7th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design

The Sagamore Resort on Lake George
Bolton Landing, New York
June 17-20, 2013

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ACKNOWLEDGMENTS

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We thank all members of the Scientific Review Committee for their time and effort in evaluating the many full-paper submissions. The Honda Outstanding Student Paper Award Review Committee deserves special thanks for reviewing the student papers considered for the award.

At The University of Iowa, we thank Peter Damiano, Director, Public Policy Center; Susan McClellen, Creative Media Group; Cher Carney, Rudy Marcelino, Stephanie Peña, Michelle Reyes, Jennifer Rotkiewicz, and Alex Sukalski of the Public Policy Center.

Individuals with disabilities are encouraged to attend all University of Iowa-sponsored events. If you are a person with a disability who requires an accommodation in order to participate in this program, please contact Kathy Holeton, Driving Assessment 2013, in advance at (319) 335-6804.

7th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design
June 17-20, 2013

Monday, June 17, 2013

2:00 pm – 6:00 pm **Early Registration**
Conference Center, Lobby

6:00 pm – 8:30 pm **Welcome Reception**
The Sagamore Resort
Shelving Rock Terrace

Tuesday, June 18, 2013

7:00 am – 5:30 pm **Registration Open**
Conference Center, Lobby

7:00 am – 8:30 am **Breakfast Buffet**
Conference Center, Foyer

8:00 am – 5:00 pm **Exhibitors Available**
Conference Center, Nirvana

8:00 am – 9:00 am **TOYOTA DISTINGUISHED KEYNOTE LECTURE**
Conference Center, Bellvue

Drivers and Driver Assistance Systems: How Well do They Match? (01)
Adrian K. Lund, President
(Insurance Institute for Highway Safety and the Highway Loss Data Institute)

9:00 am – 9:15 am **BREAK**

Session 1 – Lectures
Driver Behavior and Naturalistic Studies
9:15 am – 10:45 am
Conference Center, Bellvue

Session Chair: Eric Traube

9:15 am **Not So Fast! An Investigation of Real-World Speeding Behaviors (02)** John L. Campbell, Christian Richard (Battelle), Randolph Atkins (US DOT National Highway Traffic Safety Administration), Monica G. Lichty, James L. Brown (Battelle)

9:35 am **Novice Teenage Driver Cell Phone Use Prevalence (03)** Johnathon Ehsani, Ashley Brooks-Russell, Kaigang Li, Jessamyn Perlus, Anuj Pradhan, Bruce G. Simons-Morton (National Institutes of Health)

9:55 am **Problems with Sleep Do Not Predict Self-Reported Driving Factors and Perception in Older Drivers: Evidences from the Candrive II Prospective Cohort (04)** Sylvain Gagnon, Andrea J. Hickey (University of Ottawa – *Canada*), Kelly Weegar (Ottawa Hospital Research Institute – *Canada*), Yara Kadulina (University of Ottawa – *Canada*), Shawn Marshall (Ottawa Hospital Research Institute – *Canada*), Anita Myers (University of Waterloo – *Canada*), Holly Tuokko (Centre for Aging – *Canada*), Michel Bédard (Centre for Research on Safe Driving – *Canada)*

10:15 am **Validity of the C-RDS Self-Reported Risky Driving Measure (05)** Bruce G. Simons-Morton, Kaigang Li, Ashley Brooks-Russell, Johnathon Ehsani, Anuj Pradhan (National Institutes of Health), Marie Claude Ouimet (University of Sherbrooke – *Canada*), Sheila Klauer (Virginia Tech Transportation Institute)

10:45 – 11:00 am **BREAK – Refreshments Available**
Conference Center, Foyer

Session 2 – Lectures
Coaching and Training
11:00 am – 12:30 pm
Conference Center, Bellvue

Session Chair: Jim Jenness

11:00 am **A Coaching Program for Recently Licensed Young Drivers in the Netherlands: Which Drivers are Attracted? (06)** Erik Roelofs (Cito – *The Netherlands*), Jan Vissers (Royal Haskoning – *The Netherlands*), Marieke van Onna (Cito – *The Netherlands*)

11:20 am **The Potential for IVDR Feedback and Parental Guidance to Improve Novice Young Drivers' Behavior (07)** Oren Musicant, Haneen Farah (The Ran Naor Foundation – *Israel*), Tomer Toledo (Technion – *Israel*), Yaara Shimshoni, Haim Omer (Tel-Aviv University – *Israel*), Tsippy Lotan (Or Yarok – *Israel*)

11:40 am **Using Feedback from Naturalistic Driving to Improve Treatment Adherence in Drivers with Obstructive Sleep Apnea (08)** J. Tucker Krone, Jeffrey D. Dawson, Steven W. Anderson, Nazan S. Aksan, Jon Tippin, Matthew Rizzo (University of Iowa)

12:00 pm **Assessing the Impact of "Brain Training" on Changes in Driving Performance, Visual Behavior, and Neuropsychology (09)** Jonathan Dobres (The Massachusetts Institute of Technology AgeLab), Anya Potter (The Massachusetts Institute of Technology AgeLab; University of Massachusetts), Bryan Reimer, Bruce Mehler, Alea Mehler, Joseph Coughlin (The Massachusetts Institute of Technology AgeLab)

12:30 – 2:00 pm **HONDA LUNCHEON & OUTSTANDING STUDENT PAPER AWARDS CEREMONY**
Conference Center
Mountainview Terrace

Awards presented by
Bill Konstantacos, Vice President
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The Honda Outstanding Student Paper Award winners will be announced at the luncheon.

Session 3 – Lectures
Measuring Driving Distraction
2:00 – 3:30 pm
Conference Center, Bellvue

Session Chair: Bill Horrey

2:00 pm **Towards Operationalizing Driver Distraction (10)** James P. Foley (Toyota Collaborative Safety Research Center), Richard Young (Wayne State School of Medicine), Linda Angell (Virginia Tech Transportation Institute), Joshua E. Domeyer (Toyota Collaborative Safety Research Center)

2:20 pm **Sensitivity of Detection Response Task (DRT) to the Driving Demand and Task Difficulty (11)** Marie-Pierre Bruyas, Laëtitia Dumont (IFSTTAR-LESCOT – *France*)

2:40 pm **The Tactile Detection Response Task: Preliminary Validation for Measuring the Attentional Effects of Cognitive Load (12)** Richard A. Young, Li Hsieh, Sean Seaman (Wayne State University)

3:00 pm **Detection Response Tasks: Using Remote, Headmounted and Tactile Signals to Assess Cognitive Demand While Driving (13)** Joanne L. Harbluk, Peter C. Burns, Sebastian Hernandez, Jane Tam, Viliam Glazduri (Transport Canada – *Canada*)

3:30 – 5:00 pm **BREAK – Refreshments Available**
Conference Center, Nirvana

Session 4 – Poster Session A
3:30 – 5:00 pm
Conference Center, Nirvana

Improving Restraint Feasibility through Ambulance Layout Redesign (14) Jessica Mueller, Tawny Hoyt, Laura Stanley (Western Transportation Institute, Montana State University)

Human Factors Issues Associated with Limited Ability Autonomous Driving Systems: Drivers' Allocation of Visual Attention to the Forward Roadway (15) Robert E. Llaneras (Virginia Tech Transportation Institute), Jeremy Salinger, Charles A. Green (General Motors)

How Missing a Treatment of Mixed Amphetamine Salts Extended Release Affects Performance in Teen Drivers with ADHD (16) Lana M. Trick, Ryan Toxopeus (University of Guelph – *Canada*)

Predictors of Driving in Individuals with Relapsing–Remitting Multiple Sclerosis (17) Abiodun E. Akinwuntan, Kelly Baker, Michelle Manley, Erin McGonegal, Christina O'Connor, Kendra Phillips, Kristen Turchi (Georgia Regents University)

Formulation of Driver Judgment Process around Curves for Deviated State Detection (18) Motoki Shino, Hiroshi Yoshitake (University of Tokyo – *Japan*), Machiko Hiramatsu, Takashi Sunda (Nissan Motor Co. Ltd – *Japan*), Minoru Kamata (University of Tokyo – *Japan*)

Age Differences in Driving-Specific Tests of Executive Function (19) Ann E. Lambert, Daniel J. Cox, Melissa L. O'Connor, Rick L. Moncrief, Clarissa Cho, Ronald J. Johnson (University of Virginia Health System)

Cooperative Adaptive Cruise Control: Critical Human Factors Issues and Research Questions (20) Stephen Jones (Science Applications International Corporation [SAIC]), Brian H. Philips (US DOT Federal Highway Administration)

Assessing Text Reading and Text Entry while Driving Using the Visual Occlusion Technique (21) Mahtab Ghazizadeh, John D. Lee (University of Wisconsin – Madison), Yiyun Peng, Linda Ng Boyle (University of Washington)

Can Intermittent Video Sampling Capture Individual Differences in Naturalistic Driving? (22) Nazan Aksan, Mark Schall, Steven Anderson, Jeffery Dawson, Jon Tippin, Matthew Rizzo (University of Iowa)

Shifting Between Cognitive and Visual Distraction: The Impact of Cognitive Ability on Distraction Caused by Secondary Tasks (23) Sachi Mizobuchi, Mark Chignell (Vocalage Inc.; University of Toronto – *Canada*), Junko Suzuki, Ko Koga, Kazunari Nawa (Toyota InfoTechnology Center Co., Ltd. – *Japan*)

Effects of Environmental Factors on Naturalistic Driving in Obstructive Sleep Apnea (24) Lixi Yu, Jeffrey D. Dawson, Nazan S. Aksan, Jon Tippin, Matthew Rizzo (University of Iowa)

What Makes a Good Passenger? From Teen Drivers' Perspectives (25) Yi-Ching Lee (Children's Hospital of Philadelphia), Noelle LaVoie (Parallel Consulting, LLC)

Inhibitory Control and Peer Passengers Predict Risky Driving in Young Novice Drivers - A Simulator Study (26) Ellen M.M. Jongen (Transportation Research Institute, Hasselt University – *Belgium*), Kris Brijs (Transportation Research Institute, Hasselt University – *Belgium*; XIOS University College, Department of Construction Engineering – *Belgium*), Tom Brijs, Geert Wets (Transportation Research Institute, Hasselt University – *Belgium*)

An Initial Assessment of the Significance of Task Pacing on Self-Report and Physiological Measures of Workload While Driving (27) Bruce Mehler, Bryan Reimer (The Massachusetts Institute of Technology AgeLab; New England University Transportation Center)

Using Manual Measurements on Event Recorder Video and Image Processing Algorithms to Extract Optical Parameters and Range (28) Jonas Bärgman, Julia Werneke, Christian-Nils Boda (Chalmers University of Technology, Division of Vehicle Safety – *Sweden*), Johan Engström (AB Volvo – *Sweden*), Kip Smith (Naval Postgraduate School)

Can We Predict Steering Control Performance from a 2D Shape Detection Task? (29) Bobby Nguyen (Wichita State University), Yan Zhuo (Institute of Biophysics, Chinese Academy of Science – *China*), Rui Ni (Wichita State University)

Comparison of the Minisim and Stisim Driving Simulators for the Detection of Impairment: An Alcohol Validation Study (30) Gary Kay (Cognitive Research Corporation), Omar Ahmad, Timothy Brown, Andrew Veit (University of Iowa)

Driver Distraction through Conversation Measured with Pupillometry (31) Carsten Dlugosch, Antonia S. Conti, Klaus Bengler (Technische Universität München, Institute of Ergonomics – *Germany*)

On-Road Evaluation of Driver Capability: A Medical Record Review of the Adaptive Driving Program (32) Nahom Beyene, Amy Lane, Rosemarie Cooper, Rory Cooper (University of Pittsburgh)

Comparison of Anticipatory Glancing and Risk Mitigation of Novice Drivers and Exemplary Drivers when Approaching Curves (33) Jeffrey W. Muttart, Donald L. Fisher, Alexander P. Pollatsek, Jenna Marquard (University of Massachusetts, Amherst)

Who are the Users of Speed Regulation Assistance? Comparing Driver Characteristics of Casual and Intensive System Users (34) Véronique Huth, Corinne Brusque, Marie-Pierre Bruyas, Valérie Lancelle (IFSTTAR [LESCOT], Université de Lyon – *France*)

Neuropsychological Predictors of Safety in Urban Left-Turn Scenarios (35) Jeffrey D. Dawson, Lixi Yu, Kuan-Hua Chen, Michelle Rusch, Amy M. Johnson, Nazan S. Aksan (University of Iowa), Takashi Sunda, Machiko Hiramatsu (Nissan Research Center, Nissan Motor Co. – *Japan*), Steven W. Anderson, Matthew Rizzo (University of Iowa)

Wednesday, June 19, 2013

7:00 am – 4:30 pm **Registration Open**
Conference Center, Lobby

7:00 am – 8:30 am **Breakfast Buffet**
Conference Center, Foyer

8:00 am – 5:00 pm **Exhibitors Available**
Conference Center, Nirvana

8:00 am – 9:00 am **NISSAN DISTINGUISHED KEYNOTE LECTURE**
Conference Center, Bellvue

Distraction: Friend or Foe (36)
Professor Clifford Nass
(Stanford University)

9:00 am – 9:15 am **BREAK**

Session 5 – Lectures
Fitness to Drive
9:15 am – 10:45 am
Conference Center, Bellvue

Session Chair: Natasha Merat

9:15 am **Predicting Older Adults' On-Road Driving Performance (37)** Rachel W. Ross, Charles Scialfa, Scheila Cordazzo, Katherine Bubric (University of Calgary – *Canada*)

9:35 am **Validation of Driving Simulation to Assess On-Road Performance in Huntington Disease (38)** Hannes Devos (University of Leuven – *Belgium*; University of Iowa), Alice Nieuwboer, Wim Vandenberghe (University of Leuven – *Belgium*), Mark Tant (Belgian Road Safety Institute – *Belgium*), Willy De Weerdt (University of Leuven – *Belgium*), and Ergun Uc (University of Iowa; Veterans Affairs Medical Center)

9:55 am **Video Test to Evaluate Detection Performance of Drivers with Hemianopia: Preliminary Results (39)** Alex R. Bowers (Schepens Eye Research Institute, Mass Eye and Ear, Harvard Med School; New England College of Optometry), Karen Jeng (UMDNJ-Robert Wood Johnson Medical School), Eli Peli (Schepens Eye Research Institute, Mass

Eye and Ear, Harvard Med School; New England College of Optometry), Laura Werner (New England College of Optometry), Amy Doherty (Schepens Eye Research Institute, Mass Eye and Ear, Harvard Med School)

10:15 am **The Long Road Home: Driving Performance and Ocular Measurements of Drowsiness Following Night Shift-Work (40)** William J. Horrey, Yulan Liang (Liberty Mutual Research Institute for Safety), Michael L. Lee (Division of Sleep Medicine, Harvard Medical School), Mark E. Howard (Institute for Breathing & Sleep, Austin Health – *Australia*), Clare Anderson (Monash University – *Australia*), Michael S. Shreeve, Conor O'Brien, Charles A. Czeisler (Division of Sleep Medicine, Harvard Medical School)

10:45 am – 11:00 am **BREAK – Refreshments Available**
Conference Center, Foyer

Session 6 – Lectures
Driver Performance and Simulation Studies
11:00 am – 12:30 am
Conference Center, Bellvue

Session Chair: Bryan Reimer

11:00 am **Simulator Sickness Questionnaire: Twenty Years Later (41)** Stacy A. Balk, Mary Anne Bertola, Vaughan W. Inman (Science Applications International Corporation [SAIC])

11:20 am **The Design of Haptic Gas Pedal Feedback to Support Eco-Driving (42)** Hamish Jamson, Daryl L. Hibberd, Natasha Merat (Institute for Transport Studies, University of Leeds – *United Kingdom*)

11:40 am **Interactions between Cars and Motorcycles: Testing Underlying Concepts through Integration of On-Road and Simulator Studies (43)** Michael G. Lenné (Monash University Accident Research Centre – *Australia*), Paul M. Salmon (University of the Sunshine Coast – *Australia*), Vanessa Beanland (The Australian National University – *Australia*), Guy H. Walker (Heriot-Watt University – *United Kingdom*), Geoff Underwood (University of Nottingham – *United Kingdom*), Ashleigh Filtness (Monash University Accident Research Centre – *Australia*)

12:00 pm **Driver Response to Phase Termination at Signalized Intersections (44)** Joshua Swake, Mafruhatul Jannat, Muhammad Islam, David S. Hurwitz (Oregon State University)

12:30 pm – 2:00 pm **LUNCH**
Conference Center, Mountainview Terrace

Session 7 – Poster Session B
2:00 pm – 3:30 pm
Conference Center, Nirvana

Test-Retest Reliability of Simulated Driving Performance: A Pilot Study (45) Christopher Irwin, David Shum, Michael Leveritt, Ben Desbrow (Griffith Health Institute, Griffith University – *Australia*)

The Development of a Cognitive Skills Training to Support Driver Education – Comparing Performance of Experienced and Trained Learner Drivers (46) Tibor Petzoldt, Thomas Weiß, Josef F. Krems, Maria Bannert (Chemnitz University of Technology – *Germany*)

Vehicle Detection Using Android Smartphones (47) Zhiquan Ren (Shanghai Jiao Tong University – *China*), Chun Wang (University of Minnesota), Jibo He (Wichita State University)

Traffic Sign Detection and Identification (48) Vaughan W. Inman (Science Applications International Corporation [SAIC]), Brian H. Philips (US DOT Federal Highway Administration)

Active Traffic Management Sign Comprehension (49) William A. Perez (Science Applications International Corporation [SAIC]), Brian H. Philips (US DOT Federal Highway Administration)

The Effect of Aging and Ground Texture on the Control of Braking (50) Zheng Bian, George J. Andersen (University of California, Riverside)

Using a Layered Algorithm to Detect Driver Cognitive Distraction (51) Yulan Liang (Liberty Mutual Research Institute for Safety), John D. Lee (University of Wisconsin – Madison)

Assessment of the SEEV Model to Predict Attention Allocation at Intersections During Simulated Driving (52) Nicholas D. Cassavaugh, Alex Bos, Cole McDonald (Central Michigan University), Pujitha Gunaratne (Toyota Motor Engineering & Manufacturing North America), Richard W. Backs (Central Michigan University)

Effect of Driving Experience on Change Detection Based on Target Relevance and Size (53) Alexandra S. Mueller (Western University – *Canada*), Lana M. Trick (University of Guelph – *Canada*)

A Research Synthesis of Text Messaging and Driving Performance (54) Jeff K. Caird, Kate Johnston (University of Calgary – *Canada*), Chelsea Willness (University of Saskatchewan – *Canada*), Mark Asbridge (Dalhousie University – *Canada*)

Can Young Drivers Learn to Anticipate Hidden Hazards: A Driving Simulator Study (55) Siby Samuel, Tracy Zafian, Avinoam Borowsky, Matthew R. E. Romoser, Donald L. Fisher (Arbella Human Performance Laboratory, University of Massachusetts, Amherst)

Driving and Speaking: Revelations by the Head-Mounted Detection Response Task (56) Antonia S. Conti, Carsten Dlugosch (Technische Universität München, Institute of Ergonomics – *Germany*), Felix Schwarz (BMW Group Research and Technology – *Germany*), Klaus Bengler (Technische Universität München, Institute of Ergonomics – *Germany*)

Comparison of Static and Driving Simulator Venues for the Tactile Detection Response Task (57) Johan Engström, Pontus Larsson, Christian Larsson (Advanced Technology and Research, Volvo Group Trucks Technology – *Sweden*)

Effectiveness of Bimodal Versus Unimodal Alerts for Distracted Drivers (58) Bridget A. Lewis, B. N. Penaranda, Daniel M. Roberts, Carryl L. Baldwin (George Mason University)

Driving Hazard Detection with a Bioptic Telescope (59) Amy Doherty, Eli Peli, Gang Luo (Schepens Eye Research Institute, Mass Eye and Ear, Harvard Medical School)

Can Frequency Domain Heart Rate Measures Detect Impaired Driver Performance? (60) C. Heinze (University of Applied Sciences – *Germany*), S. Schirmer (Institute for System Analysis & Applied Numeric [ISAAN] – *Germany*), U. Trutschel (Institute for System Analysis & Applied Numeric [ISAAN] – *Germany;* Circadian), Bill Sirois (Circadian), M. Golz (University of Applied Sciences – *Germany;* Institute for System Analysis & Applied Numeric [ISAAN] – *Germany*), David Edwards (Caterpillar, Inc.)

A Field Study Assessing Driving Performance, Visual Attention, Heart Rate and Subjective Ratings in Response to Two Types of Cognitive Workload (61) Yan Yang, Bryan Reimer, Bruce Mehler, Jonathan Dobres (The Massachusetts Institute of Technology AgeLab; New England University Transportation Center)

Design of Effective Feedback: Understanding Driver, Feedback, and Their Interaction (62) Jing Feng, Birsen Donmez (University of Toronto – *Canada*)

The Relationship between Real-Time EEG Engagement, Distraction and Workload Estimates and Simulator-Based Driving Performance (63) Thomas D. Marcotte, Rachel A. Meyer, Terence Hendrix, Robin Johnson (University of California, San Diego; Advanced Brain Monitoring, Inc.)

Driver Simulation-Based Training of Heavy Vehicle Operators: Targeted Task Analysis and Considerations for Training Design (64) Eve Mitsopoulos-Rubens, Michael G. Lenné (Monash University Accident Research Centre – *Australia*), Paul M. Salmon (University of the Sunshine Coast – *Australia*)

Investigating the Effect of a Visual Search Task for Simulator-Based Driver Training (65) P.M. van Leeuwen, R. Happee, J.C.F. de Winter (Delft University of Technology – *The Netherlands*)

"Choking Under Pressure" in Older Drivers (66) Kuan-Hua Chen, Steven W. Anderson, Michelle L. Rusch, Nazan S. Aksan, Jeffrey D. Dawson, Matthew Rizzo (University of Iowa)

Headway Time and Crashes Among Novice Teens and Experienced Adult Drivers in a Simulated Lead Truck Braking Scenario (67) Catherine C. McDonald (University of Pennsylvania; The Center for Injury Research and Prevention at Children's Hospital of Philadelphia), Thomas S. Seacrist, Yi-Ching Lee, Helen Loeb, Venk Kandadai (The Center for Injury Research and Prevention at Children's Hospital of Philadelphia), Flaura K. Winston (The Center for Injury Research and Prevention at Children's Hospital of Philadelphia; University of Pennsylvania)

Performance Degradation Due to Automation in Texting while Driving (68) Ben D. Sawyer, Peter A. Hancock (University of Central Florida)

2:00 pm – 5:00 pm **BREAK- Refreshments Available**
Conference Center, Nirvana

3:30 pm – 5:00 pm **Exhibitors Available**
Conference Center, Nirvana

6:00 pm – 9:30 pm **DINNER CRUISE**

6:00 pm – 6:30 pm	Board Boat, Sagamore Resort Dock
6:30 pm	Depart
6:00 pm – 9:00 pm	Cash Bar
7:00 pm – 8:00 pm	Dinner
9:30 pm	Return to Sagamore Resort Dock

Thursday, June 20, 2013

7:00 am – 1:00 pm **Registration Open**
Conference Center, Lobby

7:00 am – 8:30 am **Breakfast Buffet**
Conference Center, Foyer

Session 8 – Hybrid Presentations
8:30 am – 10:00 am
Conference Center, Bellvue

Session Chair: Susan Chrysler

3D Spatial Attention Effects are Independent of Projected 2D Size and Location for Older and Younger Drivers (69) Russell S. Pierce, George J. Andersen (University of California, Riverside)

Measuring Young Drivers' Behaviors during Complex Driving Situations (70) Anuj K. Pradhan, Kaigang Li, Johnathon P. Ehsani (National Institutes of Health), Marie Claude Ouimet (University of Sherbrooke – *Canada*), Sheila G. Klauer (Virginia Tech Transportation Institute), Bruce G. Simons-Morton (National Institutes of Health)

Cocktail Party Effect & Attention Capture in Semi-Autonomous Driving (71) Crystal Tobias, Chen-Yung Su, Lutz Kolburg, Brian Lathrop (Volkswagen Group of America, Electronics Research Laboratory)

Factors Affecting Glance Behavior when Interacting with In-Vehicle Devices: Implications from a Simulator Study (72) Yiyun Peng, Linda Ng Boyle (University of Washington), Mahtab Ghazizadeh, John D. Lee (University of Wisconsin – Madison)

The Influence of Passengers on Driving in Young Drivers with Varying Levels of Experience (73) Ryan Toxopeus, Robert Ramkhalawansingh, Lana Trick (University of Guelph – *Canada*)

Permissive Left-Turn Behavior at the Flashing Yellow Arrow in the Presence of Pedestrians (74) Patrick Marnell, Halston Tuss, David Hurwitz (Oregon State University), Kirk Paulsen, Chris Monsere (Portland State University)

Why Should I Use ADAS? Advanced Driver Assistance Systems and the Elderly: Knowledge, Experience and Usage Barriers (75) Nicole Trübswetter, Klaus Bengler (Technische Universität München, Institute of Ergonomics – *Germany*)

Does Personality Influence Engagement in Mobile Phone Tasks? (76) Natasha Merat, James Coleman (Institute for Transport Studies, University of Leeds – *United Kingdom*)

Naturalistic Studies of Driver Distraction: Effects of Analysis Methods on Odds Ratios and Population Attributable Risk (77) Richard A. Young (Wayne State University School of Medicine)

Driver Drowsiness Immediately before Crashes – A Comparative Investigation of EEG Pattern Recognition (78) M. Golz (University of Applied Sciences, Schmalkalden – *Germany*; Institute for System Analysis and Applied Numerics – *Germany*), D. Sommer (University of Applied Sciences, Schmalkalden – *Germany*), U. Trutschel (Circadian Technologies, Inc.; Institute for System Analysis and Applied Numerics – *Germany*), J. Krajewski (University of Wuppertal – *Germany*), B. Sirois (Circadian Technologies, Inc.)

Two-Minute Peripheral Motion Contrast Threshold Test Predicts Older Drivers' Collisions and Hazardous Driving in Simulator (79) Steven Henderson, Charles Collin, Sylvain Gagnon, Misha Voloaca, Heather Woods-Fry (University of Ottawa – *Canada*), John Grant, Ted Rosenthal, Wade Allen (Systems Technology Incorporated)

A Cohort-Based Data Structure Design for Analyzing Crash Risk Using Naturalistic Driving Data (80) Paul P. Jovanis (Pennsylvania State University), Kun-Feng Wu (US DOT Federal Highway Administration)

10:00 am – 10:15 am **BREAK- Refreshments Available**
Conference Center, Foyer

Session 9 – Lectures
Distraction
10:15 am – 11:45 am
Conference Center, Bellvue

Session Chair: Maria Rimini-Doering

10:15 am **A Preliminary Assessment of Perceived and Objectively Scaled Workload of a Voice-Based Driver Interface (81)** Bryan Reimer, Bruce Mehler, Hale McAnulty, Daniel Munger, Alea Mehler, Enrique Abdon Garcia Perez, Thomas Manhardt, Joseph F. Coughlin (The Massachusetts Institute of Technology AgeLab & New England University Transportation Center)

10:35 am **Comparison of Driver Distraction Evaluations across Two Simulator Platforms and an Instrumented Vehicle (82)** Susan T. Chrysler (National Advanced Driving Simulator, University of Iowa), Joel Cooper (Precision Driving Research, Inc.), Daniel V. McGehee (Public Policy Center, University of Iowa), Christine Yager (Texas A&M Transportation Institute)

10:55 am **Looming Auditory and Vibrotactile Collision Warning for Safe Driving (83)** Cristy Ho, Charles Spence (Crossmodal Research Laboratory, University of Oxford – *United Kingdom*), Rob Gray (School of Sport and Exercise Sciences, University of Birmingham – *United Kingdom*)

11:15 am **The Effects of Momentary Visual Disruption on Hazard Anticipation in Driving (84)** Avinoam Borowsky (Liberty Mutual Research Institute for Safety; University of Massachusetts, Amherst), William J. Horrey, Yulan Liang, Angela Garabet, Lucinda Simmons (Liberty Mutual Research Institute for Safety), Donald L. Fisher (University of Massachusetts, Amherst)

11:45 am **Conference Wrap-Up**

12:00 pm – 1:00 pm **Box Luncheon**
Conference Center, Foyer

Summaries

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

(01) ***TOYOTA DISTINGUISHED KEYNOTE LECTURE:*** **Drivers and Driver Assistance Systems: How Well do They Match?** Adrian K. Lund (Insurance Institute for Highway Safety and the Highway Loss Data Institute)

New technology is appearing in vehicles that increasingly allow them to "know" where they are, their relationships to other vehicles on the road, and whether a crash is imminent. At the same time, and more quickly, drivers are becoming more connected to the world outside their cars through similar advances in electronic technology. The first trend promises to help drivers prevent crashes while the second raises fears of increasingly chaotic driving as drivers' minds are elsewhere than on the driving task. Whether the promise of crash avoidance or the fear of driving chaos is realized depends on how drivers actually drive and whether the assumptions made about how they drive are correct. In fact, the US has not seen increases in crash risk as drivers' use of electronics has increased nor are all crash avoidance systems having the expected benefits. In addition to exploring these data, the presentation will address some of the assumptions made about driving (e.g., that driving is difficult, that it requires fully conscious attention, that drivers will respond to information about their vehicles, and others) and whether those assumptions appear to fit the data on crash avoidance and distracted driving. It also will discuss "old" technology (e.g., roundabout intersections and automated enforcement) that may complement vehicle electronics in bringing drivers' wandering attentions back to the road.

(02) Not So Fast! An Investigation of Real-World Speeding Behaviors John L. Campbell, Christian Richard (Battelle), Randolph Atkins (US DOT National Highway Traffic Safety Administration), Monica G. Lichty, James L. Brown (Battelle)

Although speeding is a major contributor to traffic fatalities, attempts to address this problem have not led to significant reductions in speed-related crashes. In this paper, we describe an investigation of speeding behaviors that was intended to: (1) identify which drivers speed, (2) model the relative roles of situational, demographic, and personality factors in predicting travel speeds, and (3) classify drivers based on their speeding patterns. The speeding behaviors of 88 drivers were recorded over the course of approximately four weeks of naturalistic driving in Seattle WA. Data collected included 1-Hz recordings of vehicle position and speed using a GPS receiver, and responses to survey questions. Regression models were developed to identify predictors of 1) "any" speeding and 2) amount of speeding. Significant predictors included demographic variables such as age and gender, situational factors such as time-of-day and day-of-week, and key personality factors such as attitudes towards reckless driving.

(03) Novice Teenage Driver Cell Phone Use Prevalence Johnathon Ehsani, Ashley Brooks-Russell, Kaigang Li, Jessamyn Perlus, Anuj Pradhan, Bruce G. Simons-Morton (National Institutes of Health)

Novice teenage drivers have high crash rates due to inexperience; therefore, cell phone-related secondary task engagement (distracted driving) is likely to aggravate crash risk for this population. A previous study of teenage distracted driving behavior, found that 34% of 16-17- year-olds had texted, and 52% reported talking on a cell phone while driving (Madden & Lenhart, 2009). In the current study, data from the NEXT Generation Health Study were analyzed to estimate the prevalence of cell phone-related distracted driving in a nationally representative sample of U.S. eleventh grade students, the age when most teenagers are first eligible to receive a license to drive independently. Using the subsample of teenagers that reported having a license that allowed independent, driving (n = 881), the prevalence of cell phone-related distracted driving was estimated. Nationwide, four out of five (80.0%) teenage drivers reported making or receiving a call, and 72.0% reported sending or receiving a text message at least one day in the past 30 days. In addition, teenagers reported talking on 32.6% and texting on 40.3% of the days they drove. Access to a vehicle, the number of miles teenagers drove each day (the more driving the more phone use), and race/ethnicity (Asians had lower cell phone use than Whites, Hispanics, or African-Americans), were significantly associated with cell phone-related distracted driving. These findings indicate a higher prevalence of teenage cell phone use while driving than previous studies. More research is needed to understand predictors, safety outcomes, and prevention approaches for teenage distracted driving.

(04) Problems with Sleep Do Not Predict Self-Reported Driving Factors and Perception in Older Drivers: Evidences from the Candrive II Prospective Cohort Sylvain Gagnon, Andrea J. Hickey (University of Ottawa – Canada), Kelly Weegar (Ottawa Hospital Research Institute – Canada), Yara Kadulina (University of Ottawa – Canada), Shawn Marshall (Ottawa Hospital Research Institute – Canada), Anita Myers (University of Waterloo – Canada), Holly Tuokko (Centre for Aging – Canada), Michel Bédard (Centre for Research on Safe Driving – Canada)

Given that sleep problems and serious motor vehicle collisions are increasingly prevalent in older adults, even minor drowsiness could potentially contribute to driving patterns in older drivers. To date, it is unknown whether less serious problems with sleep influence driving frequency and ability in older adults. We investigated the influence of everyday sleep disturbances on driving practices and driver perceptions in a large cohort of healthy older drivers. Self-reported measures of sleep problems were used to investigate the influence of sleep disturbance on self-reported driving practices and perceived driving abilities. On two measures of self-reported driving outcomes, participants with problems rated themselves more poorly. However, this relationship disappeared when health and demographic variables were entered prior in hierarchical regression analyses. Our results show that the relationship between sleep problems, driving frequency and perceived abilities is better explained by mediating demographic, health, and cognitive factors.

(05) Validity of the C-RDS Self-Reported Risky Driving Measure Bruce G. Simons-Morton, Kaigang Li, Ashley Brooks-Russell, Johnathon Ehsani, Anuj Pradhan (National Institutes of Health), Marie Claude Ouimet (University of Sherbrooke – *Canada*), Sheila Klauer (Virginia Tech Transportation Institute)

This study examined the reliability and validity of the Checkpoints Risky Driving Scale (C-RDS) in relation to the Dula Dangerous Driving Index (DDDI) and an objective measure of risky driving. Naturalistic and survey data were collected over an 18-month period from 42 newly-licensed teenage drivers. Kinematic Risky Driving was operationally defined as the rate of elevated gravitational-force events per 100 miles obtained from accelerometers and global positioning systems. Two self-report measures of risky driving, the C-RDS and the DDDI, were assessed at 6-months, 12-months, and 18-months after licensure. Reliability was examined for each measure with correlations and autoregressive models over three time points. Validity was assessed by correlations between the measures and cross-lagged autoregressive models of the longitudinal association of self-reported measures with Kinematic Risky Driving and vice versa. Both the C-RDS and DDDI measures demonstrated substantial stability over time and were highly correlated with each other. The C-RDS measure was significantly associated with Kinematic Risky Driving. The findings provide evidence for the reliability and validity of C-RDS.

(06) A Coaching Program for Recently Licensed Young Drivers in the Netherlands: Which Drivers are Attracted? Erik Roelofs (Cito – *The Netherlands*), Jan Vissers (Royal Haskoning – *The Netherlands*), Marieke van Onna (Cito – *The Netherlands*)

In line with European developments, a Dutch second phase coaching program was developed for young novice drivers to counteract their high accident risk. In this paper the design principles of the program are described. The empirical study focused on the entry characteristics of the participating young drivers (n=3117) as compared to a reference group of young drivers (n=345). Results show that the DX program attracted young drivers that in some respects showed a more risky profile than average young drivers in terms of speed violations, anger and the number of fines. In addition, four groups of participants with sharply differing driving styles could be distinguished.

(07) The Potential for IVDR Feedback and Parental Guidance to Improve Novice Young Drivers' Behavior Oren Musicant, Haneen Farah (The Ran Naor Foundation – *Israel*), Tomer Toledo (Technion – *Israel*), Yaara Shimshoni, Haim Omer (Tel-Aviv University – *Israel*), Tsippy Lotan (Or Yarok – *Israel*)

Young male drivers are well known for their increased involvement in road crashes when moving to the independent driving phase. This study examines the potential of IVDR (In-Vehicle Data Recorder) systems, which provide feedback on driving performances, and parental monitoring to restrain young male drivers' aggressive driving behavior. The IVDR system was installed in the family car of young drivers for a period of 12 months, starting in the accompanied driving phase and continuing to the first nine months of independent driving. The system documents events based on measurements of extreme G-forces in the vehicles. 242 families of young male drivers participated in the study. They were randomly allocated into 4 groups: (1) FFNG- Family Feedback No Guidance- all members of the family were exposed to feedback on their own driving behavior and that of the other family members; (2) FFPG- Family Feedback Parental Guidance - similar to the previous group with the addition of personal guidance given to parents on ways to enhance their involvement and monitoring of their sons' driving; (3) IFNG- Individual Feedback No Guidance- each driver received feedback only on his own driving behavior; (4) CNTL- a control group that received no feedback or parental guidance. The collected data from the IVDR was analyzed and the results indicate substantial benefits to drivers in the FFPG group in which parents received personal guidance to enhance their parental involvement and feedback on their son's driving behavior, compared to the CNTL group which did not receive any feedback.

(08) Using Feedback from Naturalistic Driving to Improve Treatment Adherence in Drivers with Obstructive Sleep Apnea J. Tucker Krone, Jeffrey D. Dawson, Steven W. Anderson, Nazan S. Aksan, Jon Tippin, Matthew Rizzo (University of Iowa)

We are studying the effects of individualized feedback upon adherence with therapy (CPAP) in ongoing research aimed at improving driving safety in at-risk individuals with obstructive sleep apnea (OSA). The feedback includes specific samples of the individual's own naturalistic driving record, both alert and drowsy, and record of CPAP adherence. We report on this methodology, provide data examples of CPAP usage, and show preliminary data on the results in the first eleven drivers who received this intervention.

(09) Assessing the Impact of "Brain Training" on Changes in Driving Performance, Visual Behavior, and Neuropsychology Jonathan Dobres (The Massachusetts Institute of Technology AgeLab), Anya Potter (The Massachusetts Institute of Technology AgeLab; University of Massachusetts), Bryan Reimer, Bruce Mehler, Alea Mehler, Joseph Coughlin (The Massachusetts Institute of Technology AgeLab)

As the population has become both older and more technologically literate, a new class of "brain training" computer programs have gained in popularity. Though these programs have attracted substantial attention from scientists and consumers, the extent of their benefits, if any, remain unclear. Here we employ neuropsychological tests and behavioral metrics collected during periods of real-world driving (with and without manipulations of cognitive load) to evaluate the effects of training with Posit Science's *DriveSharp* software. We find that *DriveSharp*'s training effects appear in in-lab measures of Useful Field of View but did not translate to changes in actual driving performance or changes in visual behavior in consistent or quantifiable ways in the sample assessed. The implications of these results and relevant limitations of the present research are discussed.

(10) Towards Operationalizing Driver Distraction James P. Foley (Toyota Collaborative Safety Research Center), Richard Young (Wayne State School of Medicine), Linda Angell (Virginia Tech Transportation Institute), Joshua E. Domeyer (Toyota Collaborative Safety Research Center)

Driver distraction has been the subject of much research interest and scientific inquiry. Operationalizing driver distraction is a complex task—one that is necessary for advancing both science and public policy in this domain. While many operational definitions can be gathered from the literature, gaps are common. In order to fill such gaps, 21 experts reviewed 55 driver distraction definitions in the literature. Aided by the results of a pre-workshop questionnaire the experts narrowed these definitions. The Regan et al. (2011) definition of driver distraction was agreed to at a workshop. Subsidiary terms related to this definition were defined to improve clarity and applicability of the definition. It is hoped that a consistent and agreed definition of driver distraction and its associated terms will advance scientific progress in understanding and measuring driver distraction.

(11) Sensitivity of Detection Response Task (DRT) to the Driving Demand and Task Difficulty Marie-Pierre Bruyas, Laëtitia Dumont (IFSTTAR-LESCOT – *France*)

The Detection Response Task (DRT) is currently discussed in the ISO working group TC22/SC13/WG8 as the basis of a standard to assess the effect of cognitive load on driver attention. This paper investigates the sensitivity of the method to cognitive and visual-manual tasks of different levels of difficulty and to different levels of driving demand. Three versions of DRT have been used in a simulator experiment: two visual versions (HDRT and RDRT) and one tactile version (TDRT). The results show that response times to DRT stimuli increase with the driving demand and with the difficulty of the cognitive auditory task. However, no difference is registered between visual-manual tasks of different levels of difficulty, which is explained in terms of attentional allocation and ceiling effect.

(12) The Tactile Detection Response Task: Preliminary Validation for Measuring the Attentional Effects of Cognitive Load Richard A. Young, Li Hsieh, Sean Seaman (Wayne State University)

Improved measures of the attentional effects of cognitive load are needed to reduce potential crashes caused by secondary tasks performed while driving. The Tactile Detection Response Task (TDRT) in the proposed ISO Draft Standard WD17488 was tested in laboratory and on-road venues with 16 and 15 subjects, respectively. A sensitivity test used a purely cognitive load increase from an easy (0-back) to hard (1-back) auditory-vocal task. The TDRT response time increased by 90±21 msec in the laboratory, and by 135±34 msec on the road, while the miss rate increased by 4% in the laboratory and 5% on the road, thus validating TDRT sensitivity to an increase in purely cognitive load. A specificity test used a visual load increase with little cognitive load difference from an easy to hard visual-manual "Surrogate Reference Task" (SuRT), to which the TDRT should not respond. The TDRT response time and miss rate to the SuRT did not increase in the laboratory or road as a result of the increased visual load, providing preliminary validation that the TDRT may be both specific and sensitive to the attentional effects of cognitive load.

(13) Detection Response Tasks: Using Remote, Headmounted and Tactile Signals to Assess Cognitive Demand While Driving Joanne L. Harbluk, Peter C. Burns, Sebastian Hernandez, Jane Tam, Viliam Glazduri (Transport Canada – *Canada*)

Three versions of the Detection Response Task (DRT) were evaluated and compared as methods to assess cognitive demand while driving. Participants performed tasks known to manipulate cognitive demand (N_Back tasks) and real-world cognitive demand tasks using the iPhone interface, Siri, while driving a simulator. The Remote DRT, the Head Mounted DRT and the Tactile DRT were all sensitive to task demands but advantages were found to using the newer versions for the assessment of cognitive distraction. This work is part of an international collaborative research effort to standardize the DRT (ISO WD17488).

(14) Improving Restraint Feasibility through Ambulance Layout Redesign Jessica Mueller, Tawny Hoyt, Laura Stanley (Western Transportation Institute, Montana State University)

This study examined the duties performed by emergency medical service workers with the goal of increasing the time EMS workers are restrained while providing patient care during transport. An optimal layout of equipment and materials in the rear patient cabin of an ambulance was created to increase seatbelt restraint feasibility for working medics. Over 13,000 EMS agency call logs were evaluated to identify medical procedures frequently performed during patient transports, which were then filmed and analyzed using Pareto and link analysis to measure restraint feasibility. An alternative ambulance layout was developed following focus group meetings, and the adjusted tasks restraint feasibilities were calculated for the alternative layout. Restraint feasibility was significantly increased for the 5^{th} percentile female, 50^{th} percentile male, and 95^{th} percentile male anthropometric populations. The proposed patient compartment design increased overall restraint feasibility from 47 percent to 90 percent. The proposed design would increase safety for medics and patients during patient transports by increasing the number of tasks that could be performed from a belted and seated position.

(15) Human Factors Issues Associated with Limited Ability Autonomous Driving Systems: Drivers' Allocation of Visual Attention to the Forward Roadway Robert E. Llaneras (Virginia Tech Transportation Institute), Jeremy Salinger, Charles A. Green (General Motors)

This study characterized driver behavior and established a foundation for defining functional performance requirements associated with a Limited Ability Autonomous Driving System (LAADS) – a system capable of automated steering and

speed/headway maintenance tasks on freeways, but does not relieve drivers of all driving tasks. The research was designed to examine and reveal potential issues associated with the use of semi-autonomous systems, exploring impacts on willingness to engage in secondary non-driving related tasks, and driver allocation of visual attention while operating under LAADS (ACC and Lane Centering). Results found meaningful differences in the allocation of visual attention across ACC and LAADS driving under situations where drivers were engaged in a secondary task. Overall findings suggest that given a rudimentary, but reliable, LAADS system (one which does not monitor or otherwise restrict behavior) drivers are likely to increase the frequency of secondary task interactions, and engage in risky tasks that are likely to increase extended glances away from the forward roadway.

(16) How Missing a Treatment of Mixed Amphetamine Salts Extended Release Affects Performance in Teen Drivers with ADHD Lana M. Trick, Ryan Toxopeus (University of Guelph – *Canada*)

Mixed Amphetamine Salts Extended Release (MAS-XR or *Adderall XR*®) is a stimulant medication used to control symptoms of ADHD. People occasionally fail to take their medications. The goal of this pilot study was to assess the impact of a single missed medication on driving performance in 14 teen drivers with ADHD mixed type as a function of driving skill. A double-blind placebo control crossover design was used and participants were tested in a driving simulator. 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 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.

(17) Predictors of Driving in Individuals with Relapsing–Remitting Multiple Sclerosis Abiodun E. Akinwuntan, Kelly Baker, Michelle Manley, Erin McGonegal, Christina O'Connor, Kendra Phillips, Kristen Turchi (Georgia Regents University)

Evaluations on fitness-to-drive of individuals with multiple sclerosis (MS) usually involve the administration of several physical, visual, and cognitive tests. In some instances, a practical road test is also administered. The use of several tests, many of which are only remotely driving-related, increases the time, cost, and human resources involved in the evaluation process, and sometimes lead to erroneous decisions. In this study, we investigated the usefulness of using a short battery of a few highly predictive tests to predict fitness-to-drive of individuals with MS. Forty-four individuals with relapsing–remitting MS (age = 46 ± 11 years, 37 females) and Expanded Disability Status Scale values between 1 and 7 were administered selected physical, visual and cognitive tests including the Stroke Driver Screening Assessment (SDSA) battery. Performance on 12 cognitive and three visual tests were significantly associated with participants' performance on a practical road test. The five psychometric/off-road tests, which together can be administered in less than 45 minutes, cost approximately $150, and is 91% accurate, can be used as a screening battery. Those who pass should be further tested on-road to finally decide their fitness-to-drive while those who fail should be further evaluated, trained, or advised on alternative transportation means. Future studies are needed to confirm and validate the findings in this study.

(18) Formulation of Driver Judgment Process around Curves for Deviated State Detection Motoki Shino, Hiroshi Yoshitake (University of Tokyo – *Japan*), Machiko Hiramatsu, Takashi Sunda (Nissan Motor Co. Ltd – *Japan*), Minoru Kamata (University of Tokyo – *Japan*)

The objective of this study is to propose indices that detect deviated states of drivers during driving considering their judgment process and using a road environment and natural driving behavior database. To this end, we focus on curved roads because as road curvature changes continuously, drivers need to adapt their behavior to not go wide of the lane or the road. The drivers' speed choice behavior around curve situations was focused upon, and a speed choice process was formulated. Moreover, the validity of the formulated speed choice behavior in curve situations was examined using the real vehicle and the simulator.

(19) Age Differences in Driving-Specific Tests of Executive Function Ann E. Lambert, Daniel J. Cox, Melissa L. O'Connor, Rick L. Moncrief, Clarissa Cho, Ronald J. Johnson (University of Virginia Health System)

The purpose of the present study was to examine age differences in executive function as measured by novel driving-specific tests of executive function using a novel driving simulator. Developmental changes in executive function have been implicated as possible contributing factors to elevated crash statistics for both older adult (over age 65) and adolescent (between age 15 and 20) populations, however for different reasons. Poorer older adult driving performance has been partially attributed to general age-related cognitive decline in executive function mediated by age-related frontal-lobe atrophy and neural disconnection. Immature executive function has been implicated in poorer adolescent driving performance and is thought to be expressed in situations where the developmentally high sensitivity of the socio-emotional reward system outcompetes the regulatory influence of the under developed executive system. Using a new, high fidelity, virtual reality driving simulator, we created driving-specific tests to assess executive function. These operational tests employed driving-relevant stimuli, with driving-relevant challenges, that required driving-relevant responses, in a driving-relevant context. Fifteen older adult and 20 adolescent drivers completed these driving-specific executive function tests. We hypothesized that poorer older adult driving performance would be reflected on these driving specific tests of executive function due to general cognitive decline and that, given the absence of social-emotional reward, adolescents would outperform older adults. Analyses of both bivariate correlations and group comparisons generally supported these predictions.

(20) Cooperative Adaptive Cruise Control: Critical Human Factors Issues and Research Questions Stephen Jones (Science Applications International Corporation [SAIC]), Brian H. Philips (US DOT Federal Highway Administration)

As traffic volume and delay on highways increase each year, new solutions are required to meet travel demand and ease congestion. One possible solution, Cooperative Adaptive Cruise Control, permits vehicles and infrastructure to communicate, providing the capability to maintain safety while increasing travel lane capacity. The technical capabilities have been demonstrated, but as important to ensuring successful implementation is an understanding of the potential human factors-related issues. Use of automation in the driving environment can have numerous pitfalls, which are heavily influenced by a variety of both deliberate and reflexive human judgments and decisions known to be error-prone. This paper examines these potential issues and identifies research areas and questions that may guide future research to evaluate the safety, efficacy, and acceptance of this new technology.

(21) Assessing Text Reading and Text Entry while Driving Using the Visual Occlusion Technique Mahtab Ghazizadeh, John D. Lee (University of Wisconsin – Madison), Yiyun Peng, Linda Ng Boyle (University of Washington)

This study estimated the time drivers spend completing text reading and text entry tasks of varying difficulty levels using visual occlusion to mimic the timesharing between driving and interacting with text. The findings showed that text entry took longer than text reading and task time increased with longer text length. In the occlusion condition, the total task time with vision unoccluded was shorter than the task time in the static condition, although this finding was not consistent across reading and entry. Ambient text (irrelevant text surrounding the text of interest) had no effect on time on task. These results should be considered in light of the acceptable limits for time on task and can inform the design of in-vehicle systems that require text reading or entry.

(22) Can Intermittent Video Sampling Capture Individual Differences in Naturalistic Driving? Nazan Aksan, Mark Schall, Steven Anderson, Jeffery Dawson, Jon Tippin, Matthew Rizzo (University of Iowa)

We examined the utility and validity of intermittent video samples from black box devices for capturing individual difference variability in real-world driving performance in an ongoing study of obstructive sleep apnea (OSA) and community controls. Three types of video clips were coded for several dimensions of interest to driving research including safety, exposure, and driver state. The preliminary findings indicated that clip types successfully captured variability along targeted dimensions such as highway vs. city driving, driver state such as distraction and sleepiness, and safety. Sleepiness metrics were meaningfully associated with adherence to PAP (positive airway pressure) therapy. OSA patients who were PAP adherent showed less sleepiness and less non-driving related gaze movements than nonadherent patients. Simple differences in sleepiness did not readily translate to improvements in driver safety, consistent with epidemiologic evidence to date.

(23) Shifting Between Cognitive and Visual Distraction: The Impact of Cognitive Ability on Distraction Caused by Secondary Tasks Sachi Mizobuchi, Mark Chignell (Vocalage Inc.; University of Toronto – *Canada*), Junko Suzuki, Ko Koga, Kazunari Nawa (Toyota InfoTechnology Center Co., Ltd. – *Japan*)

We conducted an experiment in order to investigate impacts of central executive (CE) functions and modality of secondary task presentation in a dual-task experiment. We found that shifting ability, out of three major CE functions (inhibition, shifting, and updating) was particularly important in determining whether primary (pedal-tracking) task performance was better in the presence of auditory, vs. visual, presentation of the secondary task.

(24) Effects of Environmental Factors on Naturalistic Driving in Obstructive Sleep Apnea Lixi Yu, Jeffrey D. Dawson, Nazan S. Aksan, Jon Tippin, Matthew Rizzo (University of Iowa)

Reduced visibility and other environmental factors can impair driver ability to respond to roadway hazards. We examined the effects of reduced visibility on naturalistic driving in 66 drivers, including 45 at-risk drivers with obstructive sleep apnea (OSA) and 21 controls. We analyzed three months of electronic data using "black box" recorder technology and assessed the extent to which driver speed, longitudinal acceleration, and lateral acceleration metrics depend on ambient visibility from web-based environmental data archives. We calculated summary driving metrics within 10-second intervals, and reduced these to within-subject means and tested for associations of interest. OSA drivers did not differ from controls with respect to electronic measures or visibility conditions in which they drove. On average, drivers drove slower when visibility was reduced. After controlling for speed, variations in lateral and longitudinal acceleration were positively associated with high-visibility conditions. These findings suggest that drivers exert greater vehicular control when visibility is limited, and that this association is not just due to slower speeds. Weaker relationships between visibility and driving measures in OSA suggest reduced adaptive strategies. Our methods provide a framework for analyzing the effects of other environmental factors on driving, and we provide an additional example using wind speed.

(25) What Makes a Good Passenger? From Teen Drivers' Perspectives Yi-Ching Lee (Children's Hospital of Philadelphia), Noelle LaVoie (Parallel Consulting, LLC)

An exploratory study was designed to examine male and female teenage drivers' perceptions and expectations of peer passengers. Qualitative methods were used to interview and survey 16- and 17-year-old licensed drivers. 10 interviewees and 96 survey respondents were included in the analysis. Consistent with previous studies, teenage drivers were concerned about passenger-related distractions. There were noticeable differences between males and females in their perceptions of peer

behaviors: females most expected passengers to be non-distracting and polite and males most expected passengers to behave maturely. Future studies should focus on social factors and the psychosocial function of driving for better understanding of the peer passenger interactions, and ultimately the development of passenger-related crash prevention efforts.

(26) Inhibitory Control and Peer Passengers Predict Risky Driving in Young Novice Drivers - A Simulator Study Ellen M.M. Jongen (Transportation Research Institute, Hasselt University – *Belgium*), Kris Brijs (Transportation Research Institute, Hasselt University – *Belgium*; XIOS University College, Department of Construction Engineering – *Belgium*), Tom Brijs, Geert Wets (Transportation Research Institute, Hasselt University – *Belgium*)

This driving simulator study aimed to investigate (1) effects of peer passengers on a variety of risky driving measures, and (2) moderating effects of inhibitory control on these peer passenger effects. Two age groups (n = 30, 17-18 year-olds; n = 20, 21-24 year-olds) participated. Each participant completed two 28km test drives in a medium-fidelity driving simulator. In the first drive, participants were asked to drive as they normally do. In the second drive, participants again were asked to drive as they normally do, now in the presence of a peer passenger. Measures of risky driving were: standard deviation of lateral lane position (SDLP), collisions with road hazards, speeding, and red light running. The results showed: (1) that peer presence can have negative ('risk increasing') but also positive ('protective') effects on driving performance, depending on the specific driving measure: whereas red light running increased, the number of collisions and SDLP decreased with peer passengers; (2) a moderating effect of inhibitory control on the peer passenger effect of speeding as (a) in a sub-group with low inhibitory control an increase in speeding occurred with peers, while (b) in a sub-group with high inhibitory control there was no effect of peers on speeding. This suggests that those with higher inhibitory control are more successful in resisting peer pressure.

(27) An Initial Assessment of the Significance of Task Pacing on Self-Report and Physiological Measures of Workload While Driving Bruce Mehler, Bryan Reimer (The Massachusetts Institute of Technology AgeLab; New England University Transportation Center)

In block A of a simulator study, a sample of 38 drivers showed a stepwise increase in heart rate and skin conductance level (SCL) from single task driving and across 3 levels of an auditory presentation – verbal response dual task (n-back), replicating findings from on-road research. Subjective ratings showed a similar stepwise increase, establishing concurrent validity of the physiological indices as measures of workload. In block B, varying the inter-stimulus interval in the intermediate 1-back level of the task resulted in a pattern across self-report workload ratings, heart rate, and SCL suggesting that task pacing may influence effective workload. Further consideration of the impact of task pacing in auditory-verbal in-vehicle applications is indicated.

(28) Using Manual Measurements on Event Recorder Video and Image Processing Algorithms to Extract Optical Parameters and Range Jonas Bärgman, Julia Werneke, Christian-Nils Boda (Chalmers University of Technology, Division of Vehicle Safety – *Sweden*), Johan Engström (AB Volvo – *Sweden*), Kip Smith (Naval Postgraduate School)

Vehicle kinematics and optical parameters such as optical angle, optical expansion rate, and tau are thought to underlie drivers' ability to avoid and handle critical traffic situations. Analyses of these parameters in naturalistic driving data with video, such as commercial event recordings of near-crashes and crashes, can provide insight into driver behavior in critical traffic situations. This paper describes a pair of methods, one for the range to a lead vehicle and one for its optical angle, that are derived from image processing mathematics and that provide driver behavior researchers with a relatively simple way to extract optical parameters from video-based naturalistic data when automatic image processing is not possible. The methods begin with manual measurements of the size of other road users on a video on a screen. To develop the methods, 20 participants manually measured the width of a lead vehicle on 14 images where the lead vehicle was placed at different distances from the camera. An on-market DriveCam Event Recorder was used to capture these images. A linear model that corrects distortion and modeling optics was developed to transform the on-screen measurements distance (range) to and optical angle of the vehicle. The width of the confidence interval for predicted range is less than 0.1m when the actual distance is less than 10m and the lead-vehicle width estimate is correct. The methods enable driver behavior researchers to easily and accurately estimate useful kinematic and optical parameters from videos (e.g., of crashes and near-crashes) in event-based naturalistic driving data.

(29) Can We Predict Steering Control Performance from a 2D Shape Detection Task? Bobby Nguyen (Wichita State University), Yan Zhuo (Institute of Biophysics, Chinese Academy of Science – *China*), Rui Ni (Wichita State University)

Research has shown the importance of spatial and temporal integration of visual information in motion perception and steering control under reduced visibility conditions. The current study examined the relationship between a 2D shape detection task and a steering control task under reduced visibility conditions for younger drivers. In the 2D shape detection task, the spatial and temporal characteristics, and the contrast of the stimuli were manipulated by varying the number, the lifetime, and the contrast of the random dots. In the steering task, the visibility of the driving scene was manipulated by varying the quantity and quality of the optical flow information. We found that the correlation between shape detection task and steering control task under low contrast conditions depended on temporal integration. These results suggest that under reduced visibility conditions, temporal integration of visual information may play a larger role than spatial integration.

(30) Comparison of the Minisim and Stisim Driving Simulators for the Detection of Impairment: An Alcohol Validation Study Gary Kay (Cognitive Research Corporation), Omar Ahmad, Timothy Brown, Andrew Veit (University of Iowa)

Detection of alcohol impairment is often used to evaluate the sensitivity of a protocol to detect the effects of other types of impairment. This study was designed to compare the sensitivity of two simulator platforms with different underlying architectures using equivalent driving scenarios. The driving scenario consisted of a twenty minute drive on a relatively straight rural roadway with a divided attention task presented infrequently during the drive. A total of 18 subjects completed drives on both simulators at two levels of BAC. It was hypothesized that both simulator platforms would be sensitive to the effects of alcohol. On driving variables and on divided attention variables the MiniSim simulator showed greater sensitivity to the impairing effects of alcohol (at doses below 0.10% BAC) than was found with the STI simulator. The SDLP variable (lane position deviation) was sensitive to alcohol effects with both simulators. However, there was clearly greater sensitivity seen with the MiniSim simulator. For a number of driving and divided attention variables significant results were obtained with the MiniSim, whereas results for the STISIM failed to show a significant alcohol effect. The greater sensitivity of the MiniSim compared to the STISIM is potentially due to a number of differences between the two simulators, though the difference in the vehicle dynamics model would be expected to be the largest determining factor.

(31) Driver Distraction through Conversation Measured with Pupillometry Carsten Dlugosch, Antonia S. Conti, Klaus Bengler (Technische Universität München, Institute of Ergonomics – *Germany*)

Assessing a driver's mental workload during tasks that are not visual-manual is a challenging endeavor. Especially with the rapid development of speech systems, this is becoming increasingly important. Pupillometry promises to be a suitable physiological measurement method, sensitive to variations of cognitive workload. This driving simulator study shows that the pupillometry data indicate a significant increase in cognitive activity during conversation tasks regardless of the acoustic channel used.

(32) On-Road Evaluation of Driver Capability: A Medical Record Review of the Adaptive Driving Program Nahom Beyene, Amy Lane, Rosemarie Cooper, Rory Cooper (University of Pittsburgh)

The purpose of the present study was to illustrate how driver capability could be measured based on the presence of assistance during on-road evaluation. As an objective, this study explored the potential of a new method to measure declines in driver independence (steering/braking assistance) and safety (driving cues) for driver fitness determinations. A study at the Adaptive Driving Program (ADP) was conducted through a medical record review of 132 clients served in 2009. Following creation of an enumerated list of unique errors committed in baseline driving sessions, follow-up analysis focused on the association between assistance during on-road evaluation and case outcomes. The analysis also involved associations between assistance and five classes of errors reported among all clients. Findings showed that the proposed measures of driver independence and safety were associated with 90% of clients that did not pass on-road evaluation and a majority of errors related to tracking vehicle position within a lane. Though documented assistance showed low association to four out of five classes of errors, the potential for detection of these assisted-events may be 60-80% of all errors in each class except for lane changes.

(33) Comparison of Anticipatory Glancing and Risk Mitigation of Novice Drivers and Exemplary Drivers when Approaching Curves Jeffrey W. Muttart, Donald L. Fisher, Alexander P. Pollatsek, Jenna Marquard (University of Massachusetts-Amherst)

Novice drivers are overrepresented in run-off-the-road crashes. Indeed, the previous literature demonstrates that novice drivers are less likely to anticipate hazards or maintain attention to the forward roadway and as a result fail to mitigate hazards by slowing. This research was an effort to compare the linked hazard anticipation and hazard mitigation behaviors of novice drivers with exemplary experienced drivers at curves, locations that are known to have a greater crash risk. Each driver navigated three drives in a driving simulator, one of which included a moderate curve left and one of which included a tightening curve right. Experienced drivers made more anticipatory glances and began slowing significantly earlier in the curves than did novice drivers. However, novice drivers who anticipated hazards were much more likely to also mitigate the hazard. The use of these results in a PC-based driver hazard mitigation training program will be discussed.

(34) Who are the Users of Speed Regulation Assistance? Comparing Driver Characteristics of Casual and Intensive System Users Véronique Huth, Corinne Brusque, Marie-Pierre Bruyas, Valérie Lancelle (IFSTTAR [LESCOT], Université de Lyon – *France*)

Speed regulation assistance can contribute to road safety provided that drivers use the systems on a regular basis. With the objective to gain knowledge about drivers who use Cruise Control and the Speed Limiter, a comparison of the characteristics of casual and intensive users was performed with survey data. The results show that gender and annual mileage play a role for the usage frequency of Cruise Control, whereas the usage frequency of the Speed Limiter depends on age. Consistent effects of the car use for business matters and the use of other in-vehicle technologies were found on the usage frequency of both systems. The predominant motive to reduce speeding found for both systems corresponds with the objective of speed regulation assistance as a safety measure. It was complemented with a comfort benefit perceived by Cruise Control users.

(35) Neuropsychological Predictors of Safety in Urban Left-Turn Scenarios Jeffrey D. Dawson, Lixi Yu, Kuan-Hua Chen, Michelle Rusch, Amy M. Johnson, Nazan S. Aksan (University of Iowa), Takashi Sunda, Machiko Hiramatsu (Nissan Research Center, Nissan Motor Co. – *Japan*), Steven W. Anderson, Matthew Rizzo (University of Iowa)

Left turns at urban intersections can be dangerous, especially when views are obstructed or pedestrians are present. Impairments in driver vision, motor, and cognition functions may further increase left-turn risk. We examined this problem in a simulated environment that included left-turn scenarios to study the driving behaviors of 28 drivers, ages 37 to 88 years, six of whom had "Useful Field of View" (UFOV) impairments. Subjects also completed a battery of neuropsychological tests. The simulated drive included an urban section with six left turns in three types of scenarios: 1) a semi truck blocking the view of oncoming traffic, 2) a lead vehicle obstruction, and 3) a pedestrian crossing ahead of the turning driver. Results showed a mean (SD) of 1.46 (1.60) collisions per driver (range 0 to 7), 83% of which occurred at intersections with semi trucks. Far visual acuity, contrast sensitivity, UFOV, Mini Mental State Examination, Trail-Making Test Part B, the Wisconsin Card Sort task, and age were all associated with the total number of collisions (Pearson correlation magnitudes between 0.37 to 0.77; p-values<0.05). Spearman correlations were less significant. Findings indicate that visual obstruction by an oncoming semi-truck is a particularly dangerous left-turn situation.

(36) *NISSAN DISTINGUISHED KEYNOTE LECTURE*: Distraction: Friend or Foe Professor Clifford Nass (Stanford University)

The classic image in the psychology of driver-car interaction is that of a driver that wants to pay attention to the road: the job of designers is to avoid drawing the driver's attention away from the road. A number of changes in drivers and cars makes this approach obsolete. Specifically, the following questions are pertinent: (1) Do drivers want to pay attention to the road? (2) Can drivers pay attention to the road? (3) Is attention/distraction the right metric for assessing the effects (positive or negative) of design? (4) How do new interfaces necessitate a change in our thinking about attention/distraction? (5) How do fully automated (autonomous) and partially automated vehicles necessitate a change in our thinking about attention/distraction? (6) How can interface design improve driver attention/performance (as opposed to merely reducing attentional demands)?

(37) Predicting Older Adults' On-Road Driving Performance Rachel W. Ross, Charles Scialfa, Scheila Cordazzo, Katherine Bubric (University of Calgary – *Canada*)

We examined the predictive utility of the Roadwise Review and the Hazard Perception Test on a standardized driving assessment using both conventional and alternative scoring criteria in a sample of older adults (N = 57). Our results indicate that the Roadwise Review is not a significant predictor of driving performance using either conventional or alternative scoring criteria. The Hazard Perception Test, in contrast, demonstrated significant predictive utility using alternative scoring criteria and limited but significant predictive utility using conventional scoring criteria.

(38) Validation of Driving Simulation to Assess On-Road Performance in Huntington Disease Hannes Devos (University of Leuven – *Belgium*; University of Iowa), Alice Nieuwboer, Wim Vandenberghe (University of Leuven – *Belgium*), Mark Tant (Belgian Road Safety Institute – *Belgium*), Willy De Weerdt (University of Leuven – *Belgium*), and Ergun Uc (University of Iowa; Veterans Affairs Medical Center)

Driving simulators are increasingly used to assess the driving capabilities of persons with neurodegenerative conditions. However, few driving simulator evaluations have been validated against standardized on-road tests. The aim of this study was to investigate the concurrent validity of a comprehensive driving simulator evaluation in 29 persons with Huntington disease (HD). The Test Ride for Investigating Practical fitness to drive (TRIP) checklist was administered after a 15 km simulator drive and 20 km on-road drive. The total driving simulator TRIP score and each of its item scores were compared with the on-road TRIP scores using Spearman rho correlation statistics. We found significant correlations for 9 of the 12 items. Correlations ranged between 0.12 for the item gap distance at speed below 50 km/h and 0.72 for the total TRIP score, indicating variable strength of the associations. Items assessing operational skills correlated better with on-road driving performance than tactical or higher-order visual items. The results indicate that a fixed-base, single screen driving simulator is a valid tool to assess on-road driving capabilities in persons with HD.

(39) Video Test to Evaluate Detection Performance of Drivers with Hemianopia: Preliminary Results Alex R. Bowers (Schepens Eye Research Institute, Mass Eye and Ear, Harvard Med School; New England College of Optometry), Karen Jeng (UMDNJ-Robert Wood Johnson Medical School), Eli Peli (Schepens Eye Research Institute, Mass Eye and Ear, Harvard Med School; New England College of Optometry), Laura Werner (New England College of Optometry), Amy Doherty (Schepens Eye Research Institute, Mass Eye and Ear, Harvard Med School)

The ability of individuals with hemianopia to compensate for their vision impairment by eye/head scanning to detect hazards in their non-seeing (blind) hemifield varies widely in both simulator and on-road tests. Conventional visual fields tests do not reflect this variability, while simulator and on-road tests are time-consuming and expensive. We therefore developed a simple, 15-minute video-based pedestrian detection test suitable for implementation on a desktop computer and monitor. The test was found to be sensitive to detection deficits in both hemianopia and quadranopia, and predictive of detection performance in a driving simulator. Our preliminary findings suggest that the test provides a simple method of measuring detection ability relevant to driving which may be useful both as a screening test and as an evaluation tool for rehabilitation devices and training.

(40) The Long Road Home: Driving Performance and Ocular Measurements of Drowsiness Following Night Shift-Work William J. Horrey, Yulan Liang (Liberty Mutual Research Institute of Safety), Michael L. Lee (Division of Sleep Medicine, Harvard Medical School), Mark E. Howard (Institute for Breathing & Sleep, Austin Health – *Australia*), Clare Anderson (Monash University – *Australia*), Michael S. Shreeve, Conor O'Brien, Charles A. Czeisler (Division of Sleep Medicine, Harvard Medical School)

Because time-of-day effects on sleepiness interact with duration of prior waking, the commute home following a night shift is an especially vulnerable time for night shift workers. The current study aimed to explore the impact of night shift work on critical driving events as well as to explore physiological indices leading up to these events. Sixteen healthy night shift workers (18-65 years) each participated in two 2-hour driving sessions in an instrumented vehicle on a driving track. A baseline driving session was conducted following a night of rest, while another session was conducted following a night of shift work. Objective physiological measurements of drowsiness were monitored and collected continuously throughout the drive session as well as different measures of driving performance. Following the night-shift, drivers had higher Johns Drowsiness Scores (based on ocular measures) and were more likely to experience lane excursion events and investigator-initiated braking events than following a night's rest. While they also reported increasing failures in lane keeping ability, the pattern was not always consistent with actual observed data. The implications for countermeasures are discussed.

(41) Simulator Sickness Questionnaire: Twenty Years Later Stacy A. Balk, Mary Anne Bertola, Vaughan W. Inman (Science Applications International Corporation [SAIC])

The present study used simulator sickness questionnaire data from nine different studies to validate and explore the work of the most widely used simulator sickness index. The ability to predict participant dropouts as a result of simulator sickness symptoms was also evaluated. Overall, participants experiencing nausea and nausea-related symptoms were the most likely to fail to complete simulations. Further, simulation specific factors that increase the discrepancy between visual and vestibular perceptions are also related to higher participant study dropout rates. As a result, it is suggested that simulations minimize turns, curves, stops, et cetera, if possible, in order to minimize participant simulation sickness symptoms. The present study highlights several factors to attend to in order to minimize elevated participant simulation sickness.

(42) The Design of Haptic Gas Pedal Feedback to Support Eco-Driving Hamish Jamson, Daryl L. Hibberd, Natasha Merat (Institute for Transport Studies, University of Leeds – *United Kingdom*)

Previous literature suggests that haptic gas pedals can assist the driver in search of maximum fuel economy. This study investigated three haptic pedal designs, each with high and low intensities of feedback, in a rapid prototyping, paired comparison design. Twenty drivers took part, experiencing the systems in a high-fidelity driving simulator. Results suggested that drivers were best guided towards an "idealized" (most fuel efficient) gas pedal position by force feedback (where a driver feels a step change in gas pedal force) as opposed to stiffness feedback (where a driver feels a changing gas pedal firmness). In either case, high levels of force/stiffness feedback were preferred. Objective performance measures mirrored the subjective results. Whilst the short-term nature (brief system exposure) of this study led to difficulties in drawing longer-term conclusions, it would appear that force feedback haptics are better suited than stiffness feedback to augment an effective driver interface supporting "green" driving.

(43) Interactions between Cars and Motorcycles: Testing Underlying Concepts through Integration of On-Road and Simulator Studies Michael G. Lenné (Monash University Accident Research Centre – *Australia*), Paul M. Salmon (University of the Sunshine Coast – *Australia*), Vanessa Beanland (The Australian National University – *Australia*), Guy H. Walker (Heriot-Watt University – *United Kingdom*), Geoff Underwood (University of Nottingham – *United Kingdom*), Ashleigh Filtness (Monash University Accident Research Centre – *Australia*)

We conducted on-road and simulator studies to explore the mechanisms underpinning driver-rider crashes. In Study 1 the verbal protocols of 40 drivers and riders were assessed at intersections as part of a 15km on-road route in Melbourne. Network analysis of the verbal transcripts highlighted key differences in the situation awareness of drivers and riders at intersections. In a further study using a driving simulator we examined in car drivers the influence of acute exposure to motorcyclists. In a 15 min simulated drive, 40 drivers saw either no motorcycles or a high number of motorcycles in the surrounding traffic. In a subsequent 45-60 min drive, drivers were asked to detect motorcycles in traffic. The proportion of motorcycles was manipulated so that there was either a high (120) or low (6) number of motorcycles during the drive. Those drivers exposed to a high number of motorcycles were significantly faster at detecting motorcycles. Fundamentally, the incompatible situation awareness at intersections by drivers and riders underpins the conflicts. Study 2 offers some suggestions for a countermeasure here, although more research around schema and exposure training to support safer interactions is needed.

(44) Driver Response to Phase Termination at Signalized Intersections Joshua Swake, Mafruhatul Jannat, Muhammad Islam, David S. Hurwitz (Oregon State University)

Type-II dilemma zones are the segment of roadway approaching an intersection where drivers have difficulty deciding to stop or proceed at the onset of the circular yellow indication. Signalized intersection safety is improved when dilemma zones are correctly identified and steps are taken to reduce the likelihood that vehicles are caught in such zones. This research purports that using driving simulator as a means to collect driver response data at the onset of the circular yellow indication is a valid methodology to augment our analysis of decisions and reactions made within the dilemma zone. The data obtained was

compared against that from previous experiments documented in the literature and the evidence suggests that driving simulation is a valid mechanism for describing driver behavior under the given conditions.

(45) Test-Retest Reliability of Simulated Driving Performance: A Pilot Study Christopher Irwin, David Shum, Michael Leveritt, Ben Desbrow (Griffith Health Institute, Griffith University – *Australia*)

Twenty-seven volunteers completed three simulated driving tests to determine test-retest reliability of performance on a low-cost, fixed-base computerized driving simulator. One retest was completed a few hours after the initial drive and the final retest was completed 7 days following the initial test drive. Driving performance was compared using measures of vehicle control, speed, and reaction time to critical events. A measure of participants' ability to inhibit a pre-potent response was also assessed using an inhibition task during each drive, with the number of incorrect inhibition responses recorded. Practice effects were evident for measures of vehicle control (deviation of lane position and number of line crossings) and participants' ability to withhold responses to inhibition tasks. Good test-retest reliability was observed for measures of vehicle control, speed, reaction time, and variability measures. Poor test-retest reliability was observed for the number of stopping failures observed during driving. The findings from this study suggest that the driving scenario used provides reliable assessment tasks that could be used to track the effects of pharmacological treatments on driving performance. However, an additional familiarization drive should be included as part of future study protocols employing this driving scenario to reduce learning effects during trials. Care should also be taken when interpreting results from tasks with low test-retest reliability.

(46) The Development of a Cognitive Skills Training to Support Driver Education – Comparing Performance of Experienced and Trained Learner Drivers Tibor Petzoldt, Thomas Weiß, Josef F. Krems, Maria Bannert (Chemnitz University of Technology – *Germany*)

Deficits in cognitive skills such as hazard perception are considered one of the major factors explaining the high numbers of crashes for novice drivers. Computer based trainings (CBTs) have been identified as a potential measure to improve such skills. Several CBTs have been developed since. Some of them have been evaluated, however, only by comparing a treatment group and a control group. While results show that the evaluated CBTs are somewhat effective, it is unclear how an experienced driver would have performed in the test scenarios. We developed our own CBT, and in a first step, evaluated it following the same known strategy (treatment and control group, adding a "paper based training group). Results provided evidence for the assumption that the CBT had a positive effect on learner drivers' glance behaviour in simulated driving (Petzoldt et al., 2013). However, after we confirmed the effectiveness, we tested a group of experienced drivers on exactly the same simulator scenarios. The comparison between treatment, control and experienced driver group is presented in this paper. Results show comparable patterns of glance behaviour for the treatment group and the experienced drivers, superior to that of the control group. Driving performance rated by experts was mostly appropriate for all groups, with notable exceptions for some scenarios.

(47) Vehicle Detection Using Android Smartphones Zhiquan Ren (Shanghai Jiao Tong University – *China*), Chun Wang (University of Minnesota), Jibo He (Wichita State University)

Rear-end collisions are the most common traffic accidents. Technologies, such as collision warning systems, are developed to reduce the risks of rear-end collisions. This study presents a mobile technology using smartphones to detect the leading vehicle, allowing the possibility to make collision warning systems more affordable and portable. This technology uses the rear camera of an Android smartphone to capture images of driving scenes, and then uses advanced computer vision algorithms to detect and track the leading vehicle. This study may have important applications to improve driving safety.

(48) Traffic Sign Detection and Identification Vaughan W. Inman (Science Applications International Corporation [SAIC]), Brian H. Philips (US DOT Federal Highway Administration)

Previous studies using eye-trackers have suggested that drivers can extract information from traffic signs and markings without fixating them. The first study reported here examined the angle of gaze away from signs that enables sign detection: detection conspicuity angle. A second study examined the angle of gaze away from signs that enables identification of the signs' messages: identification conspicuity angle. Because conspicuity is viewed as a product of the properties of objects and their surrounding environment, both studies manipulated the background of the signs. Detection conspicuity was sensitive to the background environment, particularly for regulatory signs, for which detection conspicuity was reduced with light-colored or cluttered backgrounds. Background environment had little measureable effect on sign message identification. It is recommended that sign backgrounds be considered when locating signs, and that if the background does not provide adequate contrast, conspicuity enhancement strategies should be considered.

(49) Active Traffic Management Sign Comprehension William A. Perez (Science Applications International Corporation [SAIC]), Brian H. Philips (US DOT Federal Highway Administration)

Active traffic management (ATM) strategies are being deployed in the United States to deliver additional information to drivers. Per lane variable speed limit and lane control signs are being deployed along with dynamic message signs that display warning and other motorist information. The Manual of Uniformed Traffic Control Devices currently does not provide guidelines or standards for these signs. The present research is the first in a series of studies aimed at providing data that can be used to develop guidelines and standards. This study used laboratory procedures to examine comprehension and preference for

various variable speed limit and lane control sign messages. The results indicate that while participants sometimes make errors interpreting some advisory messages, they generally correctly interpreted the lane control and speed limit ATM signs.

(50) The Effect of Aging and Ground Texture on the Control of Braking Zheng Bian, George J. Andersen (University of California, Riverside)

In the current study we examined age-related difference in the use of visual information in regulating braking. Younger and older drivers were presented with computer generated 3-D scenes simulating driving on a roadway towards three red stop signs at a constant speed. The task of the drivers was to control braking and to stop as close as possible to the stop signs. The texture density on the ground, initial time to contact (TTC) and initial distance from the stop signs were manipulated. We found that older drivers had larger mean stop distance and lower crash rate than younger drivers. In addition, older drivers, as compared to younger drivers, tended to regulate $\dot{\tau}$ more frequently at values larger than -0.5 and less frequently at values smaller than -0.5. These results, taken together, suggest that older drivers may use a more conservative strategy to control braking in order to avoid collisions.

(51) Using a Layered Algorithm to Detect Driver Cognitive Distraction Yulan Liang (Liberty Mutual Research Institute for Safety), John D. Lee (University of Wisconsin – Madison)

Detection of cognitive distraction presents an indispensable function for driver distraction mitigation systems. In this study, we developed a layered algorithm that integrated two data mining methods—Dynamic Bayesian Network (DBN) and supervised clustering method—to identify cognitive distraction from drivers' eye movements and driving performance measures. We used the data collected in a simulator study to compare the layered algorithm with the original DBN and found that the layered algorithm obtained comparable prediction performance as the original DBN. Meanwhile, the layered algorithm shortened training and prediction time and revealed rich information on the relationship between driver cognitive state and performance. This study demonstrates that data mining methods are suitable to identify human cognitive state from performance.

(52) Assessment of the SEEV Model to Predict Attention Allocation at Intersections During Simulated Driving Nicholas D. Cassavaugh, Alex Bos, Cole McDonald (Central Michigan University), Pujitha Gunarante (Toyota Motor Engineering & Manufacturing North America), Richard W. Backs (Central Michigan University)

We attempted to model attention allocation of experienced drivers using the SEEV model. Unlike previous attempts, the present work looked at attention to entities (vehicles, signs, traffic control devices) in the outside world rather than considering the outside world as a unitary construct. Model parameters were generated from rankings of entities by experienced drivers. Experienced drivers drove a scenario that included a number of intersections interspersed with stretches of straight road. The intersections included non-hazard events. Eye movements were monitored during the driving session. The results of fitting the observed eye movement data to our SEEV model were poor, and were no better than fitting the data to a randomized SEEV model. A number of explanations for this are discussed.

(53) Effect of Driving Experience on Change Detection Based on Target Relevance and Size Alexandra S. Mueller (Western University – *Canada*), Lana M. Trick (University of Guelph – *Canada*)

Earlier studies that investigated the effects of driving experience and target safety relevance on change detection have produced conflicting results. Using a flicker change detection task to investigate the effect of driving experience on the ability to detect changes in objects that vary in safety relevance and size, the present study attempted to clarify some controversies by addressing three important methodological issues. The data showed that experienced drivers exhibited more efficient selection strategies than novice drivers and thus may have more spare resources to analyze less relevant objects in the driving environment. Selection strategies for relevant information appear to be sensitive to object size whereas selection of irrelevant information is downgraded comparatively and unaffected by size. Findings are discussed as they relate to theoretical and practical implications.

(54) A Research Synthesis of Text Messaging and Driving Performance Jeff K. Caird, Kate Johnston (University of Calgary – *Canada*), Chelsea Willness (University of Saskatchewan – *Canada*), Mark Asbridge (Dalhousie University – *Canada*)

To determine the effects of text messaging on driving performance, all available experimental studies that measured driving performance were identified through a variety of database searches and backtracking strategies, and analyzed using standard research synthesis methods. Fourteen studies with a total of 519 participants were coded and analyzed. Methodology, independent and dependent variables, and statistical analyses varied widely across studies, but conclusions were clear and convergent. Reaction time, crashes, longitudinal and lateral control, eye movements, hazard detection and subjective workload measures indicate significant decrements in driving performance while reading and typing text messages. The importance of the results for further policy development and methodological reporting is briefly introduced.

(55) Can Young Drivers Learn to Anticipate Hidden Hazards: A Driving Simulator Study Siby Samuel, Tracy Zafian, Avinoam Borowsky, Matthew R. E. Romoser, Donald L. Fisher (Arbella Human Performance Laboratory, University of Massachusetts, Amherst)

Modern technology makes possible improvements in training programs designed to develop young drivers' abilities to anticipate hazardous situations. These improvements which come from increases in the range of scenarios to which young drivers are exposed and the number of times young drivers can practice the skills they are learning. In this study, a new Flash-based, PC training program that runs on the web, Road Aware® (RA), is evaluated using a driving simulator. The program was developed by State Farm. Twenty-four young trained drivers and twenty four young untrained drivers were asked to drive various simulated hazardous scenarios while their gaze was monitored by an eye tracking system. The results show that trained drivers were more likely to anticipate hazards than their untrained peers, a difference which was present for both near transfer (scenarios that appeared in training) and far transfer scenarios. The effectiveness of RA is compared with other hazard anticipation training programs that were evaluated on a driving simulator and in the field. It appears every bit as effective in general and more effective for some scenarios. Additionally, there is evidence suggesting that, for the first time, young drivers can be trained to anticipate hazards as well as drivers who are older and more experienced.

(56) Driving and Speaking: Revelations by the Head-Mounted Detection Response Task Antonia S. Conti, Carsten Dlugosch (Technische Universität München, Institute of Ergonomics – *Germany*), Felix Schwarz (BMW Group Research and Technology – *Germany*), Klaus Bengler (Technische Universität München, Institute of Ergonomics – *Germany*)

The cognitive workload of speech-related activity needs to be examined in an economic and simple way. This is especially important as in-vehicle technology is becoming more cognitive with, for example, the use of speech-interaction and industry will need a way to keep pace with new technologies. One proposed way to measure cognitive workload is the detection response task (DRT) method. In this study, the DRT was used to assess different speech-related cognitive tasks. Three conversation tasks and the n-back task were performed together with a simulated driving task and a head-mounted DRT (HDRT). The aim was to evaluate the conversation and n-back tasks with the HDRT and to quantify the respective cognitive workload. Results show an increase in HDRT reaction times when additional cognitive tasks are performed relative to baseline measurements. In line with other research methods, the HDRT provided a reliable measurement of additional workload.

(57) Comparison of Static and Driving Simulator Venues for the Tactile Detection Response Task Johan Engström, Pontus Larsson, Christian Larsson (Advanced Technology and Research, Volvo Group Trucks Technology – *Sweden*)

The general objective of the present study was to validate a low-cost, static, version of the Tactile Detection Response Task (TDRT) intended for driver-vehicle interface evaluation in industrial settings. The static TDRT venue was compared to the more commonly used driving simulator venue, where the TDRT and the secondary task under evaluation are performed during simulated driving. The results indicated that the effect of venue was additive over a range of visual-manual and cognitive secondary tasks, which offers preliminary support for the static TDRT venue as a surrogate for the driving simulator TDRT venue. However, a more detailed analysis revealed a counterintuitive effect for one of the visual-manual secondary tasks (SuRT), where the easier version of the task (as confirmed by subjective workload ratings) yielded a stronger effect on the TDRT than the more difficult version. Possible explanations and implications for the TDRT and its application to driver-vehicle interface evaluation are discussed.

(58) Effectiveness of Bimodal Versus Unimodal Alerts for Distracted Drivers Bridget A. Lewis, B. N. Penaranda, Daniel M. Roberts, Carryl L. Baldwin (George Mason University)

Twenty-two participants drove a simulated vehicle while engaged in a low or high working memory load task and responded to signals presented in auditory, visual and tactile modalities or their bimodal combinations by pressing on the brake. Signals were designed to be of low or high urgency in both unimodal and bimodal combinations. High urgency and bimodal signals were responded to faster than their low urgency and unimodal counterparts. Fewer bimodal signals were missed overall. This bimodal advantage was particularly significant relative to unimodal signals of low urgency in the high working memory load condition. Together these results indicate that hazard mapping can most effectively be obtained by designing with both the perceived urgency level of the signal and modal plurality in mind.

(59) Driving Hazard Detection with a Bioptic Telescope Amy Doherty, Eli Peli, Gang Luo (Schepens Eye Research Institute, Mass Eye and Ear, Harvard Medical School)

Driving by visually impaired people using bioptic telescopes is permitted in 43 states, yet their use remains controversial. One of the concerns is that the ring scotoma (blind area caused by the telescope magnification) may block the field-of-view, impacting detection of potential hazards when looking through the telescope. We evaluated the ability of the non-telescope eye to detect hazards in the field-of-view covered by the ring scotoma. Three participants watched a series of 54 real world driving videos that included 45 potential hazardous events and pressed a button as soon as a hazard was detected, in three conditions: just watching the videos, and while performing a reading task without or with a bioptic telescope. Results showed that all participants had either reduced detection rates or increased reaction times to hazards when performing the reading task with a bioptic telescope. These preliminary results suggest that attention demanding tasks and viewing through the telescope might impair hazard detection ability. Additional study is needed to fully understand the safety of bioptic driving.

(60) Can Frequency Domain Heart Rate Measures Detect Impaired Driver Performance? C. Heinze (University of Applied Sciences – *Germany*), S. Schirmer (Institute for System Analysis & Applied Numeric [ISAAN] – *Germany*), U. Trutschel (Institute for System Analysis & Applied Numeric [ISAAN] – *Germany;* Circadian), B. Sirois (Circadian), M. Golz (University of Applied Sciences – *Germany;* Institute for System Analysis & Applied Numeric [ISAAN] – *Germany*), D. Edwards (Caterpillar, Inc.)

An overnight driving simulation scenario with partial sleep deprivation was utilized to induce driver performance impairment. Heart rate (HR) was recorded over the entire experiment; frequency domain HR measures were derived and correlated to variation of lane deviation (VLD), a driving performance measure, and to the driver's state, which was estimated by the Karolinska Sleepiness Scale (KSS). The aim of this study is to evaluate whether frequency domain heart rate measures can be used to detect impaired driver performance as well as reduced driver state. We generalize the concept of the conventional frequency domain HR measures – namely the very-low frequency (VLF), low frequency (LF) band and high frequency (HF) band – into finer-grained frequency bands of 0.02 Hz width. These newly defined frequency bands show a more detailed correlation to driving performance and to driver sleepiness state, taking subject-specific differences into account.

(61) A Field Study Assessing Driving Performance, Visual Attention, Heart Rate and Subjective Ratings in Response to Two Types of Cognitive Workload Yan Yang, Bryan Reimer, Bruce Mehler, Jonathan Dobres (The Massachusetts Institute of Technology AgeLab; New England University Transportation Center)

In an on-road experiment, driving performance, visual attention, heart rate and subjective ratings of workload were evaluated in response to a working memory (n-back) and a visual-spatial (clock) task. Subjective workload ratings for the two types of tasks did not statistically differ, suggesting a similar level of overall workload. Gaze concentration and heart rate showed significant changes relative to single task driving during the extra tasks and the magnitude of change was similar for both, while driving performance measures were not sensitive to the increase in workload. The results suggest high sensitivity of both gaze dispersion and heart rate as measures of workload across these two different types of cognitive demand.

(62) Design of Effective Feedback: Understanding Driver, Feedback, and Their Interaction Jing Feng, Birsen Donmez (University of Toronto – *Canada*)

Risky driving behaviors such as speeding, close car following and engaging in non-driving related secondary tasks are commonly observed and may increase crash risks. Providing effective feedback to drivers of their risky behaviors may decrease the likelihood of hazardous situations, thereby reducing crashes or crash severity. However, inappropriate feedback could lead to distraction and/or added workload to the driver, resulting in undesirable effects on road safety. Successful design of effective feedback builds on a comprehensive understanding of the characteristics of the driver, the feedback, and their interaction. As a first step to this approach, we summarize literature and propose a cognitive model of driver-feedback interaction. This model considers characteristics of the driver and the feedback, and illustrates three feedback loops through which feedback can influence the driver. Although still at a preliminary stage, the model provides a framework for future feedback design and empirical investigations.

(63) The Relationship between Real-Time EEG Engagement, Distraction and Workload Estimates and Simulator-Based Driving Performance Thomas D. Marcotte, Rachel A. Meyer, Terence Hendrix, Robin Johnson (University of California, San Diego; Advanced Brain Monitoring, Inc.)

Identifying potentially impaired drivers is often dependent upon using cognitive testing from a controlled environment (clinic, laboratory) to predict behavior in a dynamic and unpredictable real world driving environment. The goal of this study was to determine the feasibility, and validity, of using a wireless EEG system to ultimately differentiate between impaired and unimpaired drivers. We utilized the B-Alert X10 portable wireless EEG/ECG system and applied previously validated EEG algorithms estimating engagement, workload, and distraction within a sample of normal control (n = 10) and HIV seropositive individuals (n = 14). Participants underwent a 30-minute fully interactive driving simulation. Overall, the HIV+ group evidenced significantly higher distraction during the simulation. When grouped according to poor and good performers on the simulation (regardless of HIV serostatus), those performing worse on the simulation had higher distraction, with a trend for lower workload, levels. We then examined EEG profiles immediately preceding a crash. Prior to a crash, participants evidenced a significant increase in distraction ~ 10-14 seconds leading up to the crash; the greatest increase was seen in the HIV+ group. These preliminary data support the potential utility of using EEG data in patient populations to identify individuals who might be at risk for impaired driving.

(64) Driver Simulation-Based Training of Heavy Vehicle Operators: Targeted Task Analysis and Considerations for Training Design Eve Mitsopoulos-Rubens, Michael G. Lenné (Monash University Accident Research Centre – *Australia*), Paul M. Salmon (University of the Sunshine Coast – *Australia*)

The use of simulation for training operators of heavy vehicles is gaining momentum. However, there still exists a gap in knowledge about the appropriate skills to target, and in particular, with regards to skill areas of a non-technical nature. By taking a first-principles approach, we first sought to conduct a targeted analysis of the heavy vehicle operator task and, in turn, to assess which of the goal-based tasks identified through the task analysis would be most appropriate for simulation-based training. In general, simulation provides a safe and efficient option for training critical skills that could otherwise be trained on road (e.g., gear shifting). Simulation also provides the opportunity to train critical skills in a structured and formal way that could otherwise not be achieved in a real heavy vehicle, except on an opportunistic or incidental basis (e.g., hazard

perception). Nonetheless, the challenge for training system design still remains: what constitutes the appropriate balance between simulator-based and real truck-based practical training, and for which curriculum components and skill sets.

(65) Investigating the Effect of a Visual Search Task for Simulator-Based Driver Training P.M. van Leeuwen, R. Happee, J.C.F. de Winter (Delft University of Technology – *The Netherlands*)

Novice drivers tend to direct their gaze to the road ahead and not scan the environment properly. This study investigated the training effectiveness of a visual search task in a driving simulator, aimed at increasing young drivers' spread of visual search. Two groups of inexperienced drivers were instructed to drive as accurately as possible in the center of the right lane in a self-paced driving task of four 6-min sessions in a rural environment. While driving, one group performed a visual search task, consisting of detecting and fixating on visual stimuli in the peripheral area. The stimuli were purple dots that faded in slowly and disappeared when fixated by the participant. After training, both groups drove a transfer session in an urban environment, in which various hazardous situations occurred. Results showed that both groups improved their lane keeping performance, whereas the training group became more proficient in the visual search task. However, in the transfer session no group differences were detected. In conclusion, despite improvements in visual search performance during a relatively short training period, the visual search training did not detectibly influence the spread of visual search of novice drivers during a post training transfer session.

(66) "Choking Under Pressure" in Older Drivers Kuan-Hua Chen, Steven W. Anderson, Michelle L. Rusch, Nazan S. Aksan, Jeffrey D. Dawson, Matthew Rizzo (University of Iowa)

Aging can impair executive control and emotion regulation, affecting driver decision-making and behavior, especially under stress. We used an interactive driving simulator to investigate ability to make safe left-turns across oncoming traffic under pressure in 13 older (> 65 years old) and 16 middle-aged (35-56 years old) drivers. Drivers made left-turns at an uncontrolled intersection with moderately heavy oncoming traffic. Gaps between oncoming vehicles varied and increased gradually from 2 s to 10 s. Drivers made two left-turns with a vehicle honking aggressively behind (pressure condition), and two left-turns without the honking vehicle (control condition). Results showed that middle-aged drivers made more cautious turning decisions under pressure (by waiting for larger and safer gaps, $p < .001$), but older drivers did not. Further, older driver turning paths deviated under pressure compared to the control condition ($p < .05$), but the middle-aged group did not. Moreover, across all subjects, better executive function was significantly correlated with larger increases of accepted gap size from control to honking ($p < .01$). The findings suggest that older drivers are more sensitive to traffic challenges from environmental pressure and that neural models of older driver performance and safety must factor in age-related changes in executive control and emotion processing.

(67) Headway Time and Crashes Among Novice Teens and Experienced Adult Drivers in a Simulated Lead Truck Braking Scenario Catherine C. McDonald (University of Pennsylvania; The Center for Injury Research and Prevention at Children's Hospital of Philadelphia), Thomas S. Seacrist, Yi-Ching Lee, Helen Loeb, Venk Kandadai (The Center for Injury Research and Prevention at Children's Hospital of Philadelphia), Flaura K. Winston (The Center for Injury Research and Prevention at Children's Hospital of Philadelphia; University of Pennsylvania)

Driving simulators can be used to evaluate driving performance under controlled, safe conditions. Teen drivers are at particular risk for motor vehicle crashes and simulated driving can provide important information on performance. We developed a new simulator protocol, the Simulated Driving Assessment (SDA), with the goal of providing a new tool for driver assessment and a common outcome measure for evaluation of training programs. As an initial effort to examine the validity of the SDA to differentiate performance according to experience, this analysis compared driving behaviors and crashes between novice teens (n=20) and experienced adults (n=17) on a high fidelity simulator for one common crash scenario, a rear-end crash. We examined headway time and crashes during a lead truck with sudden braking event in our SDA. We found that 35% of the novice teens crashed and none of the experienced adults crashed in this lead truck braking event; 50% of the teens versus 25% of the adults had a headway time <3 seconds at the time of truck braking. Among the 10 teens with <3 seconds headway time, 70% crashed. Among all participants with a headway time of 2-3 seconds, further investigation revealed descriptive differences in throttle position and brake pedal force when comparing teens who crashed, teens who did not crash and adults (none of whom crashed). Even with a relatively small sample, we found statistically significant differences in headway time for adults and teens, providing preliminary construct validation for our new SDA.

(68) Performance Degradation Due to Automation in Texting while Driving Ben D. Sawyer, Peter A. Hancock (University of Central Florida)

Previous research concerning the use of cell phones indicates that physical manipulation of the phone in conjunction with the cognitive need to compose a message together contribute to driving performance degradation. We have suggested that automated assistive text entry schemes such as Nokia's T9 may mitigate some of these identified costs. In this work drivers in a simulator drove and texted using either the assistive T9 system or an unassisted multitap system. Contrary to previous pilot findings, participants showed greater degradation of driving performance when using the automated assistive T9 than the unassisted multitap. Findings support the idea that cognitive composition of a message combined with entry interface automation contributed to driving performance degradation. It further implies that the costs of that automation may exceed the benefits.

(69) 3D Spatial Attention Effects are Independent of Projected 2D Size and Location for Older and Younger Drivers
Russell S. Pierce, George J. Andersen (University of California, Riverside)

Previous research has found the reaction time (RT) to light change targets when performing a car following task, is partially dependent on the distance in depth of the target from the driver. Researchers have concluded from this evidence that the spatial extent of attention is three dimensional (3D) during dual-task driving. However, in prior experiments the effect of two-dimensional (2D) projected size and position was not experimentally controlled. If spatial attention is 3D, then there should be an effect of target distance when 2D projected size and position are constant. The purpose of the current work was to assess this hypothesis. We manipulated the size and position of light-change targets at different depths to hold the projected size and position of targets constant between blocks. Although projected size and position were identical in this experiment, the results demonstrated that for younger and older drivers, targets further from the driver were responded to more slowly than targets closer to the driver. These results demonstrate that 3D attention effects are not dependent on projected size or position, and that the mechanism of 3D attention is present in younger and older drivers. These results, considered with the findings of other studies, suggest that tests to assess crash risk, such as the UFOV, are limited in scope because such tests fail to incorporate variation in attention as a function of distance.

(70) Measuring Young Drivers' Behaviors during Complex Driving Situations Anuj K. Pradhan, Kaigang Li, Johnathon P. Ehsani (National Institutes of Health), Marie Claude Ouimet (University of Sherbrooke – *Canada*), Sheila G. Klauer (Virginia Tech Transportation Institute), Bruce G. Simons-Morton (National Institutes of Health)

Driving behaviors of teenagers and adults in complex driving situations, viz., merges and intersections, from an 18-month longitudinal naturalistic driving study were analyzed. Variables from multiple sources were selected to create an *Unsafe Driving Index* to rate drivers' behaviors in these locations. Teenagers scored lower on this index, corresponding to safer driving behaviors, than adults. However, the teenagers' scores for the index increased across the study period. The interpretations of these findings are discussed with respect to the methodological aspects of the study and in terms of driver training and rule following.

(71) Cocktail Party Effect & Attention Capture in Semi-Autonomous Driving Crystal Tobias, Chen-Yung Su, Lutz Kolburg, Brian Lathrop (Volkswagen Group of America, Electronics Research Laboratory)

A personal name has proven to be an effective stimulus to capture attention. The goal of this pilot study is to test if a personal name can be used as an effective audio warning for drivers of semi-autonomous vehicles. Participants drove a driving simulator in both manual and semi-autonomous driving conditions while doing a secondary task. An emergency situation was simulated, and participants were presented with a warning tone or his/her personal name. Reaction times for braking, steering, and eye disengagement were recorded. There was no significant main effect for cue type, a marginally significant interaction effect across driving condition and cue type, and a significant main effect for driving condition. These results suggest that engagement in a secondary task while driving semi-autonomously causes diverted driver attention to be at its highest. Importantly, however, the use of one's personal name shows promise in capturing attention back to the driving task and warrants deeper investigation for future research.

(72) Factors Affecting Glance Behavior when Interacting with In-Vehicle Devices: Implications from a Simulator Study Yiyun Peng, Linda Ng Boyle (University of Washington), Mahtab Ghazizadeh, John D. Lee (University of Wisconsin — Madison)

This study examined the effects of text entry and reading on drivers' eye glance behavior, as influenced by text length and presence of ambient text (i.e., text around targeted text). A simulator study was conducted with 28 drivers. The findings showed that text entry tasks required longer eyes-off-road (EOR) time than text reading tasks. The presence of ambient text also increased the total EOR time for text reading. Tasks with shorter text required shorter individual glances, but even the shortest text entry tasks resulted in long glances for those who entered text in large chunks. Thus, shortening the text length alone may not ensure safe glance behavior and other countermeasures may need to be considered.

(73) The Influence of Passengers on Driving in Young Drivers with Varying Levels of Experience Ryan Toxopeus, Robert Ramkhalawansingh, Lana Trick (University of Guelph – *Canada*)

Young drivers are at disproportionate risk of collision. It is unclear whether it is age or lack of driving experience that is the problem because age and experience are confounded in most studies (experienced drivers are typically much older). This study focused on drivers who were about the same age: all within the critical first years of skill development. We compared drivers just starting to drive (learner's license) with those with a full license. Young drivers are especially at risk when driving with passengers. Consequently, we were interested in how the ability to drive with passengers changes in these first years. Driving performance was measured in a driving simulator when the passenger was absent (Absent condition), and when there was a passenger who was either asking the driver questions or was silent (Talking and Silent conditions). As predicted, the experienced young drivers had lower hazard response times and fewer collisions. Similarly, as predicted, performance was worse in the Talking condition, insofar as more drivers missed their turnoff in the way-finding task (where they were required to arrive at a certain destination using signs and landmarks). However, there were also interactive effects of experience and condition. In-vehicle conversation had an especially negative effect on the least experienced drivers, producing more collisions. Conversely, the more experienced young drivers sped up when they were driving with a passenger who talked with them.

There was little difference between Silent and Absent conditions for all measures. This suggests in-vehicle conversation may be the critical factor.

(74) Permissive Left-Turn Behavior at the Flashing Yellow Arrow in the Presence of Pedestrians Patrick Marnell, Halston Tuss, David Hurwitz (Oregon State University), Kirk Paulsen, Chris Monsere (Portland State University)

Use of the flashing yellow arrow indication for permissive left-turn control has become more common in the U.S. since it was adopted in the 2009 Edition of the Manual on Uniform Traffic Control Devices. A complete understanding of the safety implications at signalized intersections is critically important. This paper examines the results of a permissive left-turn driver behavior study conducted in a high fidelity driving simulator. The experimental results suggest 1) that when there are more pedestrians present in the conflicting crosswalk, the driver's average fixation duration on crossing pedestrians is greater than when there is minimal pedestrian activity; 2) that 4% to 7% of drivers do not fixate on pedestrians in the crosswalk when completing their left turn; and 3) that 39% of drivers do not fixate on likely pedestrian locations when pedestrians are not present.

(75) Why Should I Use ADAS? Advanced Driver Assistance Systems and the Elderly: Knowledge, Experience and Usage Barriers Nicole Trübswetter, Klaus Bengler (Technische Universität München, Institute of Ergonomics – *Germany*)

A vast number of Advanced Driver Assistance Systems (ADAS) are commercially available, all of which have the potential to increase the safety and comfort of driving a car. Due to age-specific performance limitations, older drivers could benefit a great deal from such in-vehicle technologies, provided that they are purchased and used. Based on the results of several market research studies, awareness of ADAS is significantly higher than their usage rate, which is still very low. To analyze the discrepancy between awareness and willingness to use ADAS, 32 older car drivers were surveyed in a semi-structured interview study. This paper examines the knowledge, experience, and barriers toward the use of ADAS in the elderly.

(76) Does Personality Influence Engagement in Mobile Phone Tasks? Natasha Merat, James Coleman (Institute for Transport Studies, University of Leeds – *United Kingdom*)

Drivers' propensity to engage in a telephone conversation and text messaging was observed in a driving simulator study and compared to self-reported engagement in such tasks in the real world. As sensation seeking has been linked to unsafe driving behaviours and self-reported driving violations, drivers were preselected for the study using the Arnett Inventory of Sensation Seeking. In general, drivers' observed engagement with their mobile phone was not as high in the driving simulator as their self-reported declarations. Some differences were found between the high and low sensation seekers, with more phone calls executed by the high sensation seekers and more text messages performed by the low sensation seekers. Self-report results showed higher engagement in hands-held conversations and text messaging by high sensation seekers.

(77) Naturalistic Studies of Driver Distraction: Effects of Analysis Methods on Odds Ratios and Population Attributable Risk Richard A. Young (Wayne State University School of Medicine)

When analyzing naturalistic driver performance data, different analysis methods can have large impacts on safety estimates for the condition being assessed. To illustrate, this paper reanalyzed the data for a secondary task (conversation on a hand-held cell phone) from the recently-released Virginia Tech Transportation Institute (VTTI) 100-Car databases, using a standard method for epidemiological analysis. It found substantially lower estimates for the odds ratio (OR), population exposure percent ($P_e\%$), and population attributable risk percent (PAR%) than with the VTTI analysis method. The crash/near-crash OR was reported by VTTI as 1.29, but was found to be 0.78 with the standard method, a reversal in direction from a potentially crash-increasing to a potentially crash-reducing effect. The $P_e\%$ for crashes/near-crashes was 12.5% using the VTTI method, but declined to 6.7% with the standard method. The PAR% was reported as 3.6% but a population preventive fraction of 1.5% (a protective effect) was estimated by the standard method. The OR difference was traced to an "assumption bias" in the VTTI method that had unequal effects for the unexposed vs. exposed cases. The $P_e\%$ and PAR% differences were traced to an error in the VTTI calculation of $P_e\%$. This bias and error were systemic in the VTTI analysis methods, overestimating OR, $P_e\%$, and PAR% for all tasks examined. Future research should seek to better understand the epidemiologic analysis methods that are most appropriate in the new and emerging field of naturalistic driving research.

(78) Driver Drowsiness Immediately before Crashes – A Comparative Investigation of EEG Pattern Recognition M. Golz (University of Applied Sciences, Schmalkalden – *Germany*; Institute for System Analysis and Applied Numerics – *Germany*), D. Sommer (University of Applied Sciences, Schmalkalden – *Germany*), U. Trutschel (Circadian Technologies, Inc.; Institute for System Analysis and Applied Numerics – *Germany*), J. Krajewski (University of Wuppertal – *Germany*), B. Sirois (Circadian Technologies, Inc.)

Periodogram and other spectral power estimation methods are established in quantitative EEG analysis. Their outcome in case of drowsy subjects fulfilling a sustained attention task is difficult to interpret. Two novel kind of EEG analysis based on pattern recognition were proposed recently, namely the micro-sleep (MS) and the alpha burst (AB) pattern recognition. We compare both methods by applying them to the same experimental data and relating their output variables to two independent variables of driver drowsiness. The latter was an objective lane tracking performance variable and the first was a subjective variable of self-experienced sleepiness. Results offer remarkable differences between both EEG analysis methodologies. The expected increase with time since sleep as well as with time on task, which also exhibited in both independent variables, was not identified after applying AB recognition. The EEG immediately before fatigue related crashes contained both patterns. MS

patterns were remarkably more frequent before crashes; almost every crash (98.5 %) was preceded by MS patterns, whereas less than 64 % of all crashes had AB patterns within a 10 sec pre-crash interval.

(79) Two-Minute Peripheral Motion Contrast Threshold Test Predicts Older Drivers' Collisions and Hazardous Driving in Simulator Steven Henderson, Charles Collin, Sylvain Gagnon, Misha Voloaca, Heather Woods-Fry (University of Ottawa – *Canada*), John Grant, Ted Rosenthal, Wade Allen (Systems Technology Incorporated)

Older drivers' contrast thresholds for low spatial frequency drifting Gabor stimuli at 15 degrees eccentricity were measured with a previously validated 10-minute forced-choice test and a 2-minute increasing contrast detection test (implemented on an iMac and a PC). Older drivers' contrast thresholds significantly predict collisions, near collisions, hazardous lane excursions, and speeding, during a simulated drive with surprising hazard encounters and highway merging tasks. The 2-minute tests also correlate with each other and with the 10-minute test. The 2-minute tests are potentially suitable for use in an operational driver assessment setting.

(80) A Cohort-Based Data Structure Design for Analyzing Crash Risk Using Naturalistic Driving Data Paul P. Jovanis (Pennsylvania State University), Kun-Feng Wu (US DOT Federal Highway Administration)

Although naturalistic driving studies (NDS) have become more prevalent in recent years, many challenges remain in analyzing the data. One challenge is inclusion of exposure in modeling crash risk. While this is a potential strength of NDS, comparatively few studies have emphasized exposure-based analyses. A second challenge is the formulation of analysis methods that include driver attributes, event attributes, and driving environment in a structured formulation. A third challenge is the formulation of baseline hazard to frequently accompany the identification of NDS "events" (e.g. crashes, near crashes and/or safety critical events). This paper reports on a cohort-based data structure design to address these three challenges. Collision warning alert frequency data from University of Michigan Transportation Institute (UMTRI)'s Roadway Departure and Curve Warning System (RDCW) Field Operation Test (FOT) are used to demonstrate this approach. The paper concludes with a discussion of applications which include crash and other NDS-observed events, including potential applications to road safety management through the development of enhanced safety performance functions.

(81) A Preliminary Assessment of Perceived and Objectively Scaled Workload of a Voice-Based Driver Interface Bryan Reimer, Bruce Mehler, Hale McAnulty, Daniel Munger, Alea Mehler, Enrique Abdon Garcia Perez, Thomas Manhardt, Joseph F. Coughlin (The Massachusetts Institute of Technology AgeLab & New England University Transportation Center)

Interaction with a voice-command interface for radio control, destination entry, MP3 song selection, and phone dialing was assessed along with traditional manual radio control and a multi-level audio–verbal calibration task (n-back) on-road in 60 drivers. Subjective workload, compensatory behavior, and physiological indices of cognitive workload suggest that there may be both potential benefits and cautions in the implementation of a representative production level interface.

(82) Comparison of Driver Distraction Evaluations across Two Simulator Platforms and an Instrumented Vehicle Susan T. Chrysler (National Advanced Driving Simulator, University of Iowa), Joel Cooper (Precision Driving Research, Inc.), Daniel V. McGehee (Public Policy Center, University of Iowa), Christine Yager (Texas A&M Transportation Institute)

The purpose of this work was to assess the cross-platform validity of two driving simulators and an instrumented vehicle operated on a closed driving course. Characteristics of vehicle speed and performance to an Alert Response Task were evaluated using a MiniSim, manufactured by the National Advanced Driving Simulator group, a Realtime Technologies, Inc. desktop simulator, and an instrumented 2005 Toyota Highlander. Results indicate a high degree of relative validity between the three research platforms with mean and standard deviation of vehicle speeds showing near identical patterns under various secondary task demands. Performance on an auditory Alert Response Task also showed a high degree of consistency across the three research platforms. Performance on a visual Alert Response Task appeared to be highly reactive with the testing conditions present in the instrumented vehicle evaluations. These data have practical implications for the use of driving simulators in experimentally controlled research and also make suggestions about the use of visual warnings to elicit emergency response behaviors in drivers.

(83) Looming Auditory and Vibrotactile Collision Warning for Safe Driving Cristy Ho, Charles Spence (Crossmodal Research Laboratory, University of Oxford – *United Kingdom*), Rob Gray (School of Sport and Exercise Sciences, University of Birmingham – *United Kingdom*)

Looming auditory warning signals (that is, signals whose intensity increases over time) have proven to be particularly effective in terms of reducing a driver's brake reaction times (BRTs) to impending collisions, and are also associated with very low false alarm rates. We report two experiments designed to further investigate how the presentation of looming auditory warnings with increasing frequency or increasing spatial extent would compare to those with increasing intensity. A third experiment was conducted in order to evaluate the potential efficacy of presenting looming warnings to drivers in another modality, namely via vibrotactile signals. Participants' speeded BRTs to potential collision events following the presentation of various warning signals in a simulated car following scenario were measured. While both looming frequency and spatial warnings were effective in terms of speeding the driver's responses to critical driving events, the magnitude of the benefit resembled that of a typical non-looming constant intensity warning. Looming intensity warnings outperformed their looming frequency counterparts in terms of facilitating drivers' collision avoidance responses. As for vibrotactile warnings, the results revealed that

looming vibrotactile stimuli did not offer any additional benefits over and above the other non-looming vibrations tested in the study. The implications of these findings for collision warning systems design are discussed.

(84) The Effects of Momentary Visual Disruption on Hazard Anticipation in Driving Avinoam Borowsky (Liberty Mutual Research Institute of Safety; University of Massachusetts, Amherst), William J. Horrey, Yulan Liang, Angela Garabet, Lucinda Simmons (Liberty Mutual Research Institute of Safety), Donald L. Fisher (University of Massachusetts, Amherst)

Driver distraction is known to increase crashes, especially when the driver glances for especially long periods of time inside the vehicle. While it is clear that such glances increase risk for the driver when looking inside the vehicle, it is less clear how these glances disrupt the ongoing processing of information outside the vehicle once the eyes return to the road. The present study was aimed at exploring the effect of visual disruptions on the top-down processes that guide the detection and monitoring of hazards on the forward roadway. Using a driving simulator, twelve participants were monitored with an eye tracking system while they navigated various hazardous scenarios. Six participants were momentarily interrupted by a visual secondary task (simulating a glance inside the vehicle) prior to the hazard occurrence and six were not. Eye movement analyses show that interrupted drivers often failed to continue scanning for a hazard when their forward view reappeared. Implications of this study are discussed.

Driving Assessment 2013 Daily Schedule

Monday, June 17, 2013

2:00-6:00 PM	**Early Registration**
2:00-5:30 PM	**Exhibitor Set Up**
6:00-8:30 PM	**Welcome Reception**

Tuesday, June 18, 2013

7:00 AM–5:30 PM	**Registration Open**
7:00-8:30 AM	**Breakfast Buffet**
8:00 AM-5:00 PM	**Exhibitors Available**
8:00-9:00 AM	**Toyota Distinguished Keynote Lecture** **Drivers and Driver Assistance Systems: How Well Do They Match** Adrian K. Lund, President *(Insurance Institute for Highway Safety and the Highway Loss Data Institute)*
9:00-9:15 AM	**Break**
9:15-10:45 AM	**Session 1 - Lectures** **Driver Behavior and Naturalistic Studies**
10:45-11:00 AM	**Break-Refreshments Available**
11:00 AM-12:30 PM	**Session 2 - Lectures** **Coaching and Training**
12:30-2:00 PM	**Honda Luncheon & Outstanding Student Paper Awards Ceremony**
2:00-3:30 PM	**Session 3 - Lectures** **Measuring Driving Distraction**
3:30-5:00 PM	**Break-Refreshments Available**
3:30- 5:00 PM	**Session 4 - Poster Session A** *(Set-up 7:00-11:00 AM)* *(Tear down 5:00-5:30 PM)*

Wednesday, June 19, 2013

7:00 AM–4:30 PM	**Registration Open**
7:00-8:30 AM	**Breakfast Buffet**
8:00 AM-5:00 PM	**Exhibitors Available**
8:00-9:00 AM	**Nissan Distinguished Keynote Lecture** **Distraction: Friend or Foe** Professor Clifford Nass *Stanford University, United States*
9:00-9:15 AM	**Break**
9:15-10:45 AM	**Session 5 - Lectures** **Fitness to Drive**
10:45-11:00 AM	**Break-Refreshments Available**
11:00 AM-12:30 PM	**Session 6 - Lectures** **Driver Performance and Simulation Studies**
12:30-2:00 PM	**Lunch**
2:00-3:30 PM	**Session 7 Poster Session B** *(Set-up 7:00-11:00 AM)* *(Tear down 3:30-4:00 PM)*
2:00-5:00 PM	**Break-Refreshments Available**
3:30-5:00 PM	**Exhibitors Available** *(Tear down 5:00-5:30)*
6:00 PM	**Dinner Cruise -- Board from Hotel**
6:30 PM	**Depart from Sagamore Dock**
6:00-9:00 PM	**Cash Bar**
7:00-8:00 PM	**Dinner**
9:30 PM	**Return to Sagamore Dock**

Thursday, June 20, 2013

7:00 AM–1:00 PM	**Registration Open**
7:00-8:30 AM	**Breakfast Buffet**
8:30-10:00 AM	**Session 8 - Hybrid Presentation** *(Set-up 7:00-8:30 AM)* *(Tear down 10:00-10:15)*
10:00-10:15 AM	**Break-Refreshments Available**
10:15-11:45 AM	**Session 9 - Lectures** **Distraction**
11:45 AM	**Conference Wrap-Up**
12:00-1:00 PM	**Box Luncheon**