Environment and Human Factors – *Germany*)

10:50 am   **Psychiatric Disorders and Driver Safety: A Systematic Review (41)**
Jessica Williams, Stephen Tregear, Arit Amana (MANILA Consulting Group, Inc.)

11:10 am	**Evaluation of Motorcycle Conspicuity in a Car DRL Environment (42)**
Viola Cavallo, Maria Pinto (French Institute of Science and Technology for Transport, Development and Networks [IFSTTAR – INRETS], LPC – *France*)

11:30 am	**Driving Consistency Errors Overestimate Crash Risk from Cellular Conversation in Two Case-Crossover Studies (43)**
Richard Young (Wayne State University)

12:00 pm – 1:30 pm	**LUNCH**
Alpine Ballroom

12:30 pm – 1:15 pm	**TOYOTA KEYNOTE LUNCHEON SPEAKER**
Alpine Ballroom

Driving by the Seat of Your Pants! A Multisensory Approach to Capturing Driver Attention (44)
Professor Charles Spence
University of Oxford, *UK*

Session 6 – Lectures
Attention & Distraction
1:30 pm – 3:00 pm
Grand Sierra Ballroom A&B

Session Chair:	Eric Traube

1:30 pm	**Dynamic Attention as a Predictor of Driving Performance in Clinical Populations: Preliminary Results (45)**
Alex Bowers, Julius Anastasio (Schepens Eye Research Institute, Harvard Medical School), Piers Howe (University of Melbourne – *Australia*), Margaret O'Connor, Ann Hollis, Lissa Kapust (Beth Israel Deaconess Medical Center), Matt Bronstad (Schepens Eye Research Institute, Harvard Medical School), Todd Horowitz (Brigham & Women's Hospital, Harvard Medical School)

1:50 pm	**Age-Related Limits of 3D Spatial Attention in Dual-Task Driving (46)**
Russell Pierce, Zheng Bian, George Andersen (University of California, Riverside)

2:10 pm	**How Do Task Structure and Uncertainty Influence Task-Interleaving Strategies During Distracted Driving? (47)**
David Kidd (George Mason University)

2:30 pm	**Exploring the Influence of Light and Cognitive Load on Pupil Diameter in Driving Simulator Studies (48)**
Oskar Palinko, Andrew Kun (University of New Hampshire)

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Session 7 – Poster Session B
3:00 pm – 4:30 pm
Grand Sierra Ballroom C&D

Evaluating Changes in the Driving Behavior of Young Drivers a Few Years After Licensure Using In-Vehicle Data Recorders (49) Gila Albert (Holon Institute of Technology – *Israel*), Oren Musicant (Tel-Aviv University – *Israel*), Tsippy Lotan (Or Yarok – *Israel*), Tomer Toledo (Technion-Israel Institute of Technology – *Israel*), Einat Grimberg (Or Yarok – *Israel*)

How Missing a Treatment of Mixed Amphetamine Salts Extended Release Affects Performance in Teen Drivers with ADHD (50) Lana Trick (University of Guelph – *Canada*), Grazyna Jackiewicz (McMaster University – *Canada*)

On-Road Driving Assessment Errors Associated with Pass and Fail Outcomes for Older Drivers with Cognitive Impairment (51) Petra Hoggarth (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury – *New Zealand*), Carrie Innes (Van der Veer Institute for Parkinson's & Brain Research; Christchurch Hospital – *New Zealand*), John Dalrymple-Alford (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury; University of Otago – *New Zealand*), Richard Jones (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury; Christchurch Hospital; University of Otago – *New Zealand*)

Effect of Driving Simulation Parameters Related to Ego-Motion on Speed Perception (52) Shaun Durkee, Nicholas Ward (Western Transportation Institute, Montana State University)

Fast Microsleep and Yawning Detections to Assess Driver's Vigilance Level (53) Nawal Alioua (Mohammed V-Agdal University – *Morocco*), Aouatif Amine (Mohammed V-Agdal University; Ibn Tofail University – *Morocco*), Mohammed Rziza, Driss Aboutajdine (Mohammed V-Agdal University – *Morocco*)

Influence of Headlight Design on Sensory Conspicuity of Powered Two-Wheelers (54) Maria Pinto, Viola Cavallo (French Institute of Science and Technology for Transport, Development and Networks [IFSTTAR – INRETS], LPC – *France*)

Exploring Older Driver Lateral Head Rotations at Intersections Using Naturalistic Driving Data (55) Jon Antin, Brian Wotring (Virginia Tech Transportation Institute), James Foley (Toyota Technical Center)

Developing Driving Task Scenarios for Developmentally Tailored Driving Assessments: Using an Evidence-Centered Design Model (56) Erik Roelofs, Marieke van Onna (Cito, National Institute for Educational Measurement – *The Netherlands*), Karel Brookhuis (Delft University of Technology; University of Groningen – *The Netherlands*)

Encouraging Environmentally Friendly Driving Through Driver Assistance: The eCo Move Project (57) Nicola Fricke, Caroline Schießl (German Aerospace Center [DLR] – *Germany*)

On-Road Evaluation of Destination Entry and Wayfinding Tasks: Comparisons Against Normal Driving (58) Miguel Perez, Derek Viita, Jonathan Hankey (Virginia Tech Transportation Institute), Sherri Voran-Nowak, Steven Tengler (OnStar Corporation)

Cognitive, Perceptual and Motor Decline as Predictors of Risky Street-Crossing Decisions in Older Pedestrians (59) Sabine Langevin, Aurèlie Dommes, Viola Cavallo (French Institute of Science and Technology for Transport, Development and Networks [IFSTTAR – INRETS], LPC – *France*), Jennifer Oxley (MUARC, Monash University Sunway Campus – *Malaysia*), Fabrice Vienne (IFSTTAR – INRETS, LEPSIS – *France*)

Use of a Simulator to Objectively Distinguish Behaviors Between Low-Risk and High-Risk Drivers (60) Yi-Ching Lee (Children's Hospital of Philadelphia), Noelle LaVoie, Ursula Lauper (Parallel Consulting), Anna Cianciolo (Command Performance Research)

Texting While Driving: Evaluation of Glance Distributions for Frequent/Infrequent Texters and Keypad/Touchpad Texters (61) Siby Samuel, Alexander Pollatsek, Donald Fisher (University of Massachusetts, Amherst)

The Impact of Distraction on an Intersection Crossing Assist System (62) Ensar Becic, Christopher Drucker, Michael Manser, Max Donath (University of Minnesota)

Revisiting Driver Behavior at Unsignalized Intersections: Time of Day Implications for Two-Way Left Turn Lanes (TWLTL) (63) Sahar Nabaee, Derek Moore, David Hurwitz (Oregon State University)

Aging and Steering Control Under Reduced Visibility Conditions (64) Bobby Nguyen (Wichita State University), Yan Zhuo (Institute of Biophysics, Chinese Academy of Sciences – *China*), Rui Ni (Wichita State University)

Driving Performance of Drug-Impaired Bus Drivers in Work Zone Areas (65) Chris Deits, Linda Boyle (University of Washington), John Morrison (Cahill Swift, LLC)

Influence of Riding Experience on Glance Behavior, Brake Response Time and Deceleration Rates by Drivers and Motorcyclists (66) Jeffrey Muttart, Donald Fisher (University of Massachusetts, Amherst), Chris Kauderer (Kauderer & Associates), Wade Bartlett (Mechanical Forensic Engineering Services), Louis Peck (SD Lyons, Inc.), Steve Guderian (San Francisco Municipal Transportation Authority & Motorcycle Safety Consulting), Lisa Ton, Matthew Muttart (Crash Safety Solutions, LLC)

The Effects of Route Guidance on Spatial Learning (67) Yi-Fang Tsai, Matthew Peterson (George Mason University)

Asymmetric Properties of Heart Rate Variability to Assess Operator Fatigue (68) Christian Heinze (University of Applied Sciences Schmalkalden – *Germany*), Udo Trutschel (Circadian Technologies, Inc.), Dave Edwards (Caterpillar, Inc.), Bill Sirois (Circadian Technologies, Inc.), Martin Golz (University of Applied Sciences Schmalkalden – *Germany*)

Withdrawn **(69)**

Effects of Concurrent Continuous Visual Feedback on Learning the Lane Keeping Task (70) Peter van Leeuwen, Stefan de Groot, Riender Happee, Joost de Winter (Delft University of Technology – *The Netherlands*)

Use of Instrumented Motorcycle to Measure the Effectiveness of Malaysian Rider Training: A Pilot Study (71) Mohd Khairul Alhapiz Ibrahim, Mohd Faudzi Mohd Yusoff (Malaysian Institute of Road Safety Research [MIROS] – *Malaysia*)

*Paper 80 will be presented in this poster session

Wednesday, June 29, 2011

4:45 pm – 10:30 pm	**M.S. DIXIE II – DINNER CRUISE** Zephyr Cove	
	4:45 pm – 5:15 pm	**Depart Squaw Creek** by shuttle bus Squaw Creek Resort Lobby *Maps provided if you prefer to drive*
	6:30 pm – 9:30 pm	**Social Hour** (cash bar)
	7:10 pm & 8:10 pm	**Dinner seatings**
	9:30 pm	**Depart M.S. Dixie II** by shuttle bus
	10:30 pm (approx.)	**Return to Squaw Creek**

Thursday, June 30, 2011

7:00 am – 1:00 pm	**Registration Open** Outside Grand Sierra Ballroom
7:00 am – 8:30 am	**Breakfast Buffet** Outside Grand Sierra Ballroom

Session 8 – Hybrid Presentations
8:30 am – 10:00 am
Grand Sierra Ballroom A&B

Session Chair: Hamish Jamson

An Autonomous Intelligent Driving Simulation Tutor for Driver Training and Remediation: A Concept Paper (72) Matthew Romoser (University of Massachusetts, Amherst)

Eye Movement Patterns and Driving Performance (73) Zheng Bian, Russell Pierce, George Andersen (University of California, Riverside)

The Accuracy of Drivers' Judgments of the Effects of Headlight Glare: Are We Really Blinded by the Light? (74) Stacy Balk, Richard Tyrrell (Clemson University)

Integrating Kinematic- and Vision-Based Information to Better Understand Driving Behaviour (75) Oren Musicant (Tel-Aviv University – *Israel*), Tomer Toledo (Technion–Israel Institute of Technology – *Israel*), Tsippy Lotan, Einat Grimberg, Dov Ganor (Or Yarok – *Israel*)

Perception of Approaching Motorcycles by Distracted Drivers May Depend on Auxiliary Lighting Treatments: A Field Experiment (76) James Jenness, Richard Huey, Shawn McCloskey, Jeremiah Singer, Jeremy Walrath, Elisha Lubar, Neil Lerner (Westat)

A Simulator Comparison of Riding Performance Between New, Returned and Continuing Motorcycle Riders (77) Mark Symmons, Christine Mulvihill (Monash University – *Australia*)

Inhibitory Control and Reward Predict Risky Driving in Young Novice Drivers: A Simulator Study (78) Ellen Jongen (Transportation Research Institute [IMOB], Hasselt University – *Belgium*), Kris Brijs (IMOB, Hasselt University; XIOS University College – *Belgium*), Marcell Komlos, Tom Brijs, Geert Wets (IMOB, Hasselt University – *Belgium*)

Traumatic Brain Injury and Driver Safety: A Systematic Review (79) Stephen Tregear, Jessica Williams, Damilola Funmilayo (MANILA Consulting Group, Inc.)

Effectiveness of an Intersection Violation Warning System (80) Dawn Marshall, Robert Wallace, James Torner, Michelle Birt-Leeds (University of Iowa) *Note: this paper will be presented in Poster Session B*

Assessing the Transfer of Simulator Trained Skills to Real Vehicle Control (81) Barry Coutermarsh, Kelley MacDonald, Sally Shoop (U.S. Army Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory)

Effects of Familiarity and Age on Driver Safety Errors During Wayfinding (82) Katherine Read, Lixi Yu, Jamie Emerson, Jeffrey Dawson, Nazan Aksan, Matthew Rizzo (University of Iowa)

Systematic Analysis of Real-World Driving Behavior Following Focal Brain Lesions (83) Kelsey Thompson, Katherine Read, Steven Anderson, Matthew Rizzo (University of Iowa)

Assessing Drivers' Tailgating Behavior and the Effect of Advisory Signs in Mitigating Tailgating (84) Jyh-Hone Wang, Miao Song (University of Rhode Island)

A Comparison of Heart Rate and Heart Rate Variability Indices in Distinguishing Single-Task Driving and Driving Under Secondary Cognitive Workload (85) Bruce Mehler, Bryan Reimer, Ying Wang (Massachusetts Institute of Technology [MIT] AgeLab)

Driver Control Actions in High-Speed Circular Driving (86) Diomidis Katzourakis (Delft University of Technology – *The Netherlands*), Efstathios Velenis (Brunel University – *UK*), Riender Happee (Delft University of Technology – *The Netherlands*)

Effect of Driving Breaks and 34-hour Recovery Period on Motor Carrier Crash Odds (87) Kun-Feng Wu, Paul Jovanis (Pennsylvania State University)

10:00 am – 10:15 am   BREAK

Thursday, June 30, 2011

Session 9 – Lectures
Perception & Decision Making
10:15 am – 11:45 am
Grand Sierra Ballroom A&B

Session Chair: Paul Green

10:15 am   Hazard Perception and Distraction in Novice Drivers: Effects of 12 Months Driving Experience (88)
Anuj Pradhan, Bruce Simons-Morton (National Institute of Child Health and Human Development), Suzanne Lee, Sheila Klauer (Virginia Tech Transportation Institute)

10:35 am   The Effect of Age and Gender on Visual Search During Lane Changing (89)
Martin Lavallière (Massachusetts Institute of Technology [MIT] AgeLab; Université Laval – *Canada*; Centre de recherche FRSQ du CHA Universitaire de Québec – *Canada*), Bryan Reimer, Bruce Mehler, Lisa D'Ambrosio, Ying Wang (MIT AgeLab), Normand Teasdale (Université Laval; Centre de recherche FRSQ du CHA Universitaire de Québec – *Canada*), Joseph Coughlin (MIT AgeLab)

10:55 am   Developing a North American Static Hazard Perception Test (90)
John Lyon, David Borkenhagen, Charles Scialfa, Micheline Deschênes, Mark Horswill (University of Calgary – *Canada*)

11:15 am   The Effect of Traffic Complexity and Speed on Young and Elderly Pedestrians' Street-Crossing Decisions (91)
Aurèlie Dommes, Sabine Langevin, Viola Cavallo (French Institute of Science and Technology for Transport, Development and Networks [IFSTTAR – INRETS], LPC – *France*), Jennifer Oxley (MUARC, Monash University Sunway Campus – *Malaysia*), Fabrice Vienne (IFSTTAR – INRETS, LEPSIS – *France*)

11:45 am   Conference Program Wrap-Up
Grand Sierra Ballroom A&B

12:00 pm – 1:30 pm   Box Lunch
Outside Grand Sierra Ballroom

12:15 pm – 1:00 pm   SHRP2 – UPDATE & RESEARCH OPPORTUNITIES
Grand Sierra Ballroom A&B

Professor Joanne Harbluk
SHRP2-TCC and Chair
Data Access Committee

Summaries

*Please note: Summaries have been edited for space and clarity. The conference proceedings will contain final papers.

(01) *NISSAN DISTINGUISHED KEYNOTE LECTURE:* **Road Deaths and the Next U.S. Presidential Election**
Donald Redelmeier (University of Toronto – *Canada*)

The US presidential electoral process is remarkable for widespread spending, attention, conflict, and rhetoric. Whether the process has an immediate effect on public health has never been tested. Moreover, such a possibility rarely receives consideration when evaluating voter turnout statistics ranging around 50-60% of eligible Americans. We studied all US presidential elections for the last 32 years, beginning with Carter in 1976 and ending with Obama in 2008. For each election, we analyzed the national registry of fatal crashes in the US, along with the Tuesday immediately before and after to calculate expected numbers of individuals in fatal crashes for the nation at the time. Our main finding was that the average election leads to a 19% increase in the risk of a fatal crash during the hours of polling. This equaled about 24 people per election; was remarkably consistent across different ages and locations; and greatly exceeded the risk on New Year's Eve, Super Bowl Sunday, or the chance of casting a pivotal vote. We conclude that efforts to mobilize the population, along with America's reliance on motor vehicles, results in increased fatal crashes during US presidential elections. We suggest more safety advocacy by electioneers who encourage people to vote. Perhaps the US president, when elected in the aftermath of fatal crashes, might also give more thought to the 100 lives lost each day from crashes in the United States.

(02) **Fully-Automated Driving: The Road to Future Vehicles** A. Hamish Jamson, Natasha Merat, Oliver Carsten, Frank Lai (University of Leeds – *UK*)

The study investigated the impact of fully-automated vehicle control on driver behaviour, physiology and the uptake of secondary tasks in varying traffic conditions. Previous studies have indicated the potential ironies of such automation on fatigue, stress and situational awareness, but have also suggested potential benefits through enhanced safety, more efficient traffic flows and reduced driver workload. The research was undertaken in a high-fidelity driving simulator that allowed drivers to see, feel and hear the impact of the automated control. Independent factors of Drive Type (manual control, fully-automated) and Traffic Density (light, heavy) were manipulated in a repeated-measures experimental design. 49 drivers participated. Drivers experiencing full vehicle automation tended to refrain from behaviours, such as overtaking, that required them to temporarily retake manual control, accepting the resulting increase in journey time. Automation improved safety margins in car following, but this benefit was restricted only to conditions of light surrounding traffic. Automation also reduced heart rate and increased driver fatigue, the latter being mitigated somewhat by high traffic density. Furthermore, drivers became more heavily involved with in-vehicle entertainment than they were in manual driving, affording less visual attention to the road ahead. Drivers do appear happy to forgo their supervisory responsibilities in preference of a more entertaining automated drive. However, these responsibilities are taken more seriously as supervisory demand increases.

(03) **Assessing Driver Behavioral Adaptation to a Rural Intersection Driver Support System** Michael Manser, Janet Creaser (HumanFIRST, University of Minnesota)

Driver support systems have the potential to improve driving safety. However, most research only evaluates initial performance with the system and does not evaluate continued adaptation to the system to determine if the benefit continues or is negated by unintended use of the system. The efficacy of a previously evaluated rural intersection driver support system was examined in a simulated driving environment relative to system introduction, continued use, and potential positive transfer/carry over effects. Participants drove through a simulated rural intersection twelve times each day for a week with an intersection decision support system turned off during days one and five and turned on days two, three, and four. This experimental design allowed for an examination of the efficacy of the driver support system upon initial introduction, after continued use, and whether there were any carry-over effects. Results indicated drivers benefited from the rural intersection driver support system and that the benefit continued as exposure to the system continued. In addition, drivers continued to benefit from system use even after the system was no longer available. Results are discussed in terms of driver performance while using the system.

(04) **Serialization of Vehicle Control at Intersections in Older Drivers** Erwin Boer (Entropy Control, Inc.), Diane Cleij (Delft University of Technology – *The Netherlands*), Jeffrey Dawson, Matthew Rizzo (University of Iowa)

Negotiating intersections is a complex driving task that is particularly difficult for older drivers. This task requires accurate coordination of multiple driving subtasks, placing high demands on perception, attention and motor control that are known to decline with age. We analyzed intersection negotiation behavior in an instrumented vehicle and found striking differences in how drivers of different ages synchronize speed and heading control when turning right. The older drivers performed most of their steering while standing still instead of while accelerating as younger drivers do. This shift from parallel to serial control is a compensatory solution that drivers employ in response to age related decline in perception, cognition, and motor control abilities. Serialization of turning at an intersection reduces attentional demands largely by eliminating the need to switch attention between different driving sub-tasks.

(05) A Look in the (Driver's) Mirror: Use of Portable Electronic Devices While Driving by the Driver Safety Research Community Neil Lerner, Emanuel Robinson (Westat)

As the frequency and diversity of use of portable electronic devices by drivers has increased, so have the roadway safety concerns associated with such multitasking. It has been argued that the driving public needs to be better informed about the risks of multitasking, and if they were so informed, people would restrict such practices. Yet various surveys show that in general the public seems to recognize that the use of portable electronic devices while driving does impose significant risk. This study reports the results of a survey of highway and vehicle safety professionals, a group highly informed about the problem and often engaged in efforts on this very issue. It would be instructive to see how this group behaves in terms of its own portable electronic device use while driving. An internet survey was distributed to members of two prominent professional society technical groups in driver safety. The survey revealed substantial cell phone use while driving, moderate text messaging, and little engagement in such activities as social networking, internet browsing, or e-book reading. Members of this expert community actively provided guidance about portable electronic device use while driving to others, including children and teens, family, and friends.

(06) Assessing Drivers' Fatigue State Under Real Traffic Conditions Using EEG Alpha Spindles Michael Schrauf (Daimler AG; University of Regensburg – *Germany*), Michael Simon (University of Tübingen – *Germany*), Eike Schmidt (Bundesanstalt für Straßenwesen – *Germany*), Wilhelm Kincses (Daimler AG – *Germany*)

The effectiveness of EEG alpha spindles, defined by short narrowband bursts in the alpha band, as an objective measure for assessing driver fatigue under real driving conditions was examined using an algorithm for the identification of alpha spindles. The method is applied to data recorded under real traffic conditions and compared with the performance of the traditional EEG fatigue measure alpha band power. Statistical analysis revealed significant increases from the first to the last driving section of alpha band power; with larger effect sizes for the alpha spindle based measures. An increased level of fatigue for drop-outs, as compared to participants who did not abort the drive, was observed only by means of alpha spindle parameters. EEG alpha spindle parameters increase both fatigue detection sensitivity and specificity as compared to EEG alpha band power. It is demonstrated that alpha spindles are superior to EEG band power measures for assessing driver fatigue under real traffic conditions.

(07) Microsleep Episodes and Related Crashes During Overnight Driving Simulations Martin Golz (University of Applied Sciences Schmalkalden; Institute for System Analysis and Applied Numerics – *Germany*), David Sommer (University of Applied Sciences Schmalkalden – *Germany*), Jarek Krajewski (University of Wuppertal – *Germany*), Udo Trutschel (Circadian Technologies, Inc.; Institute for System Analysis and Applied Numerics – *Germany*), Dave Edwards (Caterpillar, Inc.)

Microsleep (MS) episodes and related crashes were studied in an overnight driving simulation study. A new definition of MS proposed recently was applied and the mean number as well as the mean length of MS was calculated. MS occurred much more frequently than crashes. Within all pre-crash intervals (length 1 minute) the percentage of MS was calculated. Results showed that there are numerous MS episodes before every crash. The mean length of MS was between 5 and 9 seconds and did not change significantly during the night. The mean MS percentage was high within pre-crash intervals (60-80%) and is a predictor for crashes.

(08) Lateral Control in a Driving Simulator: Correlations with Neuropsychological Tests and On-Road Safety Errors Amy Johnson, Jeffrey Dawson, Matthew Rizzo (University of Iowa)

Driving simulators provide precise information on vehicular position at high capture rates. To analyze such data, we have previously proposed a time series model that reduces lateral position data into several parameters for measuring lateral control, and have shown that these parameters can detect differences between neurologically impaired and healthy drivers (Dawson et al, 2010a). In this paper, we focus on the "re-centering" parameter of this model, and test whether the parameter estimates are associated with off-road neuropsychological tests and/or with on-road safety errors. We assessed such correlations in 127 neurologically healthy drivers, ages 40 to 89. We found that our re-centering parameter had significant correlations with five neuropsychological tests: Judgment of Line Orientation ($r = 0.38$), Block Design ($r = 0.27$), Contrast Sensitivity ($r = 0.31$), Near Visual Acuity ($r = -0.26$), and Grooved Pegboard ($r = -0.25$). We also found that our re-centering parameter was associated with on-road safety errors at stop signs ($r = -0.34$) and on-road safety errors during turns ($r = -0.22$). These results suggest that our re-centering parameter may be a useful tool for measuring and monitoring ability to maintain vehicular lateral control. As GPS-based technology continues to improve in precision and reliability to measure vehicular positioning, our time-series model may potentially be applied as an automated index of driver performance in real world settings that is sensitive to cognitive decline. This work was supported by NIH/NIA awards AG17177, AG15071, and NS044930, and by a scholarship from Nissan Motor Company.

(09) Dexamphetamine and Alcohol Effects in Simulated Driving and Cognitive Task Performance Marieke Martens, Ries Simons (TNO Human Factors – *The Netherlands*), Jan Ramaekers (University of Maastricht – *The Netherlands*)

This study assessed the effects of dexamphetamine with and without alcohol on simulated driving and cognitive tasks. 18 subjects participated in all 4 conditions: 10 mg dexamphetamine and 0.8g/kg alcohol, 10 mg dexamphetamine only, 0.8g/kg alcohol only, and a placebo control condition. A driving simulator was used to assess driving skills and risk taking on different road types. Cognitive performance was assessed using vigilance and divided attention tasks and subjects completed different rating scales. The main effects found were those of alcohol. This related to a larger standard deviation of lateral position,

shorter accepted gap time and distance, higher average and maximum driving speeds and more violations of speed limits. A higher percentage of subjects in the dexamphetamine + alcohol condition did not stop for the red traffic lights, or collided with a vehicle. Performance of vigilance and divided attention tasks was impaired in the alcohol condition and impaired to a lesser degree in the dexamphetamine + alcohol condition. The conclusions of this study are that the main effect of impaired driving was found in the effect of 0.8 g/kg alcohol dose at the control level and the maneuvering level. The amphetamine dose did not potentiate risk taking behaviour, but also did not overcome the negative effects of alcohol. The findings of the present study justify the conclusion that drivers using 0.8 g/kg alcohol, or the combination of dexamphetamine with alcohol, pose a considerable traffic safety risk.

(10) Effects of Scheduling on Sleep and Performance in Commercial Motorcoach Operations Lora Wu, Gregory Belenky (Washington State University)

Maintaining cognitive alertness during commercial motorcoach operations is important for drivers as they are responsible for preventing, detecting, and managing errors. Schedules that do not follow circadian and homeostatic sleep principles may contribute to fatigue related events and accidents. The Federal Motor Carrier Safety Administration (FMCSA) has hours-of-service (HOS) regulations in place that allow motorcoach operators to work backwardly rotating 18-23 hour duty cycles (a duty cycle being the sum of HOS mandated on and off duty periods), requiring progressively earlier start times. Such schedules do not allow for sufficient and appropriately placed rest periods, resulting in fatigue and decreased performance. This study will investigate the effect of scheduling on sleep and performance in motorcoach operators. We are collecting objective and subjective data on sleep and performance of motorcoach drivers working under the current HOS regulations to observe the prevalence of circadian friendly and mismatched schedules, and the impact work schedules have on sleep and performance. This article describes the study design and methodology.

(11) The Influence of Passenger-Driver Interaction on Young Drivers Ryan Toxopeus, Robert Ramkhalawansingh, Lana Trick (University of Guelph – *Canada*)

The mechanisms for young drivers being at increased risk of collision with peer aged passengers in the car are not well understood. Most studies infer a link between passenger distraction and the number of passengers, but a causal link has not been previously shown. A group of young drivers with their full Ontario, Canada G license were tested in a simulated driving environment in three conditions. The first condition involved a peer aged female passenger who asked the driver questions as they navigated a course. The second condition involved the same passenger sitting silently in the passenger seat while the driver navigated a course. The third condition involved the passenger being absent, and the driver was alone in the car while they navigated a course. Speed and way finding behaviours were found to deteriorate in the first condition compared to the other two, and standard deviation of lane position and reaction times were found to improve in the first condition compared to the other two, indicating that the drivers were moving their eyes around the environment less with conversation. This highlights the importance of reducing passenger distractions for younger drivers.

(12) Allocating Visual Attention: How Relevance to Driving Impacts Attention when Drivers are Distracted Teena Garrison (Mississippi State University)

Use of cell phones while driving, and safety implications thereof, has captured public and scientific interest. Previous research has shown that driver reactions and visual attention are impacted by cell phone use, even when a hands-free device is used. In addition to these effects, Strayer and colleagues also found lower recognition for items present in the driving environment when drivers were using a cellular phone than when not using the phone. Strayer and colleagues used recognition as their primary measure of attention. Relevance to driving may have an impact on how attention is allocated to the environment via eye movements, separate from the impact on recognition memory. The current project used a medium-fidelity driving simulator to extend previous research by investigating how attention is allocated across driving-relevant and -irrelevant objects in the environment. Driving-relevant objects consisted of signs and potential hazards. Driving-irrelevant objects were billboards. Eye movement patterns (primarily measured by number of gazes) were impacted by distraction, and the pattern of gazes also differed across relevance levels, with hazards receiving the most gazes, and signs receiving the fewest. When only considering driving-relevant objects (i.e., signs vs. hazards), the eye movement measures showed an interaction between distraction and relevance. Signs received fewer gazes when drivers were distracted, whereas there was no comparable decrease in gazes to hazards.

(13) Self-Rated Distress Related to Medical Conditions is Associated with Future Crashes or Traffic Offences in Older Drivers Petra Hoggarth (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury – *New Zealand*), Carrie Innes (Van der Veer Institute for Parkinson's & Brain Research; Christchurch Hospital – *New Zealand*), John Dalrymple-Alford (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury; University of Otago – *New Zealand*), Richard Jones (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury; Christchurch Hospital; University of Otago – *New Zealand*)

Ageing is associated with the development of medical conditions, both acute and chronic. The aim of this study was to determine whether medical factors were associated with subsequent self- and officially-reported crashes and traffic offences in a group of cognitively healthy older drivers. We surveyed medical conditions, medications taken for these conditions, and the amount of subjective distress associated with medical conditions in a group of 56 drivers aged 72-85 years for a period of 24 months. We also compared exposure to driving at baseline to the number of crashes or offences at 24 months. We found no relationship between the number of medical conditions or medications taken and whether a participant had a crash or

offence. However, those who reported more subjective distress associated with their condition/s were more likely to have a crash or offence during the study period. Drivers who had a crash or offence also had a higher mean driving exposure. However, there was no relationship between reported distress and driving exposure which indicates that these may be independent risk factors for experiencing a crash or traffic offence.

(14) Impact of Cognitive Workload on Physiological Arousal and Performance in Younger and Older Drivers
Joonwoo Son (Daegu Gyeongbuk Institute of Science & Technology – *South Korea*), Bruce Mehler (Massachusetts Institute of Technology [MIT] AgeLab; New England University Transportation Center [UTC]), Taeyoung Lee, Yunsuk Park (Daegu Gyeongbuk Institute of Science & Technology – *South Korea*), Joseph Coughlin, Bryan Reimer (MIT AgeLab; New England UTC)

Two groups, aged 25-35 and 60-69, engaged in 3 levels of a delayed auditory recall task while driving a simulated highway. Heart rate and skin conductance increased with each level of demand, demonstrating that these indices can correctly rank order cognitive workload. Effects were also observed on speed and SD of lane position, but they were subtle, nonlinear, and did not effectively differentiate. Patterns were quite consistent across age groups. These findings on the sensitivity of physiological measures replicate those from an on-road study using a similar protocol. Together, the results support the validity of using these physiological measures of workload in a simulated environment to model differences likely to be present under actual driving conditions.

(15) Making Auditory Warning Signals Informative: Examining the Acceptance of Auditory Icons as Warning Signals in Trucks Johan Fagerlönn (Interactive Institute, Sonic Studio – *Sweden*)

Auditory icons have the potential to enhance a driver's situation awareness, to reduce his or her visual load, and to improve his or her response time in an emergency situation. However, the level of acceptance of this type of auditory signal as a warning signal is not well understood. The present study was carried out to investigate truck drivers' initial acceptances of auditory icons as warnings. The drivers selected warning signals for a number of dangerous driving situations. A method that was based on subjective ratings was also used to assess the drivers' acceptances of the sounds and to gain a better understanding of the factors that influence the drivers' selections. The results showed that the level of acceptance can be very high, but it varied significantly among the auditory icons that were encountered in five driving situations. Perceived "usefulness" and "satisfaction" may be used to determine whether the drivers prefer an auditory icon in specific situations. However, the subjective ratings related to the satisfaction should be complemented with a deeper qualitative investigation when examining the acceptance of auditory icons as warnings.

(16) Exploring Factors that Influence Vehicle Purchase Decisions of Older Drivers: Where Does Safety Fit?
Jenny Zhan, Brenda Vrkljan (McMaster University – *Canada*)

Vehicle design features that enhance safety can mitigate older driver frailty and declines in ability. We have investigated the older driver's perception of vehicle safety and how this influences their vehicle purchase. Focus groups ($n = 27$) were conducted among drivers aged 70-90 in South-Western Ontario. Questions focused on participants' perceptions of vehicle safety and design, the vehicle purchasing process, and resources used therein. Participants emphasized the importance of a few standard safety features (e.g., seatbelt, reliable brakes) but de-emphasized the role of safety on their purchase decisions. Safety was superseded by other purchasing considerations, most notably price. Stressful dealer-buyer interactions and poor congruency of information created barriers. Purchasing aids for older drivers should be developed that speak to the spectrum of safety technologies and emphasize the relationship between safety and other design features on driving ability.

(17) The Development of a Cognitive Skills Training to Support Driver Education: Experimental Validation of Theoretical Underpinnings Tibor Petzoldt, Thomas Weiß, Josef Krems, Maria Bannert (Chemnitz University of Technology – *Germany*)

Crash numbers of novice drivers are, despite best efforts of all involved institutions, alarmingly high. One central explanation refers to deficits in cognitive skills such as hazard perception, which have a tremendous influence on accident involvement of younger drivers. Conventional forms of driver training have largely failed to build up skills that go beyond a rather descriptive knowledge of how to drive. Computer based trainings (CBTs) are assumed to provide new ways of tackling this problem. There are already CBTs available that address relevant issues and are presumed to be effective. However, their evaluations lack evidence for the superiority of the specific features of multimedia based interventions over other forms of training. This shortcoming, in addition to the fact that all available relevant CBTs have been developed within contexts that differs significantly from European conditions in terms of the "average" driving environment as well as the respective educational schemes, has prompted us to develop a new CBT that is intended to complement the existing driver training program by addressing critical cognitive skills. In a first step, we tested the CBTs theoretical validity by comparing the performance in the training itself between learner drivers and experienced drivers. The results show that experienced drivers achieve higher scores in the CBT. We conclude that our application does indeed address relevant cognitive skills that are associated with driving experience.

(18) A Schema of Possible Negative Effects of Advanced Driver Assistant Systems Angela Mahr, Christian Müller (German Research Center for Artificial Intelligence – *Germany*)

The purpose of Advanced Driver Assistance Systems (ADAS) is to enhance traffic safety and efficiency. ADAS can be considered as a (still incomplete) collection of systems and subsystems towards a fully automated highway system, such as autonomous cars. However, as many researchers argue, in assessing the benefits of ADAS it has to be taken into account that any gains in terms of security may be again reduced by the fact they affect the drivers' behavior. In this paper, we introduce a schema of possible negative effects of advanced driver assistant systems according to which consequences of a system failure largely depend on the magnitude of over-reliance. Based on that schema, we itemize hypotheses on possible behavioral effects of a specific ADAS type, namely local danger alerts.

(19) Subjective Data Regarding Changes in Geometric Field of View During a Speed-Matching Test
Richard Goodenough, Johnell Brooks (Clemson University), Douglas Evans (DriveSafety, Inc.)

One method to adjust speed perception in a driving simulator is to adjust the rendered, geometric field of view (GFOV); however, little is known regarding users' sensitivity to changing the GFOV. The current research examined 24 licensed drivers' subjective experience with changes in GFOV during a speed matching task when examining the relationship between speed estimate and GFOV in a small-footprint driving simulator. Following the completion of the speed-matching task, participants were asked three questions regarding (1) strategy used to match speed: "What strategies did you use to complete the speed matching task?"; (2) awareness of GFOV setting: "Did you notice any changes in the simulation at any time during the experiment?"; and (3) subjective accuracy: "How accurate do you think you were in performing the task on a one to ten scale, one being 'extremely inaccurate' and ten being 'extremely accurate'?" Results indicated participants were not (directly) aware of changes in the GFOV; some misattributed the change in GFOV to a change in the vehicle's acceleration rate. Furthermore, many participants' cited strategies that were later categorized as 'using optic flow' and, in general, were unsure about their accuracy in the task.

(20) Driver Opinions of Simulator-Based Commercial Driver Training Justin Morgan, Scott Tidwell, Myra Blanco, Alejandra Medina, Richard Hanowski (Virginia Tech Transportation Institute), Olu Ajayi (Federal Motor Carrier Safety Administration)

Simulator-based training provides the opportunity to train drivers in a potentially lower cost and safer environment than traditional, behind-the-wheel, training methods. Thus, many motor carriers have begun adopting simulators for use during in-house driver training. This report presents the result of focus groups with drivers who experienced truck simulator-based training at two large motor carriers. In general, drivers at both carriers had positive opinions of simulator-based training. Most suggestions to improve the program were directed towards modification of how the program was implemented and/or creating a more realistic simulation of the driving environment.

(21) An Analysis of Driver Reactions to Tire Failures Simulated with the National Advanced Driving Simulator (NADS) Robert Rucoba, Lee Carr, Robert Leibbe, Amanda Duran (Carr Engineering, Inc.)

Analyses of real-world tire tread belt detachment and/or sudden air loss events as well as vehicle testing of those events have been presented in scientific literature since the 1990's. These confirm that such tire failures are complex and semi-random events that produce numerous sensory feedback cues to real-world drivers. These analyses further demonstrate that vehicles representing a full spectrum of steering characteristics are typically controllable and are controlled by drivers both during and after the tire disablement event. In 2003, the National Highway Traffic Administration (NHTSA) sponsored a study using the National Advanced Driving Simulator (NADS) to evaluate the technical hypothesis that there is a correlation between vehicle linear range understeer gradient and the likelihood of control loss when subject drivers experience a simulated tread belt detachment. The NADS subjects "drove" three simulated "vehicles" with different understeer gradients in a simulated tread separation even. The study's authors reached conclusions regarding the drivers' ability to control the "vehicles" which were inconsistent with real-world research. This paper presents an analysis of the NADS study performed to identify possible causes of the conflicting results and provides commentary upon several deficiencies noted in the NADS vehicle/tire modeling and validation. A more comprehensive understanding of the reported driver reactions when viewed in light of real vehicle experiments, real-world data, and an understanding of the limitations of the simulations is provided.

(22) Attentional Tracking of Multiple Vehicles in a Highway Driving Scenario Martin Lochner, Lana Trick (University of Guelph – *Canada*)

In this paper we introduce a 'vehicle tracking' task, which tests the ability of a driver to track the location of multiple vehicles on the roadway. Based on the 'multiple object tracking' task (Pylyshyn & Storm, 1988), the vehicle tracking task presents the driver with an array of identical vehicles immediately in front of the subject vehicle. The task consists of three distinct stages: *encoding*, during which the target vehicles are indicated to the driver; *tracking*, during which all vehicles change lanes in a random order; and *report*, during which the participant indicates the final location of the target vehicles. Using this methodology, we test the accuracy with which university-aged drivers can track multiple vehicles in a 3-lane highway driving scenario. Our particular interest in this paper is how the ability to attend to multiple vehicles changes as task load increases.

(23) Potential Benefits of a Concurrent Verbal Task when Feeling Fatigued Due to Monotonous Driving Conditions
Mark Chan, Paul Atchley (University of Kansas)

Work by Atchley and Chan (2011) reported that engaging in a concurrent verbal task might serve to alleviate performance decrements in drivers when vigilance was low. Building on previous findings, the current study investigated the potential benefits of a concurrent verbal task when drivers were likely to be fatigued due to the extended duration and monotony of a driving task. Driver performance was studied under distracted and non-distracted conditions. Results indicated that strategically engaging in a concurrent verbal task led to improved driving performance when fatigue was at its highest.

(24) Developing a Driver-Centric Roadway Classification System with Multidimensional Scaling Stacy Balk, Vaughan Inman, William Perez (Science Applications International Corporation)

Various systems exist to classify roadway environments; however most do not consider driver-relevant perceptual components. A perceptually based roadway classification system has the potential to support the placement of signage (or removal of extraneous clutter) in the right-of-way as a means to enhance driver performance. The present study sought to determine which environmental factors are attended to by roadway users. Thirteen participants first rated the similarity of 14 roadway environments and then rated each environment on 5 different descriptors (built-up, clutter, openness, aesthetically pleasing, organized/predictable). The resultant data were analyzed using a methodology rarely taken advantage of in the field of transportation: Multidimensional Scaling (MDS). MDS revealed the participants relied on two primary dimensions when rating the similarity of the roadway environments. These two dimensions related closely with: 1) organization/predictability and 2) clutter and aesthetics. This methodology provides a simple way to gain access to drivers' perceptions of the roadway environment and appears to be a promising first step toward developing a user-focused roadway classification system.

(25) Driving with Para-Central Visual Field Loss: Pilot Study Matt Bronstad, Alex Bowers, Amanda Albu, Robert Goldstein, Eli Peli (Schepens Eye Research Institute, Harvard Medical School)

We studied how para-central visual field loss affects pedestrian detection in a driving simulator. Participants with para-central field loss had relatively good visual acuity (20/15 − 20/60) and 3 of 5 met local vision requirements for an unrestricted driver's license; however, they had lower detection rates and longer reaction times to pedestrians likely to appear within the blind area than in their seeing areas. They were at collision risk for 7% to 30% of pedestrians, whereas controls were at a collision risk for 0 to 4% of pedestrians.

(26) PERCLOS: An Alertness Measure of the Past Udo Trutschel, Bill Sirois (Circadian Technologies, Inc.), David Sommer, Martin Golz (University of Applied Sciences Schmalkalden – *Germany*), Dave Edwards (Caterpillar, Inc.)

The growing number of fatigue related accidents in recent years has become a serious concern. Accidents caused by fatigue, or more precisely impaired alertness, in transportation and in mining operations involving heavy equipment can lead to substantial damage and loss of life. Preventing such fatigue related accidents is universally desirable, but requires techniques for continuously estimating and predicting the operator's alertness state. PERCLOS (percentage of eye closure) was introduced as an alertness measure. Some years later, it was claimed to be superior in fatigue detection to any other measure, including the general Eye-Tracking Signal (ETS) and even EEG recordings. This study will show that this is not the case. To put things into the prospective a fair and objective comparison between PERCLOS, the general ETS and EEG/EOG has to be established. To achieve this purpose, a protocol was established to investigate the fatigue detection capabilities of PERCLOS, ETS, and EEG/EOG in a simple two class discrimination analysis using an ensemble of Learning Vector Quantization (LVQ) networks as a classification tool. Karolinska Sleepiness Scale (KSS) and Variation of Lane Deviation (VLD) were used in order to obtain independent class labels, whereas KSS provided subjective alertness labels while VLD provided objective alertness labels. The general ETS and the fused EEG/EOG measures contain substantially greater amounts of fatigue information than the PERCLOS measures alone. These conclusions were found to be valid for all three commercially available infrared video camera systems that were utilized in the study. The data utilized in the discrimination analysis were obtained from 16 young volunteers who participated in overnight experiments in the real car driving simulation lab at the University of Schmalkalden.

(27) The Effect of Visual Clutter on Driver Eye Glance Behavior William Perez, Mary Anne Bertola (Science Applications International Corporation)

Drivers' eye glance behavior was examined as they drove on a variety of roadways that varied in visual clutter and the presence or absence of advertising billboards. Eye glance behavior appeared to be more heavily influenced by the nature of the driving task than by the stimulus attributes along the roadside. The mean proportion of glances to the road ahead ranged between 0.80 and 0.87 across conditions. The lowest mean proportion of glances to the road ahead was seen in conditions of high visual clutter, which contained off-premise billboards. Under high levels of clutter, drivers directed more glances to the left and right side of the road than under conditions of low clutter. The longest mean glance durations away from the forward roadway were to the right side of the road (0.105 s) and not to billboards. Mean glances to billboards were 0.078 s and 0.087 s under low and high clutter environments, respectively. The results showed that level of visual clutter present in the highway environment affects how drivers glance at scenes. However, this did not appear to be at the expense of focusing on the forward roadway.

(28) Long-Term Effects of Hazard Anticipation Training on Novice Drivers Measured on the Open Road Thalia Taylor, Kathleen Masserang, (University of Massachusetts, Amherst), Anuj Pradhan (National Institute of Child Health and Human Development), Gautam Divekar, Siby Samuel, Jeffrey Muttart, Alexander Pollatsek, Donald Fisher (University of Massachusetts, Amherst)

The purpose of this study was to determine whether novice drivers that were trained to anticipate hazards did so better than novice drivers who were not so trained immediately after training and up to one year after training occurred. Novice drivers who had held their restricted license for about one month were randomly assigned to a PC-based hazard anticipation training program (RAPT) or a placebo (control) training program. The programs took about one hour to complete. The effects of training were assessed in a field drive by using patterns of eye movements to assess whether drivers anticipated a potential unseen hazard. The effects of training persisted over time. In the field test immediately after training, the RAPT group anticipated the hazards 65.8% of the time whereas; the control group anticipated them only 47.3% of the time. Six or more months later, the groups were brought back for a second field test and the effects of training did not diminish; the RAPT group anticipated the hazards 61.9% of the time compared to 37.7% for the control group.

(29) Investigating HUDs for the Presentation of Choice Lists in Car Navigation Systems Garrett Weinberg, Bret Harsham (Mitsubishi Electric Research Labs), Zeljko Medenica (University of New Hampshire)

It has been established that head-down displays (HDDs), such as those commonly placed in the dashboard of commercial automobiles, can draw drivers' attention away from the primary driving task (Bach et al., 2008). This problem can be exacerbated when screens are "busy" with graphics or rich information. In this paper, we present the results of a driving simulator-based user study where we examined two potential alternatives to HDDs for presenting textual lists. Subjects conducted a series of street name finding tasks using each of three system variants: one with a HDD, one with a head-up display (HUD), and one with only an auditory display. We found that the auditory display had the least impact on mental load, but at the expense of task completion efficiency. The HUD variant also had a low impact on mental load and scored highest in user satisfaction, and therefore appears to be the most viable target for future study.

(30) Detecting Transfer of Training Through Simulator Scenario Design: A Novice Driver Training Study Wade Allen, George Park, Scott Terrace, John Grant (Systems Technology, Inc.)

Novice drivers in comparison to experienced drivers perform poorly due to incomplete mental models of roadway hazards. This paper describes the driving simulator scenario design methods used in a novice driver training study to detect a possible transfer of training for hazard perception. Applied in a high school driver education classroom, the data of trained versus un-trained drivers is presented for pre/post-test driving scenarios, $N = 67$. Results showed that while general simulator control performance between the trained and un-trained groups was similar, the trained group performed better at hazard events and exhibited fewer speeding behaviors at the post-test. Specific hazard encounters indicated that simulator training may have had an effect on performance even when the training group was not trained on the specific situation. Arguments for training transfer in hazard perception are presented.

(31) Cognitive and Psychomotor Correlates of Hazard Perception Ability and Risky Driving Nebi Sümer (Middle East Technical University – *Turkey*)

Deficits in specific cognitive and psychomotor capacities, such as attention, reaction time, memory, and hand-eye coordination ability are associated with increased crash risk, especially among older drivers (e.g., Anstey et al., 2005). Higher-order cognitive processes are also closely linked with hazard perception skills (e.g., Groeger, 2000). Employing a large professional driver sample, this study examines cognitive and psychomotor correlates of driver hazard perception detection accuracy (HPDA) and risky driving. Professional drivers (N = 2541) who applied to psycho-technical driver assessment centers were administered a number of computer-based measures of hazard perception, monotonous and selective attention, reasoning, visual pursuit, visual perception, hand-eye coordination, and reaction time. They also completed a self-reported measure of aberrant driver behaviors and reported the accidents involved and violation tickets taken in last three years. Results showed that attention capacity and psychomotor abilities were consistently associated with HPDA. Regression analyses revealed that selective attention, reasoning ability, and visual pursuit were moderately strong predictors of HPDA. These variables, however, weakly but significantly predicted the indicators of risky driving including aberrant driving behaviors, road traffic accidents, and violation tickets. These results suggest that hazard perception skills mediate the link between specific cognitive/perceptual skills and risky driving. The findings underscore the role of higher-order perceptual and cognitive processes, especially selective attention and reasoning, underlying hazard perception ability and have implications for driver assessment, training, and cognitive demands for driving.

(32) Attention Factors Compared to Other Predictors of Simulated Driving Performance Across Age Groups Richard Backs, Stephanie Tuttle, Davis Conley, Jr., Nicholas Cassavaugh (Central Michigan University)

Groups of young, middle-aged, and older adults performed a battery of computer-based attention tasks, the UFOV® and neuropsychological tests, and simulated low-speed driving in a suburban scenario. Results from the attention tasks were submitted to Maximum Likelihood factor analysis and 6 factors were extracted that explained more than 57% of the task variance. The factors were labeled speed, switching, visual search, executive, sustained, and divided attention in descending order of amount of task variance explained. The factor scores were used to predict simulated driving performance. Step-wise regressions were computed with driving performance as the criterion, and age, sex and the factor scores, the UFOV® scores,

or the neuropsychological test scores as predictors. Results showed that the perceptual-motor speed and divided attention measures from the UFOV® and attention battery were more likely to explain driving performance variance than the neuropsychological tests.

(33) A Driving Simulator Study to Examine the Role of Vehicle Acoustics on Drivers' Speed Perception Natasha Merat, A. Hamish Jamson (University of Leeds – *UK)*

In recent years, there has been a desire by vehicle manufacturers to reduce the in-cab noise of vehicles, in order to improve driver comfort and enhance the enjoyment of in-vehicle entertainment systems. This reduction of in-cab noise is accompanied by policy initiatives to reduce transport related noise by implementing low noise road surfaces. However, it is not known how such reductions in the availability of auditory cues affect drivers' ability to judge speed, and there is a danger that drivers will increase their speed, to compensate for the absence of auditory cues. In this study, drivers were required to maintain speed at 30 and 70 mph, in the absence of a speedometer, with and without accompanying vehicle noise. Results showed that drivers' ability to maintain the correct speed profile was much more variable in the absence of accompanying vehicle noise and this variation was found to be higher when drivers were asked to travel at higher speeds of 70 mph. Drivers were also found to travel faster than the required speed in the absence of vehicle noise, although their ability to maintain speed was generally worse at 70 mph, even in the presence of auditory cues.

(34) Driver Fitness in Patients with Cognitive Impairment and Glaucoma Peter Rosen (University of California, San Diego; DrivingLab, LLC), Abiodun Akinwuntan, Jerry Wachtel (DrivingLab, LLC), Erwin Boer, Robert Weinreb, Felipe Medeiros (University of California, San Diego)

Recent evidence suggests a relationship between cognitive impairment and glaucoma. Whether impaired visual perception in glaucoma contributes to reduced cognitive function in patients with dementia, or cognitive impairment further limits visual perception due to optic nerve damage in glaucoma is unclear. One objective of this study was to see if there were significant differences on measures of perceptual, cognitive and driving performance between older drivers with cognitive impairment and/or glaucoma who still had good visual acuity. A second goal was to measure the strength of association between measures of visual, cognitive, and driving performance. 302 older drivers were classified as having glaucoma alone (n=69), cognitive impairment alone (n=41), both (n=21) or neither (n=171). All participants had good visual acuity, a valid driver's license and were still driving. Demographic, health status, driving accidents and clinical tests of vision and driving performance variables were analyzed using one-way ANOVAS and Pearson correlations. Across demographic, clinical and driving measures there were significant differences between those with cognitive impairment, with or without glaucoma, and controls. Subjects with glaucoma showed significant differences with controls on accidents, driving simulation tests of divided attention and car following delay. Driving simulator and UFOV measures were significantly correlated with self-reported accidents. Driving simulation is a valid way to evaluate task performance and may be a more sensitive and salient method of detecting the additive and/or interactive effects of glaucoma and cognitive impairment in older drivers than vision and neuropsychological tests alone.

(35) The United States Version of the Stroke Drivers' Screening Assessment Battery: A Report of Preliminary Findings Abiodun Akinwuntan, Diana Gantt, Gina Gibson, Kurt Kimmons, Valerie Ross (Georgia Health Sciences University), Peter Rosen (Sharp Rees-Stealy Medical Group; University of California, San Diego), Jerry Wachtel (Veridian Group, Inc.)

We investigated the potential for predicting driving performance of a United States (US)-based population of participants using an adapted version of the Stroke Drivers' Screening Assessment (SDSA) battery. Participants included seven first-ever stroke survivors (age 51±8 years) and 11 individuals with Hoehn & Yahr Stage 2 or 3 Parkinson's disease (PD) (age 65±8 years). We adapted the original United Kingdom (UK) version of the SDSA to make it suitable for use in the US by replacing all UK-specific traffic situations and road signs with their US equivalents. Following administration of the adapted (US) version of the SDSA, stroke participants' driving performance was evaluated in a driving simulator. PD participants' driving performance was evaluated in the driving simulator as well as on-road. The pass/fail SDSA equations of the original UK version of the SDSA were applied to predict the pass/fail outcome of participants' driving evaluation. The SDSA predicted stroke participants' simulator-based driving performance with 100% accuracy. The SDSA predicted PD participants' simulator-based performance with 73% accuracy and the on-road performance with 82% accuracy. The accuracy with which driving performance of stroke and PD participants in this preliminary study was predicted by the US version of the SDSA is promising and informs the need for a larger study to better investigate and validate its predictive accuracy.

(36) Driver Rehabilitation in Parkinson's Disease Using a Driving Simulator: A Pilot Study Ergun Uc (University of Iowa; Veterans Affairs Medical Center of Iowa City), Matthew Rizzo, Steven Anderson, Jessica Lawrence, Jeffrey Dawson (University of Iowa)

Parkinson's disease (PD) impairs driving performance. In this pilot study, four drivers with PD (selected based on poor road driving performance in the past) participated in a rehabilitation program using a driving simulator. Two different training drives (#1- multiple intersections of varying visibility and traffic load, where an incurring vehicle posed a crash risk, #2-various scenarios on decision making, hazard perception and response) were administered in each session (total 3 sessions once every 1-2 weeks) with immediate feedback after the drives. We observed reduction in crashes in drive #1 and improved scores on drive #2 in the simulator. In addition, 3 subjects showed marked improvements in their total error counts on a standard road test between baseline and post-training sessions, one subject stayed stable. These findings suggest that our simulator training program is feasible and potentially useful in impaired drivers with PD.

(37) Longitudinal Two-Year Follow-Up of Updating and Flexibility Functions in Drivers with Parkinson's Disease: Preliminary Results Maud Ranchet, Laurence Paire-Ficout (French Institute of Science and Technology for Transport, Development and Networks [IFSTTAR – INRETS], LESCOT; Université de Lyon – *France*), Emmanuel Broussolle (Université de Lyon; Centre de Neurosciences Cognitives [CNRS] – *France*)

This paper outlines the preliminary results of a longitudinal follow up at two years interval (t0 versus t2) in 10 drivers with mild to moderate Parkinson's disease (PD) and 10 matched controls. Changes of (1) driving habits assessed by a questionnaire, (2) neuropsychological performances measured by a set of cognitive tests and (3) cognitive abilities while driving using a simulator, were analyzed. Two types of changes were observed: the *decline over time* in PD group at two years interval and the *appearance of some deficits* in PD patients (compared to controls) at the second assessment (t2). These deficits were not observed at the first one (t0). The results showed that PD patients had changed their driving habits over time (reduction of mileage, more avoidance, underestimation of their own driving competency). The cognitive status of PD patients remained relatively stable over time, except for the Trail Making Test performances (part A and part B) which declined. A deficit for the TMT-part A in PD patients, compared to controls, appeared at t2. The data from driving simulator showed no significant decline in PD patients for both updating and flexibility performances. However, a deficit in flexibility appeared at t2 in PD patients, as demonstrated by their poorer performances on the flexibility cost. Our data suggest that flexibility may be significantly affected in PD patients with more advanced disease. The small size on our sample does not allow us any conclusion on updating function in both PD patients and controls.

(38) Using In-Vehicle Devices to Examine Exposure and Patterns in Drivers with Parkinson's Disease Compared to an Age-Matched Control Group Alex Crizzle, Anita Myers (University of Waterloo – *Canada*), Brenda Vrkljan (McMaster University – *Canada*), Quincy Almeida (Wilfrid Laurier University – *Canada*)

Symptoms associated with Parkinson's disease (PD), as well as medications, can influence safe driving. Some studies have shown that drivers with PD make more errors and may have more crashes. Although a few studies have suggested drivers with PD may self-regulate by reducing amount of driving and avoiding challenging situations, findings are based on self-report data. The purpose of this study was to objectively examine naturalistic driving exposure and patterns in drivers with PD compared to an age-matched group of healthy drivers using electronic, in-vehicle devices over a two week monitoring period. Compared to the controls, the PD group drove significantly less overall (number of trips, kilometres, duration), on weekends and at night. When adjusted for number of days of driving, the PD group still made fewer trips and drove proportionately less at night. This was the first study to examine the actual driving practices of a PD population using objective measures.

(39) Translating Laboratory Measures to Real-World Outcomes: Application of the UFOV® Test in an Insurance Company Setting Lesley Ross, David Vance, Karlene Ball, Leslie Cak, Michelle Ackerman, David Benz, David Ball (University of Alabama, Birmingham)

Poor performance on the Useful Field of View (UFOV® test) has been linked to negative driving outcomes, such as crashes. The UFOV® test was given to a sample of drivers 75+ years across the state of Alabama (N=2235) as a means of attaining a reduction in insurance rates if successful on the test. Results revealed that retrospectively, participants who failed the assessment were 1.65 times more likely to have an at-fault crash and 1.66 times more likely to have an at-fault insurance claim in the previous five years as compared to participants who passed the assessment. Prospectively, these same participants were 1.85 times more likely to have an at-fault crash and 2.73 times more likely to have an at-fault claim in the subsequent 1.29 years after assessment as compared to participants who passed the assessment. To the authors' knowledge, this is the first translational study to investigate the impact of offering an insurance discount for passing such an assessment on prospective at-fault crashes and at-fault insurance claims.

(40) Effect of Feedback on Performance in the Lane-Change Test Vera Berthon-Donk, Marc Grosjean, Gerhard Rinkenauer (Leibniz Research Centre for Working Environment and Human Factors – *Germany*)

The Lane-Change Test (LCT) is an easy-to-use methodological tool that has proven useful for researching dual-task driving situations. This paper examines the effect of feedback on LCT performance. Feedback is important for maintaining the focus of attention on the primary (driving) task and providing motivation for learning. An experiment was conducted in which two driver groups performed the LCT with or without end-of-block summary feedback. Results showed that the presence of feedback significantly improved performance, as revealed by lower overall means and lower standard deviations (with practice) of lateral deviation values. We conclude that feedback can have a positive effect on performance in the LCT and, therefore, it may be critical to include such feedback when using this, as well as similar tasks, to investigate dual-task driving situations.

(41) Psychiatric Disorders and Driver Safety: A Systematic Review Jessica Williams, Stephen Tregear, Arit Amana (MANILA Consulting Group, Inc.)

Driving is a complicated psychomotor performance that depends on the driver's ability to maintain effective and reliable control of his or her vehicle; respond to the road, traffic, and other external clues; and follow the "rules of the road". Psychiatric disorders may interfere with any of the aforementioned driving skills to a significant degree, resulting in impaired driving ability. A systematic review and meta-analysis was conducted to examine the relationship between psychiatric disorders and driver safety. The relationship between driver safety and four subgroups of psychiatric disorders was examined,

as well as the relationship between crash risk and personality disorder traits. Our results indicate that, while the possibility of an increased crash risk among drivers with psychiatric disorders cannot be ruled out, the evidence concerning crash risk for drivers with psychiatric disorders is inconclusive. Current evidence concerning crash risk among drivers with psychotic, mood, anxiety or personality disorders is inconclusive, although some evidence suggests that individuals with mood disorders are at increased risk for crash. The evidence also suggests an association between certain traits of patients with personality disorders (including aggression, hostility, impulsivity, disregard for law, and various psychological symptoms) and increased crash risk. These results underscore the necessity of more research in the area of psychiatric disorders and driver safety.

(42) Evaluation of Motorcycle Conspicuity in a Car DRL Environment Viola Cavallo, Maria Pinto (French Institute of Science and Technology for Transport, Development and Networks [IFSTTAR – INRETS], LPC – *France*)

Daytime Running Lights (DRL) on motorcycles have been shown to counteract the inherently lower sensory conspicuity of these vehicles and to significantly improve their safety. The advantage of the use of DRL exclusively by motorcycles is presently becoming lost by the increasing use of DRLs on cars. The present experiment aimed at evaluating the effects of car DRLs on motorcycle perception in a situation that specifically brought attentional conspicuity to bear. Photographs representing complex urban traffic scenes were displayed to 24 participants who were asked to detect vulnerable road users (motorcyclists, bicyclists, pedestrians) appearing at different locations and distances. Car DRLs noticeably hampered motorcycle perception compared to conditions where car lights were not on, especially when the motorcycle was at a greater distance from the observer and when it was located in the central part of the visual scene. Car DRLs were also detrimental to the perception of bicyclists and pedestrians. These findings suggest that more attention should be paid to motorcyclists and other vulnerable road users when introducing car DRLs. Several means of improving motorcycle conspicuity in car DRL environments are discussed.

(43) Driving Consistency Errors Overestimate Crash Risk from Cellular Conversation in Two Case-Crossover Studies Richard Young (Wayne State University)

The goal of this study is to help resolve the discrepancy in relative risk estimates between recent and early epidemiological studies of call-crash association. Recent epidemiological studies estimate a crash risk for cellular conversation near that of baseline driving – a relative risk of about one. In contrast, two early case-crossover studies estimated a relative crash risk of about four for cellular conversation while driving. One hypothesis to explain this four-fold discrepancy is that the early studies had less driving time in the control window on a day before the crash, than in the crash window just before the crash. This bias in driving exposure translated into relatively lower exposure to cellular conversation during control windows than during crash windows, thereby introducing an overestimate of the relative risk for cellular conversation while driving. To test this hypothesis, the present study developed a new *driving consistency index* (DCI), which measures the percentage overlap in driving times from one day to the next. The mean DCI for 240 vehicles in a Chicago GPS study with known driving times for two successive days was a surprisingly low 14.8%, substantially below the driving consistency estimates in the early case-crossover studies. After adjustment by the mean DCI, the relative risk estimates for cellular conversation while driving in the early case-crossover studies are about one, resolving the discrepancy with the more recent epidemiological studies.

(44) *TOYOTA KEYNOTE LUNCHEON SPEAKER:* **Driving by the Seat of Your Pants! A Multisensory Approach to Capturing Driver Attention** Charles Spence (University of Oxford – *UK*)

The increasing availability of complex in-vehicle technologies means that 'driver inattention' constitutes one of the leading causes of car accidents. The question therefore arises as to how best to alert 'distracted' drivers to potential road dangers. The latest laboratory and simulator-based studies from the Crossmodal Research Laboratory in Oxford detailing a novel brain-based approach to the design of auditory, tactile, and multisensory warnings signals. The talk will highlight research demonstrating the potential for improving driver behavior in potentially dangerous situations and so reducing the incidence of road traffic crashes that such multisensory warning signals offer. Results of recent studies showing that multisensory stimuli can capture the attention of the driver in the simulator (and the average participant in the psychology laboratory) far more effectively than unisensory stimuli will also be described. The importance of spatial co-location in multisensory warning signal design will also be discussed, as will new evidence regarding the potentially beneficial effects of presenting warning signals in near-rear peripersonal space (i.e., from the headrest) on drivers' head-turning responses.

(45) Dynamic Attention as a Predictor of Driving Performance in Clinical Populations: Preliminary Results Alex Bowers, Julius Anastasio (Schepens Eye Research Institute, Harvard Medical School), Piers Howe (University of Melbourne – *Australia*), Margaret O'Connor, Ann Hollis, Lissa Kapust (Beth Israel Deaconess Medical Center), Matt Bronstad (Schepens Eye Research Institute, Harvard Medical School), Todd Horowitz (Brigham & Women's Hospital, Harvard Medical School)

Existing tests (e.g., useful field of view; UFOV) that are commonly used to evaluate visual attention when predicting at-risk drivers do not have a dynamic component. In this project, we developed a brief computerized test of dynamic visual attention (multiple object tracking; MOT). Estimates of threshold tracking speed from the brief MOT test showed good agreement with those determined by a full psychometric function ($n = 41$, $r = 0.876$, $p < 0.001$). The brief MOT test was then implemented in a clinical driving assessment program; participants with poorer MOT scores had higher error scores on the road test ($n = 15$, $r = -0.670$, $p = 0.006$).

(46) Age-Related Limits of 3D Spatial Attention in Dual-Task Driving Russell Pierce, Zheng Bian, George Andersen (University of California, Riverside)

A previous experiment by Andersen, Ni, Bian and Kang (2010) examined the limits of 3D spatial attention in younger drivers. In the current experiment, we examined age-related differences in the extent of 3D spatial attention by assessing participants' ability to detect a light-change target in an array of lights over a simulated roadway while performing a car following task. We found that reaction time to light-change targets presented during a car following task varied as a function of distance and horizontal position in younger adults, but only a function of distance in older adults. That is, the breadth of spatial attention for older drivers is constant across various depths. However, the depth of spatial attention may be somewhat less for older drivers as they respond to targets far away at approximately the same speed as younger drivers do for the lights at the same distance in the most extreme horizontal position. The results of the present study suggest that tests to assess crash risk, such as the UFOV, are limited in scope because such tests fail to consider the variation in attention as a function of distance.

(47) How Do Task Structure and Uncertainty Influence Task-Interleaving Strategies During Distracted Driving? David Kidd (George Mason University)

During distracted driving, people commonly alternate or interleave attention between driving and another task. One factor that influences task interleaving is task structure. Specifically, people tend to switch between tasks at sub-tasks boundaries. Uncertainty about the roadway environment during glances away from the road, however, may play a larger role in shaping task interleaving strategies during distracted driving. The purpose of this study was to examine task interleaving strategies when drivers completed a distracting task of various sub-task sizes. Participants entered phone numbers, modified zip codes, or digit strings while performing a lane-keeping task. In general, the time between button presses in the secondary task was significantly greater between sub-tasks than within sub-tasks. However, as sub-tasks became larger drivers switched more frequently within sub-tasks than between sub-tasks. Additionally, participants did not change their visual sampling strategies as the size of sub-tasks increased. Thus, uncertainty influenced decisions to switch between two interleaved tasks in the driving environment more than sub-task boundaries.

(48) Exploring the Influence of Light and Cognitive Load on Pupil Diameter in Driving Simulator Studies Oskar Palinko, Andrew Kun (University of New Hampshire)

Pupil diameter can be used as a physiological measure of cognitive load in driving simulator studies. However, pupil size depends on both cognitive load and lighting conditions. In order to accurately estimate cognitive load these two effects must be separated. In our study we introduce illumination only, cognitive only and combined tasks. Based on these we decouple the two effects on pupil diameter and we design a predictor of the pupil's reaction to light which can be used to estimate changes in pupil diameter that are due to cognitive load.

(49) Evaluating Changes in the Driving Behavior of Young Drivers a Few Years After Licensure Using In-Vehicle Data Recorders Gila Albert (Holon Institute of Technology – *Israel*), Oren Musicant (Tel-Aviv University – *Israel*), Tsippy Lotan (Or Yarok – *Israel*), Tomer Toledo (Technion-Israel Institute of Technology – *Israel*), Einat Grimberg (Or Yarok – *Israel*)

This paper aims to evaluate how young drivers drive a few years after licensure. Driving behavior in the fourth year of driving is compared to that of the first year, based on data from In-Vehicle Data Recorders (IVDR). Young drivers' cars were equipped with the same IVDR systems in both study periods. The comparison revealed that, in general, driving patterns did not change significantly. The difference in risky behaviour between weekdays and weekends was more prominent in the fourth year than in the first year. In addition, an interesting improvement occurred at the end of the fourth-year study period. The analysis results obtained should also be considered an example of the potential of what may be done with this kind of data.

(50) How Missing a Treatment of Mixed Amphetamine Salts Extended Release Affects Performance in Teen Drivers with ADHD Lana Trick (University of Guelph – *Canada*), Grazyna Jackiewicz (McMaster University – *Canada*)

Mixed Amphetamine Salts Extended Release (MAS-XR) is a stimulant medication used to control symptoms of ADHD. People occasionally fail to take their medications. The goal of this study was to assess the impact of a single missed medication on driving performance in 14 teen drivers with ADHD mixed type, as measured in a driving simulator. A double-blind placebo control crossover design was used. On the evening of the first day, baseline measures of driving performance were taken to assess driving skills (on medication). Then on two consecutive days drivers were tested three times a day, one day on medication and the other day off. Results indicated increased collisions and hazard response time off medication, with performance worst on the last test of the day (36 hours post-medication). Participants with the least developed driving skills benefited most from medication. This highlights the importance of consistent medication use in inexperienced teen drivers with ADHD.

(51) On-Road Driving Assessment Errors Associated with Pass and Fail Outcomes for Older Drivers with Cognitive Impairment Petra Hoggarth (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury – *New Zealand*), Carrie Innes (Van der Veer Institute for Parkinson's & Brain Research; Christchurch Hospital – *New Zealand*), John Dalrymple-Alford (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury; University of Otago – *New Zealand*), Richard Jones (Van der Veer Institute for Parkinson's & Brain Research; University of Canterbury; Christchurch Hospital; University of Otago – *New Zealand*)

Most on-road assessments do not make use of standardized scoring to determine driver safety. The current study sought to find a subset of driving errors that were related to on-road Pass and Fail outcomes in a group of 60 older drivers with cognitive impairment, and that were also considered important contributors to a Fail outcome by the driving specialist occupational therapist who administered the assessment. A number of useful errors were found that suggest that even a non-standardized driving assessment could incorporate a short list of driving errors that may assist in the determination of driving ability.

(52) Effect of Driving Simulation Parameters Related to Ego-Motion on Speed Perception Shaun Durkee, Nicholas Ward (Western Transportation Institute, Montana State University)

The overall effectiveness of driving simulation as a research tool is linked to how accurately modern technology can model reality. The objective of this project was to conduct a driving simulator experiment to examine the perceptual and behavioral effects of various parameters of the simulation deemed relevant from theories of ego motion. Twenty drivers completed speed production tasks (absolute production, fixed-increase production, and ratio production) while driving through a rural road scenarios that was experienced under varied conditions of motion, field of view, and optic flow. The study concluded that field of view (FOV) and optic flow simulation parameters were significant to the perception of absolute speed, with high levels of each resulting in more accurate perception of speed and speed change (acceleration/deceleration). The results of this study will allow researchers to consider the relative importance of simulation parameters in designing future behavioral research pertaining to speed perception using driving simulators.

(53) Fast Microsleep and Yawning Detections to Assess Driver's Vigilance Level Nawal Alioua (Mohammed V-Agdal University – *Morocco*), Aouatif Amine (Mohammed V-Agdal University; Ibn Tofail University – *Morocco*), Mohammed Rziza, Driss Aboutajdine (Mohammed V-Agdal University – *Morocco*)

Driver hypovigilance, often caused by fatigue and/or drowsiness, receives increasing attention in the last years; especially after it became evident that hypovigilance is a one of the major factor causing traffic accidents. Monitoring and detecting driver hypovigilance could contribute significantly to improve road traffic safety. This paper proposes fast methods to identify drowsiness and fatigue using respectively microsleep and yawning detections. In this study, the proposed scheme begins by a face detection using local Successive Mean Quantization Transform (SMQT) features and split up Sparse Network of Winnows (SNoW) classifier. After performing face detection, the novel approach for eye/mouth detection, based on Circular Hough Transform (CHT), is applied on eyes and mouth extracted regions. Our proposed methods works in real-time and yield a high detection rates whether for drowsiness or fatigue detections.

(54) Influence of Headlight Design on Sensory Conspicuity of Powered Two-Wheelers Maria Pinto, Viola Cavallo (French Institute of Science and Technology for Transport, Development and Networks [IFSTTAR – INRETS], LPC – *France*)

Conspicuity of Powered Two Wheelers (PTW) according to their frontal headlight design was evaluated in a car Daytime Running Light (DRL) environment. Three innovative headlight arrangements were studied: a triangle configuration, a lighted helmet and a colored frontal headlight. It was found that the helmet and the colored configuration led to better PTW detection performances than the standard configuration (a unique white headlight), especially when the PTW was far away. The triangle configuration did not prove to be effective. The theoretical and practical implications of these results are discussed.

(55) Exploring Older Driver Lateral Head Rotations at Intersections Using Naturalistic Driving Data Jon Antin, Brian Wotring (Virginia Tech Transportation Institute), James Foley (Toyota Technical Center)

This study represented a meta-analysis across two naturalistic driving databases which were collected in the same geographic area but focused on distinct age groups. Differences in range of lateral head rotation between older and middle-aged drivers traversing the same pathway through unprotected left turn intersections were examined. These driving scenarios are known to be among the riskiest and most difficult for older drivers, who demonstrated an increased range of head rotation compared to their middle-aged counterparts. These results are interpreted in the context of possible compensation for reduced fields of view.

(56) Developing Driving Task Scenarios for Developmentally Tailored Driving Assessments: Using an Evidence-Centered Design Model Erik Roelofs, Marieke van Onna (Cito, National Institute for Educational Measurement - *The Netherlands*), Karel Brookhuis (Delft University of Technology; University of Groningen - *The Netherlands*)

A systematic procedure was described by which task scenarios can be derived as a basis for educationally informative and developmentally tailored driving assessments. To this end, Mislevy's evidence centered design model for assessment was applied to the driving context. Borrowing from recent theories on driving and driving errors, task environment attributes were

derived which may complicate the sub processes of driving and thus may result in varying task difficulty. A universe of assessment tasks was defined by combining basic driving tasks and critical task environment attributes. A collection of 55 critical driving task scenarios was selected from 39 video recorded driving lessons, throughout different stages of driving education. Results of a difficulty rating study pertaining to these scenarios including experienced driving instructors show that the scenarios discriminate well between beginning and advanced learner drivers. Successful scenario solution can be predicted by using an IRT function, where solution probability is a function of driver ability and task difficulty. Implications for assessment design activities are discussed.

(57) Encouraging Environmentally Friendly Driving Through Driver Assistance: The eCo Move Project Nicola Fricke, Caroline Schießl (German Aerospace Center [DLR] – *Germany*)

A questionnaire study was conducted in order to identify relevant driver motives and assistance options for environmentally-friendly driving. Eighteen participants rated items belonging to the three factors time, environment, and consumption, and subsequently evaluated three types of driver assistance systems. Results concerning the motives showed that older drivers (above the age of 65) focused significantly less on the time motive, whereas high annual mileage drivers tended to focus more on the time motive compared to low annual mileage drivers. Small vehicle drivers emphasized more on the environment motive compared to middle-class/van drivers. In terms of the driver assistance options for eco-friendly driving, a display of the current consumption rate through color-coding received the highest number of first place rankings in the category intelligent vehicle information systems. A function that automatically shuts off the engine after a certain stopping time, as well as optimal gear choice and time to shift, were ranked high in the category intelligent advanced driver assistance systems. In the category intelligent navigation systems, a traffic- and situational adaptive navigation system was ranked the highest most often. Assessment of drivers' preferences additionally showed that most participants preferred the assistance functions to provide visual information as opposed to direct intervention. The results concerning the driver groups and their underlying driving motives as well as the preference statements will be used to inform the design and development of assistance functions for promoting eco-driving within the European eCo Move project.

(58) On-Road Evaluation of Destination Entry and Way-Finding Tasks: Comparisons Against Normal Driving
Miguel Perez, Derek Viita, Jonathan Hankey (Virginia Tech Transportation Institute), Sherri Voran-Nowak, Steven Tengler (OnStar Corporation)

While relative comparisons between "distracting" tasks (e.g. dialing a cell phone vs. talking on the cell phone) are useful, "normal driving" remains the benchmark for any task performed by the driver while a vehicle is in motion. Arguably, tasks that are less risky will result in observed patterns of driver behavior that are closer to those observed during normal driving. This paper describes the outcome of a study to compare destination entry and wayfinding across different navigation devices (with different input modalities) against epochs where the driver was not tasked with any other secondary or tertiary tasks (beyond occasional conversation with the experimenter). Results indicate some significant differences between destination entry tasks and normal driving, the magnitudes of which are mainly modulated by the input modality. Differences were less obvious during the navigation tasks, likely due to the intermittent nature of interactions with the navigation device in that context. Total eyes off-road time was also subjected to comparisons against previously published crash and near-crash risk estimate models. The results suggest that, assuming confidence in the models, there may be differences in the levels of crash and near-crash risk associated with different navigation devices. The approach is presented as a potential additional metric to consider in assessing devices that are used by drivers in moving vehicles.

(59) Cognitive, Perceptual and Motor Decline as Predictors of Risky Street-Crossing Decisions in Older Pedestrians
Sabine Langevin, Aurèlie Dommes, Viola Cavallo (French Institute of Science and Technology for Transport, Development and Networks [IFSTTAR – INRETS], LPC – *France*), Jennifer Oxley (MUARC, Monash University Sunway Campus – *Malaysia*), Fabrice Vienne (IFSTTAR – INRETS, LEPSIS – *France*)

Older pedestrians are well known to be over-involved in road crashes compared to younger pedestrians. This study investigates the extent to which risky street-crossing decisions in older pedestrians can be explained by age-related declines of cognitive, perceptual and physical abilities. Three age groups of participants (young, young-old, old-old) were evaluated in a street-crossing task and performed a series of functional tests. The results showed that age-related slowing in walking speed as well as a decline in cognitive flexibility and in visual acuity play a substantial role in risky decisions by the elderly. The implications of these findings, particularly in the development of a mixed physical-cognitive training to enhance the older pedestrians' road crossing decisions in complex environments, are discussed.

(60) Use of a Simulator to Objectively Distinguish Behaviors Between Low-Risk and High-Risk Drivers Yi-Ching Lee (Children's Hospital of Philadelphia), Noelle LaVoie, Ursula Lauper (Parallel Consulting), Anna Cianciolo (Command Performance Research)

The objective of this study was to validate behavioral differences between two groups of drivers through the use of a driving simulator. Controlled experiments in a driving simulator were used to gather objective and subjective evidence on how drivers reacted to roadway objects and handled various hazardous situations. Low-risk, more experienced drivers were more aware of the mental demands of having to remember and later recall a list of items when compared to high-risk, less experienced drivers. Outcomes of the study may potentially serve as the foundation for a training program that will aim to transfer risk assessment strategies from low-risk drivers to high-risk drivers.

(61) Texting While Driving: Evaluation of Glance Distributions for Frequent/Infrequent Texters and Keypad/Touchpad Texters Siby Samuel, Alexander Pollatsek, Donald Fisher (University of Massachusetts, Amherst)

The threat that cell-phones pose to driving has been a well-researched topic. There are fewer studies of the threat that texting creates for drivers, but the risks are obvious and the few existing studies confirm this. What is not obvious is whether frequent texters will expose themselves to the same risks as infrequent texters. This is important to know because many texters, especially teens who text frequently, may consider themselves immune to the dangers of texting while driving. As such, a comparison of frequent and infrequent texters was undertaken on a driving simulator. It is also not immediately clear what effects the different types of interfaces have on driving performance while text messaging. The interfaces under evaluation included keypad or "qwerty" phones (e.g., Blackberries) and touchpad phones (iPhone). It was found that the frequent and infrequent texters were equally likely to glance at least once for more than 2s inside the vehicle while sending a text message. It was also found that touchpad texters had a larger number of glances above the 2s threshold than keypad users, though this difference was not significant. The implications of this for future public policy are discussed.

(62) The Impact of Distraction on an Intersection Crossing Assist System Ensar Becic, Christopher Drucker, Michael Manser, Max Donath (University of Minnesota)

The current study examines the impact of drivers' use of an in-vehicle intersection crossing assist system under demanding cognitive load conditions. The use and adherence to the assist system is examined through intersection crossing driving performance measures. Furthermore, the impact of distraction is examined for younger and older drivers. The results suggest a more conservative approach to the crossing of rural intersections when using the assist system, a finding which was not altered by cognitive load.

(63) Revisiting Driver Behavior at Unsignalized Intersections: Time of Day Implications for Two-Way Left Turn Lanes (TWLTL) Sahar Nabaee, Derek Moore, David Hurwitz (Oregon State University)

A novel procedure was developed and validated for the accurate observation of naturalistic driver gap acceptance behavior at unsignalized intersections. Specifically, two-way stop-controlled intersections with a two way left turn lane (TWLTL) on the major road were examined. Three intersections were included as experimental locations. A sample size was collected of approximately 875 minor street vehicles which were exposed to over 2400 individual gaps. Characteristics such as gender, approximate age, vehicle type, presence of a queue behind the lead vehicle, and presence of passengers in the vehicle were collected as a function of the time of day (TOD). This work provides updated measures for the accepted gap as TOD varies, as well as exploring how accepted gaps are related to the wait time of a vehicle at the stop line.

(64) Aging and Steering Control Under Reduced Visibility Conditions Bobby Nguyen (Wichita State University), Yan Zhuo (Institute of Biophysics, Chinese Academy of Sciences – *China*), Rui Ni (Wichita State University)

The current study investigated age-related differences in a steering control task under low visibility conditions. Younger and older drivers were presented with displays simulating forward vehicle motion through a 3D scene of random dots on a ground plane. The lateral position of the vehicle was perturbed by a simulated side wind gust according to a sum of sinusoidal functions. The drivers' task was to steer the vehicle to maintain a straight path. The visibility of the driving scene was reduced by reducing the quantity and the quality of the optical flow field. We found that performance decreased when visibility was reduced for both older and younger drivers, with better performance for younger drivers as compared with older drivers. An age-related interaction was also found with deteriorated optical flow information. These results suggest that under reduced visibility conditions, older drivers may have increased accident risk due to decreased ability to successfully steer the vehicle.

(65) Driving Performance of Drug-Impaired Bus Drivers in Work Zone Areas Chris Deits, Linda Boyle (University of Washington), John Morrison (Cahill Swift, LLC)

There are several safety issues in work zone areas due to decrease lane width, and presence of large equipment and on-site workers. The safety issues are compounded for drivers that are also drug impaired. In this study, we examine the driver performance of 18 commercial bus operators in a simulated environment while they are under the influence of a benzodiazepine drug (Triazolam). The findings show that those drivers under the influence of the drug had higher steering entropy and greater difficulty staying close to the intended travel lane when compared to those who were not under the influence of the drug. These wider travelling distances around work barrels, by those under the influence of Triazolam, could have a potential impact on the safety of nearby construction workers and heavy machine operators.

(66) Influence of Riding Experience on Glance Behavior, Brake Response Time and Deceleration Rates by Drivers and Motorcyclists Jeffrey Muttart, Donald Fisher (University of Massachusetts, Amherst), Chris Kauderer (Kauderer & Associates), Wade Bartlett (Mechanical Forensic Engineering Services), Louis Peck (SD Lyons, Inc.), Steve Guderian (San Francisco Municipal Transportation Authority & Motorcycle Safety Consulting), Lisa Ton, Matthew Muttart (Crash Safety Solutions, LLC)

The focus of the research was to address the crash avoidance behaviors of drivers versus motorcyclists. Avoidance tasks include, attention maintenance and hazard anticipation measured with glance behaviors, and hazard mitigation measured with response times and deceleration. Specifically, where might the driver behavior be similar or different than that of a

motorcyclist? The performances of 23 participants were analyzed while they drove a car and rode a motorcycle over the same low-volume, open roads. Participants wore eye-tracking equipment used to record eye-glance information while the motorcycle and car were instrumented with an on-board accelerometer and GPS apparatus. Operators also responded by braking quickly to a stop when an LED, mounted in front of them, was illuminated. Motorcyclists spent less time glancing toward the road ahead and made fewer last-glances toward the direction of most threatening traffic before turning when riding the motorcycle, as opposed to when driving a car. Additionally, motorcyclists' response times were similar to those when driving, yet motorcyclists decelerated less sharply compared to drivers. These results suggest that riders may be exposing themselves to unnecessary risk. Specifically, motorcyclists frequently failed to make proper glances and practice optimal riding techniques. The implication of these results relative to a training curriculum is discussed.

(67) The Effects of Route Guidance on Spatial Learning Yi-Fang Tsai, Matthew Peterson (George Mason University)

Participants engaged in five driving routes while performing a secondary PDT task. For each route, participants drove to four distinct destinations. Route guidance was given to all subjects to help guide them to their destinations. Most of the participants were able to complete each driving route within the allotted time of 10 minutes. The drivers had repeated exposures to the locations and routes between the destinations and were told they would be asked the whereabouts of the destinations at the end of the driving routes. Overall, the participants had difficulty explicitly marking the locations of the destinations on a map, and indicating directional relationship between buildings. PDT performance and lane deviation stayed consistent across driving route tasks. The participants performed best at naming the street locations where the buildings were located. The use of route guidance on the ability to process navigation information may suppress cognitive map formation.

(68) Asymmetric Properties of Heart Rate Variability to Assess Operator Fatigue Christian Heinze (University of Applied Sciences Schmalkalden – *Germany*), Udo Trutschel (Circadian Technologies, Inc.), Dave Edwards (Caterpillar, Inc.), Bill Sirois (Circadian Technologies, Inc.), Martin Golz (University of Applied Sciences Schmalkalden – *Germany*)

The aim of this study is to evaluate the suitability of heart rate recordings for establishing a reliable connection to well-defined fatigue and performance measures in order to estimate fatigue in industrial and transportation applications. An overnight driving simulation scenario with partial sleep deprivation was utilized to induce strong fatigue. An experiment trial was divided into repeated sessions, each of which consisted of a driving performance and two vigilance tasks. Heart rate (HR) was recorded over the entire experiment; HR-measures were derived and correlated against measures that were established from driving and vigilance task performance and that represent various aspects of operator fatigue. In a previous report (Hefner et al. 2009) we presented on the basis of the data of one volunteer that multiple fatigue measures correlate well with different expressions of heart rate variability (HRV), especially with long-term HRV derived from Poincaré plots. In this work, we intensify the Poincaré analysis by dividing the distribution of HR data in different accelerating and decelerating segments and by establishing properties of asymmetry between these segments. We also show that most of the properties of long-term HRV correlate well with specific fatigue measures for a group of 5 volunteers despite their large inter-individual differences in HR-to-fatigue correlations.

(69) Withdrawn

(70) Effects of Concurrent Continuous Visual Feedback on Learning the Lane Keeping Task Peter van Leeuwen, Stefan de Groot, Riender Happee, Joost de Winter (Delft University of Technology – *The Netherlands*)

This study investigated the training effectiveness of continuous visual feedback in a simulator-based lane keeping task. Two groups of student drivers (total of 30 participants) were instructed to drive as accurately as possible in the center of the right lane in a self-paced driving task during five 8-min sessions. One group received visual feedback using a horizontal compensatory display positioned on the dashboard, which provided an indication of the momentary distance to the lane center during the three training sessions. During two retention sessions (immediate and one day delayed) both groups drove without the augmented feedback. The augmented feedback resulted in improved performance on a measure lane keeping accuracy, but this effect disappeared during retention. Furthermore, the augmented feedback resulted in increased steering wheel activity during all sessions, and increased driver workload in the delayed retention session. These results provide support for the guidance hypothesis and have possible implications for the use of continuous concurrent feedback in simulator-based driver training.

(71) Use of Instrumented Motorcycle to Measure the Effectiveness of Malaysian Rider Training: A Pilot Study Mohd Khairul Alhapiz Ibrahim, Mohd Faudzi Mohd Yusoff (Malaysian Institute of Road Safety Research – *Malaysia*)

A pilot study used an instrumented motorcycle to evaluate riding performances of Malaysian learner riders graduating from rider training and licensing program. 105 participants were asked to ride the instrumented motorcycle along a predefined route (mean 8 KM) in a mixed traffic environment. Period of turn signal activation and deactivation, maneuvering speed and deceleration of participants at unsignalized T junctions were measured as riding performances. Significant differences between male and female riders in responding to oncoming vehicles at the junctions were observed. Significant effects of age were also found in period of turn signal activation and maneuvering speed. Implications for current rider training are discussed.

(72) An Autonomous Intelligent Driving Simulation Tutor for Driver Training and Remediation: A Concept Paper
Matthew Romoser (University of Massachusetts, Amherst)

An intelligent tutoring model for use in a driving simulation training platform is proposed. Driving simulators by themselves cannot teach and staffing driving simulators with live trainers limits their ability to reach a wide audience. Research has shown that customized feedback, coupled with active practice in a simulator is very effective in changing a driver's behavior for the better. A driving simulation training program which utilizes an intelligent tutoring system (ITS) can diagnose driver errors, tailor feedback to the student's specific needs, determine when a student has mastered a specific skill set and can provide remediation as necessary. A brief discussion of basic ITS architecture is provided. An ITS model that has been successful in teaching individual skills in other domains (such as mental rotation) is applied to driving simulator instruction. The various critical components of the ITS, including the domain model, student model and tutoring model, are discussed in detail and a working example provided.

(73) Eye Movement Patterns and Driving Performance Zheng Bian, Russell Pierce, George Andersen (University of California, Riverside)

In the current study we examined the relationship between drivers' eye movement patterns and driving performance in a dual-task driving paradigm. Drivers performed two tasks in a driving simulator. In a car following task, drivers were asked to maintain a constant headway from a leading vehicle as it varied its speed. In the second task (light detection task), drivers tried to detect changes in peripheral traffic lights. The performance in the car following task was measured with headway distance and RMS, and the performance in the light detection task was measured with response time and accuracy. We found that the frequency of fixations, fixation duration and spatial distribution of fixations were significantly correlated with drivers' performance in the driving tasks. Specifically, driving performance improved with fewer eye movements, longer fixation durations and smaller spatial distribution of fixations.

(74) The Accuracy of Drivers' Judgments of the Effects of Headlight Glare: Are We Really Blinded by the Light?
Stacy Balk, Richard Tyrrell (Clemson University)

Headlights must balance two conflicting goals: maximizing visibility for the driver and minimizing glare to other drivers. Yet consumer complaints about headlights tend to focus on glare and not on poor visibility – a known casual factor of nighttime roadway crashes. These reactions may help to explain why drivers tend to underuse high beam headlights. This study explored the relationships among objective (impaired visual performance) and subjective (reports of discomfort and participants' judgments of glare-induced visual impairments) consequences of headlight glare. Sixteen participants sat in a vehicle that moved slowly on a closed road and estimated the distance at which they could determine the orientation of a retro reflective Landolt C. Actual recognition distances and reports of glare-induced discomfort were also assessed. Observers overestimated the extent to which glare degraded their ability to see the target. Participants' estimates of their own acuity decreased significantly when the opposing vehicle used high beams despite the fact that their actual acuity was unaffected. Overall, estimates of the disabling effects of glare were more tightly correlated with subjective reports of glare-induced discomfort than with actual visual performance. These results, which are consistent with psychophysical data obtained in a laboratory setting, may help explain drivers' reluctance to use their high beams. The results also underscore the need to collect data on disability glare, not only discomfort glare, when evaluating new lighting technologies.

(75) Integrating Kinematic- and Vision-Based Information to Better Understand Driving Behaviour Oren Musicant (Tel-Aviv University – *Israel*), Tomer Toledo (Technion–Israel Institute of Technology – *Israel*), Tsippy Lotan, Einat Grimberg, Dov Ganor (Or Yarok – *Israel*)

This study explored the use of two types of advanced driver assistance systems (ADAS) as tools for observing driving behavior. The first was a kinematic-based ADAS that uses speed and acceleration data to detect driving events such as hard braking, speeding and sharp turning. The second was a vision-based ADAS that uses video data to provide lane departure warnings (LDW), headway warnings (HW) and forward collision warnings (FCW). Data was collected for more than 4,500 trips and 2,200 driving hours during a period of 70 days. The sample consisted of 10 drivers that used both types of ADAS simultaneously. The information collected also included more than 17,000 records of various types of driving events. First, the events rates were estimated by the Poisson and the Poisson-lognormal models. Then, Pearson correlation and factor analysis were implemented to study the relationships among the events and to evaluate whether different types of events converged to describe the same behaviors. Significant correlations were observed between the braking and turning kinematic-based events and the FCW vision-based event, which converged under the same factor. High rates of these events may indicate that the person is driving in an urban style. The LDW, HW and speeding events converged to the second factor, which is more relevant in inter-urban areas. These findings, although based on a small-scale study, point to a potential for the use of commercial ADAS for driving behavior analysis. The integration of kinematic-based and vision-based information can provide deeper understanding of the measured behavior.

(76) Perception of Approaching Motorcycles by Distracted Drivers May Depend on Auxiliary Lighting Treatments: A Field Experiment James Jenness, Richard Huey, Shawn McCloskey, Jeremiah Singer, Jeremy Walrath, Elisha Lubar, Neil Lerner (Westat)

A field experiment was conducted in daylight with 32 participants to determine whether left turning drivers' gap acceptance in front of approaching motorcycles depends on the motorcycle's forward lighting treatment. Five experimental lighting treatments including a modulated high beam headlamp, or the low beam headlamp plus pairs of low-mounted auxiliary lamps, high-mounted auxiliary lamps, both high- and low-mounted auxiliary lamps, or low-mounted LED lamps were compared to a baseline treatment with only the low beam headlamp illuminated. Participants viewed the approaching traffic stream (including the motorcycle) on an active roadway and indicated when it would be safe (and not safe) to initiate a left turn across the opposing lanes. Participants also shared their attention with a secondary visual distraction task that took their eyes off the forward roadway. Participants did not know that the purpose of the study was to measure their responses to approaching motorcycles. Based on participants' indications of the last safe moment to turn, the mean temporal safety margin provided to the approaching motorcycle did not differ significantly between any of the experimental lighting treatments and the baseline treatment. However, having either low-mounted auxiliary lamps or modulated high beam lamps on the motorcycle significantly reduced the probability of obtaining a potentially unsafe short safety margin as compared to the baseline lighting treatment. Overall, the results suggest that enhancing the frontal conspicuity of motorcycles with lighting treatments beyond an illuminated low beam headlamp may be an effective countermeasure for daytime crashes involving right-of-way violations.

(77) A Simulator Comparison of Riding Performance Between New, Returned and Continuing Motorcycle Riders Mark Symmons, Christine Mulvihill (Monash University – *Australia*)

Motorcycle riders constitute an increasing proportion of deaths and injuries due to road crashes. Further, older riders represent an increasing proportion of motorcycle riders, with particular concern for those who have returned to riding after a substantial break (returned riders). These riders seem reluctant to undertake any sort of refresher training. In a motorcycle simulator task continuing riders performed best, followed by newly licensed riders, and then returned riders, though that result did not extend to crashes that occurred in the simulator.

(78) Inhibitory Control and Reward Predict Risky Driving in Young Novice Drivers: A Simulator Study Ellen Jongen (Transportation Research Institute [IMOB], Hasselt University – *Belgium*), Kris Brijs (IMOB, Hasselt University; XIOS University College – *Belgium*), Marcell Komlos, Tom Brijs, Geert Wets (IMOB, Hasselt University – *Belgium*)

The purpose of our study is to unravel the cognitive mechanisms that underlie risky driving in young novice drivers. Based on the two pillars of the Dual Systems Model of adolescent risk taking, we hypothesized that (1) lower capacity for cognitive control (inhibitory control), (2) a rewarding context, and (3) the interaction of these predict risky driving and constitute part of the cognitive basis for the large number of crashes in the young novice driver population. Two groups different in age (n=31, 17-18 year-olds; n=22, 22-24 year-olds), but equal in driving experience participated in our experiment. Each participant completed two 28km test-drives in a STISIM M400 driving simulator. In the first drive, participants were asked to drive as they normally do. For the second drive, participants were told they could obtain a monetary reward for completing the drive as fast as possible, although for each collision or traffic violation (except speeding), penalty time would be imposed. Inhibitory control was measured by means of a stop signal reaction time task (SSRT). Measures of risky driving included: standard deviation of lateral lane position (SDLP), responses to critical events, speeding, and red light running. We found that: (1) inhibitory control still improves within the young driver population; (2) lowered inhibitory control had a driving specific effect: drivers with lower inhibitory control (SSRT) had a higher SDLP; (3) a rewarding context predicts risky driving as speeding and red light running occurred more often in the trip with than without reward.

(79) Traumatic Brain Injury and Driver Safety: A Systematic Review Stephen Tregear, Jessica Williams, Damilola Funmilayo (MANILA Consulting Group, Inc.)

Traumatic brain injuries (TBI) can lead to impairments in cognitive, physical, and psychosocial functions, which may ultimately affect an individual's ability to drive. A systematic review was conducted to: 1) assess the impact of TBI on crash risk/driving performance; 2) determine what factors associated with TBI are predictive of increased crash risk/poor driving performance; and 3) determine if there is a likelihood of future seizure among individuals with a TBI who did not experience a seizure at the time of the injury. Results indicated that: 1) The available evidence is insufficient to determine whether crash risk is elevated for drivers with TBI compared to uninjured controls (*Summary RR=1.32; 95% CI=0.77-2.25*). However, driving performance was significantly impaired among individuals with TBI compared to uninjured controls (Strength of Evidence: Moderate); 2) Cognitive function measured by certain neuro-psychological tests may predict the outcome of driving performance measured by a road test for patients with TBI. (Strength of Evidence: Moderate); and 3) Individuals with TBI who have not experienced a seizure within the first week post-injury still have a significant likelihood of experiencing late seizure(s). Frequencies of late seizures ranged from 1% to 25% during follow-up periods ranging from 1 to 11 years (Strength of Evidence: Moderate). The highest rate of late seizures (25%) was associated primarily with penetrating missile TBIs (Strength of Evidence: Minimally Acceptable [*32% vs. 5%*]). These findings have potential implications for regulatory agencies with responsibility for road safety.

(80) Effectiveness of an Intersection Violation Warning System Dawn Marshall, Robert Wallace, James Torner, Michelle Birt-Leeds (University of Iowa)

People age 65 years and older are the fastest growing segment of the U.S. population and the fastest growing sector of the driving population. When compared to other age groups, older drivers are overrepresented in intersection crashes (Subramanian & Lombardo, 2007; Braitman et al., 2006), and approximately half of the charges in fatal intersection crashes are for failure to obey the traffic control device. This project explored an in-vehicle warning system for failure-to-obey (running a stop sign or stop light) violations. Participants who were not using the system made nearly three times as many did-not-stop errors (27%) than participants who were using the system (10%). This effect was most pronounced in older drivers with more risk factors associated with crashes; however, the effect of age group was not statistically significant.

(81) Assessing the Transfer of Simulator Trained Skills to Real Vehicle Control Barry Coutermarsh, Kelley MacDonald, Sally Shoop (U.S. Army Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory)

The Army Cold Regions Research and Engineering Laboratory is conducting a project to investigate the value of a motion based simulator in teaching vehicle control for off-road driving conditions. A primary goal is to reduce accidents caused by the loss of control of high center-of-gravity military vehicles in situations normally not found in the civilian driving experience. This study presents data from a two year portion of our work to develop metrics to assess the effectiveness of simulator training for developing vehicle control skills. For the first year, 10 drivers were trained using a simulator in an accident avoidance (AA) maneuver. Their performance was compared against 10 untrained drivers in a real vehicle. The second year 5 trained drivers from the first study were given sparse sustainment training in the simulator and again compared against 5 untrained drivers in a real vehicle. We considered metrics specifically related to the vehicle control aspects of the training to determine if the trainee acquired the necessary muscle memory to correctly implement the various vehicle control steps involved in the maneuver. We also briefly describe the participant's views on their training experience.

(82) Effects of Familiarity and Age on Driver Safety Errors During Wayfinding Katherine Read, Lixi Yu, Jamie Emerson, Jeffrey Dawson, Nazan Aksan, Matthew Rizzo (University of Iowa)

Wayfinding is a critical skill that enables drivers to navigate from one location to another. Wayfinding abilities decline as individuals age, which may increase older driver reliance on directional cues (e.g. signs) and divert cognitive resources at the expense of vehicle control and safety. Familiarity with an environment can facilitate wayfinding due to previous knowledge of the route. This study examines the role of familiarity in driving safety errors committed during a wayfinding task. Results suggest that age-related driving difficulties can be lessened by familiarity with the environment. The results underscore the need to consider geographical license restrictions in administrative policies aimed at improving older driver safety.

(83) Systematic Analysis of Real-World Driving Behavior Following Focal Brain Lesions Kelsey Thompson, Katherine Read, Steven Anderson, Matthew Rizzo (University of Iowa)

Many patients with circumscribed brain injuries, such as those caused by stroke or focal trauma, return to driving after a period of acute recovery. These persons often have chronic residual cognitive deficits that may impact on driving safety, but little is known about their driving behavior in the real world. Extant studies tend to rely on driving simulators or controlled on-road drives. These methods of observation are not able to capture the complexities of the typical driving environment, and may not accurately represent a driver's usual behavior on the road. The current study used a video event-activated data recorder (VEADR) system to observe drivers with focal brain lesions in their normal daily driving environment over a three-month period. In the context of primarily safe driving behavior, we were able to document a number of relatively infrequent and hitherto unobserved high risk behaviors and traffic violations. These findings demonstrate the feasibility and value of sampling real-world driving in neurologic patient populations such as those with focal brain lesions, and highlight the critical importance of evaluating unsafe driving behaviors which may occur with insufficient frequency to be captured by relatively brief simulator or controlled on-road evaluations.

(84) Assessing Drivers' Tailgating Behavior and the Effect of Advisory Signs in Mitigating Tailgating Jyh-Hone Wang, Miao Song (University of Rhode Island)

A human factors study was carried out to assess drivers' tailgating behavior and the effect of advisory signs in mitigating tailgating. Tailgating is a dangerous driving behavior and a leading cause of most rear-end crashes. Through a prior study, serious tailgating was identified on urban Rhode Island highways. It is critical to many urban traffic management authorities to understand tailgating and to explore means to mitigate drivers' tailgating behavior, especially on urban highways with high-speed and high-volume traffic. Properly designed advisory signs could reduce tailgating and related motor crashes. To assess drivers' behavior with regards to tailgating, a questionnaire survey was developed and given to a number of subjects with daily highway driving experience. The survey is designed to identify causes of tailgating and drivers' perceptions and engagements on tailgating behavior. Drivers' driving behaviors were further assessed through driving simulation under different traffic conditions. To help mitigate tailgating behavior, advisory signs and an educational video were developed. The effectiveness of these proposed counter-tailgating measures was assessed in the driving simulation. Subjects' real driving behaviors were further studied in a follow-up field study. Study results found that the majority had an incorrect sense regarding safe following distance and were tailgating while driving on highways. Heavy traffic was identified as the top tailgating cause. The simulation results confirmed the tailgating phenomenon observed on urban Rhode Island highways. The proposed advisory signs were found effective in mitigating tailgating behavior.

(85) A Comparison of Heart Rate and Heart Rate Variability Indices in Distinguishing Single-Task Driving and Driving Under Secondary Cognitive Workload Bruce Mehler, Bryan Reimer, Ying Wang (Massachusetts Institute of Technology [MIT] AgeLab)

Heart rate and heart rate variability (HRV) measures collected under actual highway driving from 25 young adults were compared to assess the relative sensitivity of each for distinguishing between a period of single task driving and periods of low and high additional cognitive workload. Basic heart rate, skin conductance and most, but not all, of the HRV indices were significantly different between single task driving and the high secondary demand period. Heart rate and skin conductance were also robust at distinguishing between single task driving and the low added demand period; however, several HRV measures did not show statistically significant differences between these two periods and the remaining HRV measures that did were less robust than basic heart rate as assessed by effect size and observed power. Rather than attempting to argue for the inherent superiority of any one physiological measure, these findings are presented with the intent of encouraging a broader discussion around the conditions under which particular physiological measures may be most useful and/or complementary for detecting different aspects of workload and operator state.

(86) Driver Control Actions in High-Speed Circular Driving Diomidis Katzourakis (Delft University of Technology – *The Netherlands*), Efstathios Velenis (Brunel University – *UK*), Riender Happee (Delft University of Technology – *The Netherlands*)

In this pilot study we investigate driver control actions during high speed cornering with a rear wheel drive vehicle. Six drivers were instructed to perform the fastest maneuvers possible around a marked circle, while trying to retain control of the vehicle and constant turning radius. The data reveal that stabilization of the vehicle is achieved with a combination of steering and throttle regulation. The results show that the drivers used steering control to compensate for disturbances in yaw rate and sideslip angle. Vehicle accustomed drivers had the most consistent performance resulting in reduced variance of task metrics and control inputs.

(87) Effect of Driving Breaks and 34-hour Recovery Period on Motor Carrier Crash Odds Kun-Feng Wu, Paul Jovanis (Pennsylvania State University)

This research seeks to contribute to our knowledge of the relationship between truck driver hours of service and motor carrier crash odds. Data were collected from less-than-truckload carriers in 2004-05 and 2010 including the precise hours of service for crash-involved drivers and a random sample of non-crash involved drivers. Time-dependent logistic regression models were formulated to study the probability of a crash after a certain number of hours driving, given survival until that time. In addition to driving time during a trip, the models included presence of 34 hours consecutively off-duty immediately prior to the trip of interest and the use of breaks from driving by the driver. Multi-day driving patterns, developed using cluster analysis, cover the 7 days prior to the day of interest in an attempt to capture the effect of the pattern of driving over many days. Among the findings of this research are: (1) Driving hours 6 through 11 show continuous increases in the crash risk, (2) substantial and consistent benefits for drivers who take breaks compared to drivers who drive without breaks; benefits ranged from 34 to 47 percent reduction in crash odds, depending on the number of breaks taken, (3) drivers who had 34 hours or more off-duty immediately prior to the measurement period had a nearly 43 percent increase in crash odds, and (4) additional investigation shows that drivers have the greatest difficulty immediately after returning from the extended time off; the effect then diminishes with time.

(88) Hazard Perception and Distraction in Novice Drivers: Effects of 12 Months Driving Experience Anuj Pradhan, Bruce Simons-Morton (National Institute of Child Health and Human Development), Suzanne Lee, Sheila Klauer (Virginia Tech Transportation Institute)

The high crash risk of novice drivers has been partly attributed to their underdeveloped hazard perception abilities. Novice drivers also have an increased risk of crashes due to distractions. Studies show that novice drivers do not detect risk relevant cues and are more susceptible to distractions when compared to adult drivers. This test track study was conducted to study the effects of 12 months of driving experience on teenagers. Forty-two teenagers and their parents drove through hazard perception scenarios while engaged in secondary tasks. These participants had participated in a similar session 12 months earlier. For the odometer and texting task conditions the novice drivers showed an improvement in hazard perception and a small but insignificant decrease in task suspension after 12 months. For the scenario with the cell phone task none of the novice drivers suspended the task, nor exhibited any sort of hazard perception behavior at 12 months. The results indicate that although hazard perception generally improves with experience under some distracting task conditions this is not the case for cell phone distractions.

(89) The Effect of Age and Gender on Visual Search During Lane Changing Martin Lavallière (Massachusetts Institute of Technology [MIT] AgeLab; Université Laval – *Canada*; Centre de recherché FRSQ du CHA Universitaire de Québec – *Canada*), Bryan Reimer, Bruce Mehler, Lisa D'Ambrosio, Ying Wang (MIT AgeLab), Normand Teasdale (Université Laval – *Canada*; Centre de recherche FRSQ du CHA Universitaire de Québec – *Canada*), Joseph Coughlin (MIT AgeLab)

This study examined visual search behavior relative to three regions of interest (ROI) (side mirror, rear view mirror, and blind spot) for self-initiated lane changes in a sample of 108 drivers under actual highway conditions. As has been observed previously, few drivers scan all three of the ROI prior to executing a lane change, with turning around to inspect the blind spot being the lowest frequency behavior. Age, gender and direction (left or right lane change) were found to influence visual search behaviors. For lane changes to the right, blind spot checking occurred less than 32% of the time in females and less

than 15% of the time in males. This low level of blind spot checking to the right was consistent across younger and older age groupings. Interestingly, the most notable age discrepancy was in checking the left blind spot. Younger drivers checked their left blind spot 53.3% of the time compared to a rate of 23.9% for drivers in their 60s. Implications of these findings for both driver remediation programs and the increasing availability of blind spot identification systems are considered.

(90) **Developing a North American Static Hazard Perception Test** John Lyon, David Borkenhagen, Charles Scialfa, Micheline Deschênes, Mark Horswill (University of Calgary – *Canada*)

We examined the ability of young novice (M = .19 yrs experience) and experienced drivers (M = 5.1 yrs experience) to identify and localize frequently encountered roadway hazards using static images taken in western Canada. Dependent measures also included subjective ratings of hazardrisk and scene clutter. Novice drivers reacted to roadway hazards more slowly while rating them as being less hazardous than young, experienced drivers. Using a small subset of scenes, it was determined that a brief hazard perception test employing staticimages could classify individuals with high accuracy (78%) and good reliability (Cronbach's alpha = .91).

(91) **The Effect of Traffic Complexity and Speed on Young and Elderly Pedestrians' Street-Crossing Decisions** Aurèlie Dommes, Sabine Langevin, Viola Cavallo (French Institute of Science and Technology for Transport, Development and Networks [IFSTTAR – INRETS], LPC – *France*), Jennifer Oxley (MUARC, Monash University Sunway Campus – *Malaysia*), Fabrice Vienne (IFSTTAR – IFSTTAR, LEPSIS – *France*)

This experiment aimed at studying the effects of age, traffic complexity and speed of the approaching cars on the probability of a pedestrian to be involved in a crash. Fifty nine participants aged between 20-84 years took part in a street-crossing estimation task in a simulated road environment. The results showed an overall higher number of 'collisions' with increasing age. While the number of collisions did not vary according to traffic complexity and speed of the approaching cars in the young group, the older participants were more likely to make decisions that led to collisions when the traffic was approaching from two rather than one direction, and at a high speed. The findings were discussed in relation to the effects of age-related cognitive and perceptual limitation on difficulties in selecting safe gaps. The present results have implications for improving older pedestrians' safety in terms of road design, speed reduction measures, and training opportunities.