The Eye, The Brain & The Auto
World Research Congress

9TH WORLD RESEARCH CONGRESS ON HEALTH AND MODERN MOBILITY:

Autonomous Vehicles, Driver's Fitness to Function and Naturalistic Driving Methods

December 7-8, 2020
Virtual Event

Henry Ford Health System

Department of Ophthalmology

Detroit Institute of Ophthalmology

Henry Ford Health System

DEPARTMENT OF OPHTHALMOLOGY

Detroit Institute of Ophthalmology

Thank you to

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The Eye, The Brain and The Auto

World Research Congress

Henry Ford Health System

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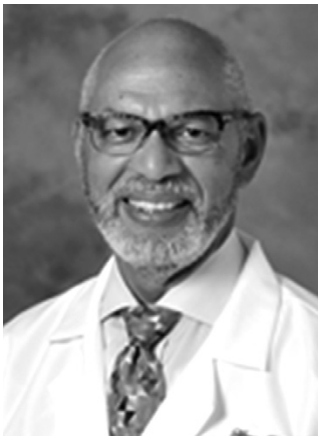


Welcome

On behalf of the Henry Ford Health System and the Department of Ophthalmology, welcome to The Eye, The Brain, and The Auto 9th World Research Congress. Philip Hessburg, M.D., Medical Director of the Detroit Institute of Ophthalmology, along with the World Congress planning team, have brought together the world's foremost experts on the relationship between vision and the safe operation of the motor vehicle. This year we have exciting topics for our attendees and participants ranging from visual and cognitive performance and their influence on driving, assessing driving disabilities and again this year a discussion on the emerging autonomous vehicle and how adoption of this technology will impact health and the loss of lives due to auto accidents on the roads and highways in this country.

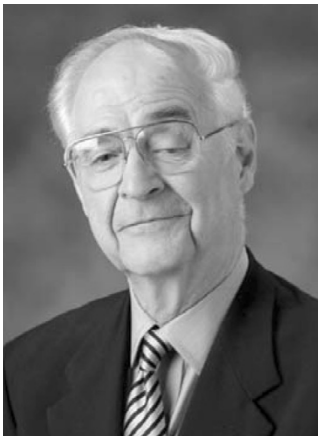
We had an exciting start to the congress with a series of pre-congress panels. These were well organized and well received. They really have added much to the quality of this congress.

Due to the relentless pandemic that has literally overwhelmed the world we have had to adapt, like many other organizations, by developing a virtual presentation of this congress. We have learned from other meetings and hope ours will go smoothly.

Thank you to the entire planning committee for their hard work in helping to organize the congress. I would like to also take this opportunity to thank our esteemed panel of presenters from around the world. Finally, I would also like to thank each of our attendees for participating in this year's congress. I am delighted that you are joining us virtually and hope that you find the presentations and conversations very valuable and informative.

Sincerely,

Paul A. Edwards, M.D., F.A.C.S.
Chairman
The McCole Chair
Department of Ophthalmology
Henry Ford Health System



Colleagues

Welcome to the 9th Biennial Research Congress, ***The Eye, The Brain and The Auto 2020*** on the relationship between vision and the safe operation of a motorized vehicle. The Detroit Institute of Ophthalmology, a Division of the Department of Ophthalmology of the Henry Ford Health System, is pleased to have you join us virtually in resurgent Detroit. Our brilliant co-organizer of this congress is Professor Cynthia Owsley, Ph.D. of the Department of Ophthalmology at the University of Alabama at Birmingham.

At the first edition of this congress we noted the challenges of those of us in medicine in attempts to understand the automobile licensure requirements in virtually every state relative to vision. Two decades later we are still bewildered. There seems to be little or no relationship between required acuity levels and crash statistics until one's vision decays to levels considerably below these mandated acceptable by law. So, by law, we punish drivers with visual acuity levels of 20/100, or even better, by denying them a driver's license with no data to establish that they might be a danger to themselves, or to you, on the world's roadways. Although two decades and nine congresses later we have not yet had a desirable rethinking by state legislators. We are not discouraged by this inequity knowing that it is not unusual for long delays before legislation reflects science.

We are especially proud that at these congresses several hundred physicians, research scientists, and engineers have presented valuable original work. Those contributions are available from the Institute for the asking.

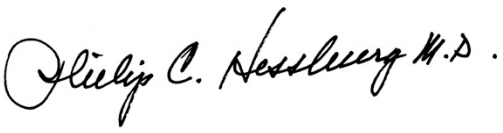
In alternate years to this congress the Institute holds another, ***The Eye and The Chip***, studying the development of a visual nano-electronic prosthetic device to be implanted in the eye or the brain of persons now blind to afford them some level of useful vision. Our co-organizer of that congress is Professor Joseph Rizzo, M.D., the distinguished director of the neuro-ophthalmology section in the Department of Ophthalmology at Harvard Medical School.

In private dialogue between Drs. Owsley and Rizzo it occurred to them that the technology necessary for an implant to assist a blind person to cross a busy street without a dog or a cane but with an eye or brain implant and the technology necessary for a driverless vehicle to autonomously travel down a major highway were very closely related to each other. Therein lies the genesis of the Detroit Institute of Ophthalmology's interest in autonomous mobility and the role it will play in health care; a major thrust of this year's congress.

Both Drs. Rizzo and Owsley are presenting a Keynote address this year. Each has contributed greatly to their field internationally and to these Henry Ford / Detroit Institute of Ophthalmology congresses. We are greatly honored to have their inspiration — and their presence!

Welcome to ***The Eye, The Brain and The Auto 2020***.
We consider it an honor, also, to have you with us.

God willing it will be an in-person meeting as we gather again in 2022 for the 10th version of this congress!



Philip C. Hessburg, M.D.
Medical Director, Detroit Institute of Ophthalmology
Senior Staff Ophthalmologist, Henry Ford Health System

The DIO: Support for the Visually Impaired, Education and Vision Research

Imagine having very poor vision or not being able to see at all. Now imagine an organization that helps you and your family – and one that's a world leader in bringing together researchers studying advances in eyesight and vision.

For more than 45 years, that's been the mission of the Detroit Institute of Ophthalmology, the research education arm of the Henry Ford Department of Ophthalmology (DIO). The DIO exists to assist and educate the visually impaired helping them maintain independence and dignity and live satisfying lives in a sighted world. The DIO also sponsors international research congresses that annually bring together the world's leading vision-related scientists.

To help the blind and visually impaired maintain the highest quality of life, the DIO offers a comprehensive range of support services. These include:

Support Groups
For more than four decades, the DIO has sought to help those who suffer from vision loss by managing support groups for the visually impaired. These groups are offered at various locations in southeast Michigan. All groups offer hope, joy, compassion, understanding and interaction with others who are similarly challenged. Thanks to Edward T. and Ellen K. Dryer Charitable Foundation and The Mary Thompson Foundation for their support.

Martha F. Gorey Resource Center
Named for a long-time benefactor and housed within the DIO, the Center offers one of the largest collections of low-vision aids in southeast Michigan. These include closed-circuit magnifying machines, hand-held and stand magnifiers up to 3x, large-print calendars, talking watches, clocks and calculators

Education
The DIO provides a variety of educational resources to both the visually impaired and sighted communities, including:

- **Professional Education:** DIO is closely affiliated with the ophthalmic technician training program at Henry Ford College, Dearborn, and the Henry Ford Health System Department of Ophthalmology's Residency Training program. One of the physicians of the DIO serves as both the Medical Director for the Henry Ford College Ophthalmic Technician Training Program and as the Residency Program Director and Vice Chair of Education for the Department of Ophthalmology at Henry Ford Hospital. Throughout the year, various workshops for training physicians in internal medicine and emergency medicine are conducted at the DIO.

- **Public Education:** DIO participates at Assumption Senior Expo each year providing information and resources for visually impaired seniors and their families.

Research Congress
The DIO sponsors two international vision-related research congresses that assemble more than 30 of the world's top vision-related scientists for two or three days of meetings and seminars in Detroit. Alternating each year, these congresses are: The Eye, The Brain and The Auto, and The Eye and The Chip. Find more information at: www.henryford.com/theeyeandthechip

Friends of Vision
Many DIO programs rely on support from its volunteer arm, the Friends of Vision. They provide support to the visually impaired in several ways, including helping to set up and provide transportation to meetings and events; escorting them

on field trips; staffing the Martha F. Gorey Resource Center store; and participating in such events as managing the cash raffle at the EyesOn Design Car Show. Volunteers receive necessary training and choose the activities that best match their schedules and interests.

DIO Support
In addition to the EyesOn Design events, DIO programs are supported by generous donations from individuals, foundations and businesses. The many ways you can help include:

- Bequests
- Fundraisers/special events
- Donations of time and/or money
- Honorary/memorial gifts
- Endowments
- Matching funds

Through the commitment of a very generous donor, DIO has established the Philip C. Hessburg, M.D. Detroit Institute of Ophthalmology Endowed Lectureship: Progress in the Eradication of Blindness. Its purpose is to honor Dr. Hessburg and to ensure that the vital work of the Detroit Institute of Ophthalmology endures.

For more information please call the DIO at (313) 824-4710, or visit henryford.com/DIO.

Henry Ford Health System

DEPARTMENT OF OPHTHALMOLOGY

Detroit Institute of Ophthalmology

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The Eye, The Brain and The Auto

World Research Congress

At the Henry Ford Health System Department of Ophthalmology, patients will find:

- Board-certified physicians, with leaders in comprehensive ophthalmology and ophthalmic sub-specialties, including surgical care
- Advanced treatment options, led by continuous research
- One of the largest practices in the United States, providing convenient, high-quality and compassionate care for over 75 years

At Henry Ford the patients come first

A leader in Michigan, as well as one of the largest ophthalmology practices in the United States, the Henry Ford Department of Ophthalmology treats more than 55,000 patients per year at 12 locations throughout southeast Michigan.

Coordinated care

Our ophthalmologists also work closely with Henry Ford Medical Group physicians in other departments, providing multi-disciplinary, coordinated care for those patients who need it.

Pioneering vision research

In addition, we are dedicated to vision research, helping to increase our understanding of disease processes and the most effective ways to detect, diagnose, treat and prevent these conditions. Ultimately, our extensive research program helps to break new ground in critical areas of vision research, keeping us at the forefront of innovation while advancing the level of eye care that we provide to our patients.

ACCREDITATION STATEMENT: Henry Ford Health System is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

DESIGNATION STATEMENT: Henry Ford Health System designates this live course for a maximum of **14.5** AMA PRA Category 1 Credit(s) TM. Physicians should only claim the credit commensurate with the extent of their participation in the activity.

FACULTY/PLANNING COMMITTEE DISCLOSURE STATEMENT: In compliance with the ACCME standards for commercial support, all individuals in a position to control/influence the content of this activity are required to disclose relevant financial interests of their own or spouse or partners with any commercial interests and /or non-FDA approved use of a drug or a device that is included in the presentation.

HEARING IMPAIRED STATEMENT: Henry Ford Health System is committed to ensuring that our guests who are deaf or hard-of-hearing have equal access to all the services provided at our facilities. We provide at no cost the appropriate auxiliary aids and services. To request an assistive listening device or service, please email Tina Miller at cmille26@hfhs.org or call (313) 916-3903.

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PROGRAM SCHEDULE

MONDAY, DECEMBER 7, 2020

(Presentations are 20-minutes long, plus a 10-minute Q & A – Challenge period)

*All Times USA, Eastern Time Zone

8:20 – 8:25 am* **Welcome: Paul A. Edwards, M.D., Chair, Department of Ophthalmology, Henry Ford Health System**

8:25 – 8:30 am* **Housekeeping: David Goldman, M.D., Department of Ophthalmology, Henry Ford Health System**

Session One - The Driver and Driving Simulators

Moderator: Eli Peli, O.D., Schepens Eye Research Institute, Massachusetts Eye and Ear Infirmary, Boston, Massachusetts

8:30 – 9:00 am* *A Driving Simulator as a Highly Standardized Tool for Benchmarking the Quality of Refractive Care*
Judith Ungewiss Ph.D., Ulrich Schiefer, Ph.D., Michael Woerner, Ph.D., Aalen University of Applied Sciences, Aalen, Germany

9:00 - 9:30 am* *Increased Visual-Cognitive Demands in Driving Simulator Result in Modifications of Eye-Head Coordination and Dynamic Visual Scanning*
Laura Mikula, Ph.D., University of Montreal, Montreal, Canada

9:30 - 10:00 am* **Keynote Address:** *Physicians and Scientists as Wayfinders on the Road to Zero*
Stewart Wang, M.D., Ph.D., University of Michigan, Ann Arbor, Michigan

10:00 - 10:30 am* *Motion Sickness in Driving Simulators: A Challenge for the Assessment of Driving Performance?*
Elizaveta Igoshina, M.A., Ph.D. Student, University of Toronto, Toronto, Canada

10:30 – 10:45 am* **Break**

Session Two - The Driver's Brain

Moderator: Edward R. O'Malley, M.D., Henry Ford Health System

10:45 - 11:15 am* *Accessibility Standardization for Cognitively and Visually Impaired Drivers*
Olivia Wanless, B.S., Kettering University, Flint, Michigan

11:15 - 11:45 am* **Keynote Address:** *How Should "Success" Be Defined for Autonomous Vehicles?*
Joseph Rizzo, M.D., Massachusetts Eye and Ear, Harvard University, Boston, Massachusetts

11:45 - 12:15 pm* *Reduction of Visual Quality Impact Driving Behaviors When Facing Increased Cognitive and Visual Demands*
Amigale Patoine, M.S., University of Montreal, Montreal, Canada

12:15 - 1:00 pm* **Break (Lunch)**

Session Three - The Driver's Future and His Neural Demands

Moderator: Joseph Rizzo M.D., Harvard Medical School, Boston, Massachusetts

1:00 - 1:30 pm* *Meeting Visual Demands at all Distances is Important with the Evolution of Visual and Cognitive Demands in Driving Environment*
Delphine Bernadin, Ph.D., University of Montreal, Montreal, Canada

1:30 - 2:00 pm* **Keynote Address:** *The Alabama VIP Older Driver Study: Naturalistic Driving Results So Far*
Cynthia Owsley, Ph.D., University of Alabama, Birmingham, AL

2:00 - 2:30 pm* *Measuring the Rate of Human Perception and the Cost of Spreading Attention*
Joseph Lappin, Ph.D., Vanderbilt University, Burnsville, North Carolina

2:30 - 2:45 pm* **Break**

Session Four - The Challenged Driver's Visual System

Moderator: Joanne M. Wood, Ph.D., Queensland University of Technology, Brisbane, Australia

2:45 – 3:15 pm* *Audio-cue Reminders Improve Scanning by Drivers with Hemianopia at Intersections*
Alex Bowers, Ph.D., Schepens Eye Research Institute, Boston, Massachusetts

3:15 - 3:45 pm* *Impact of Cataract Surgeries on Pedestrian Detection With and Without Oncoming Headlight Glare*
Alex Hwang, Ph.D., Schepens Eye Research Institute, Boston, Massachusetts

3:45 - 4:15 pm* *Which is More Important for Automobile Driving: Eye or Brain?*
Gang Luo, Ph.D., Schepens Eye Research Institute, Boston, MA

4:15 – 4:45 pm* *Insights into Visual and Cognitive Aspects of Driving Among Older Adults Using Naturalistic Driving Study Data*
John Bullough, Ph.D., Rensselaer Polytechnic Institute, Troy, NY

4:45 – 5:00 pm* **Wrap-up and Conclude Day**

TUESDAY, DECEMBER 8, 2018

(Presentations are 20-minutes long, plus a 10-minute Q & A – Challenge period)

*All Times USA, Eastern Time Zone

8:20 – 8:25 am* **Welcome: Paul A. Edwards, M.D., Chair, Department of Ophthalmology, Henry Ford Health System**

8:25 – 8:30 am* **Housekeeping: David Goldman, M.D., Department of Ophthalmology, Henry Ford Health System**

Session Five - Can We Actually Reduce Highway Mortalities?

Moderator: Ulrich Schiefer, M.D., Aalen University of Applied Science, Aalen, Germany

8:30 – 9:00 am* *The Role of Vision Related Problems in Fatal Road Accidents in Finland*
Juho Wedenoja, M.D., Ph.D., University of Helsinki, Helsinki, Finland

9:00 - 9:30 am* *Assisting Connected and Autonomous Vehicles in Rural Areas Using Smart Traffic Signs for Improved Healthcare Access*
Enes Karaaslan, Ph.D., Connected Wise, Orlando, Florida

9:30 - 10:00 am* **Keynote Address:** *A Population Aging in Place, Full Autonomy Delayed, and Expanding Remote Healthcare: Can the Mobility Industry Help Bridge the Gap?*
Todd Fletemier, Faurecia Group – Innovation and Strategy, Auburn Hills, Michigan

10:00 - 10:30 am* *Visual Perception Can Be Affected by Distance: Implication for Head-up Displays*
Jiali Song, B.Sc., McMaster University, Ontario, Canada

10:30 - 10:45 am* **Break**

Session Six - This New World is Really On Its Way!

Moderator: Daniel Rathbun Ph.D., Research Scientist, Henry Ford Health System

10:45 - 11:15 am* *Machine Vision System for Reading Barcode Signs to Support Vehicle to Infrastructure (V2I) Safety (RB3S)*
Lemin Xiao, M.S., Intelligent Automation, Inc. Rockville, Maryland

11:15 - 11:45 am* **Keynote Address:** *Mobility: Today and Tomorrow*
Trevor Pawl, Chief Mobility Officer, State of Michigan
Collin Castle, P.E., ITS Program Coordinator, Michigan Department of Transportation

11:45 - 12:15 pm* *Evaluation of a Non-Contact ECG System in a Moving Vehicle with Basic Driver Motions*
Derrick Redding, M.S., BioSense, Ann Arbor, Michigan

12:15 - 1:00 pm* **Break (Lunch)**

Session Seven - Yes, There are Problems and HIPAA Privacy Concerns

Moderator: Paul A. Edwards, M.D., Chairman, Department of Ophthalmology, Henry Ford Health System

1:00 - 1:30 pm* *The Future of Shared Autonomous Vehicles: Effects of the COVID-19 Pandemic*
Richard Young, Ph.D., Driving Safety Consulting, Inc., Troy, MI

1:30 - 2:00 pm* **Keynote Address:** *Your Car as a Wearable Health Technology: Planning for the Future of Health Data in the Vehicle*
Jennifer Dukarski, J.D., Butzel Long Law, Ann Arbor, Michigan

2:00 - 2:30 pm* *The Vehicle as a Medical Device*
Derrick Redding, M.S., BioSense, Ann Arbor, Michigan

2:30 - 2:45 pm* **Break**

Session Eight - A Potpourri of Pertinent Practical Presentations

Moderator: Edward R. O'Malley, M.D., Henry Ford Health System, Detroit, Michigan

2:45 - 3:15 pm* *Utilizing a High-Fidelity Driving Simulator to Assess the Effects of Exposure, Driving Style, Age, and Driving Conditions on Older Adults' Acceptance of Fully Automated Vehicles*
Shabnam Haghzare, Ph.D. Candidate/B.Sc., The KITE Research Institute – UHN, Toronto, Canada

3:15 - 3:45 pm* *Towards an Evaluation Schema for Naturalistic Perception and Interaction in Autonomous Driving*
Vasiliki Kondyli, Ph.D. Candidate, Örebro University, Örebro, Sweden

3:45 - 4:15 pm* *Interior Monitoring Systems: The Next Evolution in Vehicle Occupant Health and Safety*
Andrew Whydell, M.S., ZF, Northville, Michigan

4:15 - 4:45 pm* *Holography-Based Head Up Display Designs that Support Augmented Reality*
Thomas Seder, Ph.D., and Kai-Han Chang, Ph.D., General Motors Research and Development, Warren, Michigan

4:45 – 5:00 pm* **Wrap-up and Conclusion: The Eye, The Brain and The Auto 2020**
Philip C. Hessburg, M.D.
Cynthia Owsley, Ph.D.
Joseph Rizzo, M.D.

*All Times USA, Eastern Time Zone

THE EYE, THE BRAIN AND THE AUTO KEYNOTE SPEAKERS

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World Research Congress

KEYNOTE SPEAKERS

Collin Castle, P. E.
Michigan Department of Transportation
Detroit, Michigan

Mobility: Today and Tomorrow

COLLIN CASTLE has worked in the Michigan Department of Transportation (MDOT) Intelligent Transportation Systems (ITS) Program Office for the past 13 years. He is currently serving as the MDOT ITS Program Manager responsible for the administration, support and oversight of the statewide ITS, Signals, Transportation Operations Centers (TOCs), and Connected and Autonomous Vehicle program at MDOT. He is a graduate of Michigan State University with a Bachelor of Science (BS) in Civil Engineering with a focus on Transportation and is a registered Professional Engineer in the State of Michigan.

Trevor Pawl
Chief Mobility Officer
State of Michigan
Detroit, Michigan

Mobility: Today and Tomorrow

Trevor Pawl was recently appointed the Chief Mobility Officer for the State of Michigan. His role is to lead Michigan's Office of Future Mobility and Electrification. This state office sits inside the Michigan Economic Development Corporation and works in partnership with the Michigan Department of Labor and Economic Opportunity and Governor's Office.

Pawl has extensive experience in business development for the Michigan Economic Development Corporation (MEDC) and has been a leader for PlanetM, a mobility initiative representing mobility efforts across the state.

KEYNOTE SPEAKERS

Jennifer Dukarski, J.D.
Butzel Long Law
Ann Arbor, Michigan

Your Car as a Wearable Health Technology: Planning for the Future of Health Data in the Vehicle

JENNIFER A. DUKARSKI is a Shareholder based in Butzel Long's Ann Arbor office, practicing in the areas of emerging technology, media and intellectual property. She focuses her practice at the intersection of technology and communications, with an emphasis on the legal issues arising from emerging and disruptive innovation: including biotechnology, product safety, the internet of things, privacy, cybersecurity, blockchain, autonomous vehicles and mobility. Jennifer leads clients in securing and protecting technology through transactions and litigation.

Jennifer has assisted clients in multiple industries in evaluating compliance issues in blockchain and cryptocurrency, cloud computing, big data, autonomous technology, connected devices, telehealth, artificial intelligence and data breaches. She advises on compliance with the European Union General Data Protection Regulation (GDPR) as well as state and federal privacy and security regulations and law.

She co-authored the Healthcare Licensing Manual for the State Bar's Healthcare Law Section to assist individuals in navigating the licensing and disciplinary processes in Michigan. She is a national panelist on the topic of data protection in health care with an emphasis on HIPAA/HITECH, health IT and E-Health. Prior to joining Butzel Long, Jennifer advised Health Legislative Aids (HLA's) for the Michigan delegation in the United States House of Representatives and the Senate on arthritis initiatives. Working as a design engineer, Ms. Dukarski received multiple Record of Invention Awards for contributions to patents and trade secrets. She is a Six Sigma Master Black Belt.

She earned her B.S. degree in Mechanical Engineering, *summa cum laude*, from the University of Detroit Mercy College of Engineering and Science and her J.D. degree, *magna cum laude*, from the University of Detroit Mercy School of Law where she now teaches a course on the societal impacts of autonomous vehicles and the changing nature of mobility. Ms. Dukarski is a member of the American Bar Association and is the Co-Chair of the Women in Communication Law Committee of the Forum on Communication Law. She has been named a Rising Star by Super Lawyers, a Best Lawyer in America and a Top Lawyer by "dBusiness." She is also senior member of the Institute of Electrical and Electronics Engineers, where she is on the team developing standards for analyzing "fake news."

KEYNOTE SPEAKERS

Todd Fletemier
Vice President, Faurecia Group
Innovation and Strategy
Auburn Hills, Michigan

A Population Aging in Place, Full Autonomy Delayed, and Expanding Remote Healthcare: Can the Mobility Industry Help Bridge the Gap?

TODD FLETEMIER is a leader that believes success comes from leading by example, communicating clear vision, building trust, having empathy. Driven by the belief that success is defined by people, and leaders are defined by who people choose to follow. His depth of experience with international organizations combined with vast experience in Innovation, Product Engineering, Program Management, Manufacturing and Commercial Negotiations provides a broad knowledge base. This provides him the foundation to lead teams that are focused, efficient and deliver.

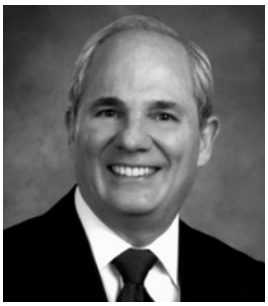
KEYNOTE SPEAKERS

Cynthia Owsley, Ph.D., M.S.P.H.
Director Clinical Research
Department of Ophthalmology and Visual Sciences
University of Alabama at Birmingham
Birmingham, Alabama

The Alabama VIP Older Driver Study: Naturalistic Driving Results So Far

CYNTHIA OWSLEY Ph.D., M.S.P.H. holds the Nathan E. Miles Chair and is Professor in the Department of Ophthalmology, University of Alabama at Birmingham (UAB). She is a Phi Beta Kappa graduate of Wheaton College, Massachusetts and received the Ph.D. in Experimental Psychology from Cornell University. She received the M.S.P.H. in Epidemiology from UAB. Dr. Owsley's research program focuses on aging-related eye disease and vision impairment. Her research program uses many techniques including psychophysics, epidemiology, clinical trials, and health services research. Dr. Owsley has been continuously funded by NIH since 1983 and has over 230 publications indexed in PubMed. She has served on panels for the National Research Council including the Committee on Vision and the Committee on Disability Determination for Individuals with Vision Impairment. She is a consulting member of the Food and Drug Administration's Ophthalmic Devices Panel of the Medical Devices Advisory Committee. Dr. Owsley chaired the scientific review panel for NIH's Center for Scientific Review on Central Visual Processing. She serves on the editorial board of *Investigative Ophthalmology and Visual Science*, and previously that for *Vision Research* and *Current Eye Research*. She is a Gold Fellow of the Association for Research in Vision and Ophthalmology for which she is immediate-past-chair for the Committee on Ethics and Regulations in Human Research. Dr. Owsley serves on the Scientific Advisory Committee for Research to Prevent Blindness and is the recipient of Glenn A. Fry Award of the American Optometric Foundation and the Bartimaeus Award of the Detroit Institute of Ophthalmology.

KEYNOTE SPEAKERS



Joseph Rizzo, M.D.
Massachusetts Eye and Ear Infirmary
Harvard Medical School
Boston, Massachusetts

How Should "Success" Be Defined for Autonomous Vehicles?

DR. RIZZO is a Board-Certified Neurologist and Ophthalmologist who has worked at the Massachusetts Eye and Ear Infirmary as a Neuro-Ophthalmologist since 1985. Since 2006, Dr. Rizzo has served as Director of the Harvard-wide program in Neuro-Ophthalmology. Dr. Rizzo dedicates his research to studying the mechanisms of vision loss, improving diagnostic methods, and developing new treatments for blinding diseases. Dr. Rizzo divides his time evenly between evaluating patients with Neuro-Ophthalmic disorders and performing research to better understand causes of blindness and to search for treatments to restore vision to the blind. In the late 1980s, Dr. Rizzo co-founded the Boston Retinal Implant Project as a multi-disciplinary research project based at Harvard Medical School and the Massachusetts Eye and Ear Infirmary with the goal of developing a retinal prosthesis to restore vision to patients with outer retinal degenerations. More recently, in collaboration with neuroscientists and neurosurgeons at Harvard's Massachusetts General Hospital, he has been leveraging the retinal technology to develop a visual prosthesis that interfaces with the brain at the level of the lateral geniculate nucleus, which potentially could treat blindness caused by inner retinal and optic nerve disease. His clinical research focuses primarily on the study of optic neuritis/multiple sclerosis, ischemic optic neuropathy, pseudo-tumor cerebri, and giant cell arteritis. Dr. Rizzo has founded two companies: Bionic Eye Technologies, Inc, which is pursuing development of the retinal prosthesis, and Visus, Inc, which has developed a suite of portable "apps" for Android phones sold through Verizon to assist the visually impaired.

KEYNOTE SPEAKERS

Stewart Wang, M.D., Ph.D.
University of Michigan, Director
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Ann Arbor, Michigan

Physicians and Scientists as Wayfinders on the Road to Zero

DR. WANG is the First Endowed Professor of Burn Surgery. He received an A.B. in History of Science and Medicine from the Yale College before going on to complete his M.D. at the University of Chicago. He also earned a Ph.D. in Molecular Immunology at the University of Pittsburgh during his general surgical residency training. He joined the University of Michigan faculty in 1995. His clinical expertise is in the areas of general surgery, acute care surgery, trauma, and burns.

Dr. Wang is Director of Burn Surgery at the University of Michigan's ABA-verified Burn Center and Director of the State of Michigan Burn Coordinating Center for Mass Casualty Incidents.

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THE EYE, THE BRAIN AND THE AUTO PLATFORM SPEAKERS 2020

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Delphine Bernadin, Ph.D.
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Meeting Visual Demands at All Distances is Important with the Evolution of Visual and Cognitive Demands in Driving Environment

Purpose: Over the past century, the vision and cognitive demands evolved with car design, appearance of inside vehicle devices as well as the road and driving environment. Previously, our team studied the interaction between vision and cognition, and its importance for driving safely and to measure driving abilities. Here, we proposed to examine how to pin down the vision correction when an individual must deal with and effectively control a vehicle and the growing visual and cognitive workload. The multiplication of in-vehicle systems raises the problem of distracted driving and any activity that might take a driver's attention off the road. But, what about the vision impact that might overload the resources? We examined what are the driving behaviors when visual demands at all distances are not satisfied particularly in the high mental workload driving context.

Methods: 20 presbyopic participants aged of 61.3 ± 8.3 (Study 1-2) and 21 young people aged of 24.8 ± 3.7 (Study 3) performed a driving and navigation task. We measured the driving and navigation tasks behavior while wearing progressive lenses vs. single vision lenses (S1); in optimal vision condition vs. simulated myopic blur conditions (S2); with normal or corrected-to-normal vision and while wearing contact lenses with a positive addition, resulting in a myopic defocus (S3) and a reduced visual acuity equivalent to either 4/10 at 3 m or 4/10 at 1m20.

Results: Presbyopic drivers were faster to detect the orientation of a biological motion when wearing progressive lenses than single vision ($Z = 2.70$, $p < .05$).

Conclusions: The results evidence the importance to correct not only the far visual acuity as requested by most of the licensing regulation agency but also to correct the visual acuity at the closest distance to maintain ability to switch from all the distances without overloading the individual mental resources.

Biography: Delphine Bernardin is adjunct Professor at the NSERG/Essilor Industrial Chair, University of Montréal, Canada, and at the research and cooperative development NSERC/Essilor Prompt project. Her research interests are human centered focusing specifically on how individuals in mobility or in action exploit their sensorial, motor and cognitive capacities; as well as innovation, particularly in the field of optics, perception, motor and cognitive health. She has published over 50 publications including peer reviewed papers on the themes of vision and driving. She has 10 distinct patents in the field of optical designs, behavioral procedural methods sponsored by Essilor International. Based on a holistic approach of the driver, she co-developed with the Faubert lab mobility team methods to assess the visual ergonomics of drivers and to capture their visual needs in realistic driving situations.

Alex Bowers, Ph.D.
Schepens Eye Research Institute
Boston, Massachusetts

Audio-cue Reminders Improve Scanning by Drivers with Hemianopia at Intersections

Objectives: Individuals with hemianopic field loss (HFL) are permitted to drive in some jurisdictions in the United States and some countries in Europe (exceptional case provision). It is possible to compensate for the hemifield loss by scanning (looking) toward the blind side. However, prior studies suggest that drivers with HFL sometimes fail to scan sufficiently, especially at intersections, resulting in impaired detection of hazards approaching from the blind side. We evaluated whether audio-cue reminders improved scanning on approach to intersections in a driving simulator. The cues were designed to encourage proactive scanning, i.e., making a large blind-side head scan well in advance of the intersection.

Methods: Participants with HFL (n = 14) completed 2 drives without and 2 with the audio cues along city routes with 35 intersections per drive. They pressed the horn as soon as they detected a motorcycle. Of 15 motorcycles in each drive, 10 appeared at intersections approaching from the right or left on a collision course. Head movements were monitored from 60 to 30m before the intersection and an audio-cue reminder was triggered at 30m if the driver had not made an early large head scan (ELHS) of at least 20° to the blind side. The cue was a single tone (1s) from a directional speaker at 45° on the blind side.

Results: Participants made an ELHS to the blind side at a significantly higher proportion of intersections in drives with than without the cues (66% vs. 43%, $p < 0.001$). In other words, they were more likely to scan proactively in drives with the cues. Making an ELHS to the blind side was significantly associated with faster fixations on blind-side hazards ($p < 0.001$)) and faster (shorter) response times (ELHS 2.6s vs. no ELHS 4.7s, $p < 0.001$). When participants did not make an ELHS and received a cue, they typically made a large head scan to the blind side about 0.6 s after the cue. Overall, participants made more large head scans to the blind side in drives with than without the cues ($p < 0.001$) and had faster response times. The majority of participants rated the cues as very helpful. There were no adverse effects of the audio-cue reminders on seeing-side scanning or detection.

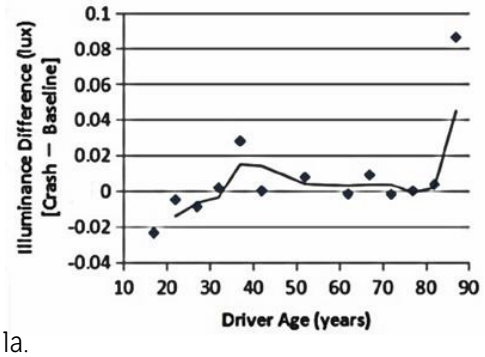
Conclusions: The audio-cue reminders successfully promoted early, proactive head scanning to the blind side on approach to intersections with significant positive effects on response times to blind-side hazards.

Biography: Alex Bowers is an optometrist with a Ph.D. in vision rehabilitation research from Glasgow Caledonian University, Scotland. She is currently Associate Professor of Ophthalmology at Harvard Medical School and Associate Scientist at Schepens Eye Research Institute of Massachusetts Eye and Ear, Boston, MA. Her research focuses on quantifying the effects of vision impairment on walking and driving in real and virtual environments and evaluating the effects of devices and interventions to assist visually impaired people when walking and driving. Dr. Bowers was the recipient of the 2010 Borish Outstanding Young Researcher Award from the American Academy of Optometry and the 2013 Low Vision Research Award from Envision. She has published over 80 peer-reviewed papers and conference proceedings.

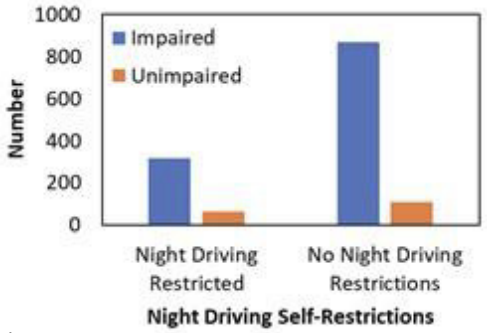
John Bullough, Ph.D.
Rensselaer Polytechnic Institute
Troy, New York

Insights into Visual and Cognitive Aspects of Driving Among Older Adults Using Naturalistic Driving Study Data

Abstract: Data from the Naturalistic Driving Study (NDS) from the 2nd Strategic Highway Research Program (SHRP2) provide opportunities to explore interactions among visual/cognitive aspects of driving. In one investigation, nighttime crashes along unlighted roads (when headlight glare is most severe) were collected. Driving data for 15 s before crashes were compared to baseline data epochs where no crash or near-miss occurred, binned by age. No significant difference ($p>0.05$) in light exposure was found between crash and baseline data, suggesting little influence of headlight glare in crash occurrence, except for the highest age bin (85-89 years), which exhibited a sharp increase in glare exposure for crashes relative to baseline driving (Fig. 1a). Because this age bin represents a very small proportion of the data, statistical reliability cannot be assessed, but is unlikely to represent the visual system's gradual optical changes with age. Between the ages of 70 and 90, the incidence of non-dementia cognitive impairment more than doubles, so these preliminary data could underlie cognitive function declines; but further validation would be needed.



1a.



1b.

Fig. 1a: Differences in glare exposures between crash and baseline data for each age bin.
Fig. 1b: Number of drivers with/without cognitive impairments reporting self-restricted night driving.

In another investigation, self-reported demographic data from the 3200+ NDS participants were cross tabulated against performance on the Clock Face Test, a metric of cognitive ability. For some self-imposed driving restrictions such as avoiding left turns, and unfamiliar areas, there were no significant differences ($p>0.05$) between participants with and without cognitive impairments. For avoiding night driving and highway/interstate travel, participants with cognitive decline reported restricting their behavior more than non-impaired participants. Comparing the number of drivers reporting restricted behavior to those with no self-restriction using Chi-square tests, there was a statistically significant ($0<0.005$) larger proportion of cognitively impaired drivers reporting driving less at night (Fig. 1b), and a statistically significantly($p<0.002$) larger proportion of impaired drivers reporting less highway/interstate driving. Data such as those from the NDS will prove valuable in establishing interactions among driver age, cognitive status and their real-world driving behavior.

Biography: John D. Bullough, Ph.D. is the Director of Transportation and Safety Lighting Programs at the Lighting Research Center, part of Rensselaer Polytechnic Institute in Troy, NY. John leads the Center's research efforts in outdoor and transportation lighting, focusing on human factors, visual performance, traffic safety and glare perception. He also teaches in the graduate programs in lighting, on topics including research methods, statistical analysis and visual ergonomics. John is a Fellow of the Illuminating Engineering Society, Vice President of the Council for Optical Radiation Measurements, and board member of the Academic Advisory Council for Signage Research and Education, and serves as a member of the Society of Automotive Engineers, the Society for Information Display, and the Committee on Human Factors of Infrastructure Design and Operations of the Transportation Research Board. Previously, he served as Chair of the Transportation Research Board's Committee on Visibility. John has written or co-written nearly 500 articles and technical publications on lighting and transportation safety, about 150 of those with student co-authors. John has presented twice before at The Eye, The Brain and The Auto, in 2009 and in 2013.

Kai-Han Chang, Ph.D.
General Motors
Warren, Michigan

Thomas Seder, Ph.D.
General Motors
Warren, Michigan

Holography-based Head Up Display Designs that Support Augmented Reality

Objective: Our objective is to use digital phase holography to generate images for Head Up Display (HUD), which is highly attractive because the technology enables creation of high resolution, colorful images on two distinct virtual image planes. This is especially important for Augmented Reality HUD. An additional objective is to create advanced optical configurations that form virtual images at variable distances in front of the vehicle, an attribute that enables the creation of 3D images.

Designs: In this paper, we;

1) provide a brief overview of Augmented Reality HUD requirements and use cases,
2) describe the key elements of digital phase holography and the use of this powerful technology for automotive HUD, including spatial light modulation, phase retrieval algorithms, distortion compensation methods, and optical configurations.
3) review design details of two distinctly different HUDs that feature digital phase holography

Results: We have created a prototype dual image plane Augmented Reality HUD that features a 10 degree field of view at 10 meter and a 4 degree FOV at 3 meter with images having over 120 pixel per degree, and an exceptionally wide color space due to the use of LASER sources. We have also developed an information architecture that governs that placement of information on the two image planes and have demonstrated the device at both the bench top and prototype vehicle level, and we will show videos of this prototype HUD in operation. Finally, we have created concept designs for possible future enhancements of this novel technology.

Biographies:

Kai-Han Chang is a Senior Researcher at General Motors in the Information Display and Simulation group within GM R&D since 2017. Her research specialty is liquid crystal display optics and device development. In this role, she is responsible for developing novel optical solution for both head-up displays and head-down displays. She received her Ph.D. degree from the Chemical Physics Interdisciplinary Program at Kent State University, Ohio in 2018. She received her M. S. degree in electro-optical engineering from the Institute of Electro-Optical Engineering, National Chiao Tung University, Hsinchu, Taiwan in 2012. Her research interests during graduate study are anchoring enhancement and stabilization of photoalignment, fast switching liquid crystal modes, and liquid crystal diffractive optics. She has co-authored one book chapter, 10 journal papers, 10 conference proceedings, and obtained 4 US patents.

Thomas Seder is currently the Chief Technologist-HMI at GM Global R&D and previously was the Lab Group Manager for HMI technology development within GM R&D. He is responsible for development of advanced display and control technologies, and cockpit interaction designs. Prior to joining GM, Tom led Displays Technology and Human Machine Interface research

groups at Rockwell Collins and ultimately was the Director of Advanced Technology and Product Planning for Rockwell Collins Air Transport Systems. Tom's current research interests are in the area of Information Architecture, Information Display, Displays Technology and HUD-based Augmented Reality. He is particularly interested in Enhanced Vision Systems and technologies that blend Enhanced Vision with Synthetic Vision. In addition to using AR to enhance driver performance, Tom is also interested in the application of AR to rear seat entertainment systems.

Dr. Seder has a Ph.D. and an M.S. in Physical Chemistry from Northwestern University, an M.B.A. from the University of Iowa.

Shabnam Haghazare, Ph.D. Candidate
The KITE Research Institute
Toronto, Canada

Utilizing a High-Fidelity Driving Simulator to Assess the Effects of Exposure, Driving Style, Age, and Driving Conditions on Older Adults' Acceptance of Fully Automated Vehicles

Objectives: The prospect of Fully Automated Vehicles (FAVs) has generated excitement around their potential to benefit older adults in maintaining their mobility and autonomy. These anticipated benefits can only be realized if this technology is accepted and thus used by older adults. However, FAVs are not yet available for wide, on-road use and testing, and it remains unclear how certain factors affect older adults' acceptance of automated vehicles. In this study we utilized a high-fidelity simulator to investigate the extent to which older adults' acceptance of fully automated vehicles are affected by exposure to automated vehicle technology (pre- vs. post-exposure), driving style (manual style relative to automated style), driving conditions (clear, rain, traffic), and age.

Method: Thirty-six older adults (M = 73.25, SD = 5.96) completed non-automated and fully automated driving scenarios under different driving conditions in an immersive, high-fidelity, and full-field-of-view driving simulator. The fully automated driving scenarios were designed to be reliably driven by the system in a conservative driving style and the non-automated driving scenarios enabled us to capture participants' individual driving styles. Driving conditions included clear daytime, rain, and high traffic. To assess the effect of exposure to automated vehicle technology on comfort, participants rated their comfort level with FAVs pre- and post-exposure to the simulated fully automated driving experience. Additionally, to compare older adults' acceptance of FAVs under different driving conditions, participants answered a validated questionnaire on their acceptance of the simulated fully automated experience pertaining to each respective driving condition.

Results: Among the factors considered, only age and driving style were found to have a significant effect on older adults' acceptance of FAVs, with older age and greater dissimilarity of an individual's manual driving style from the FAV's driving style being associated with lower acceptance. Conclusion: The results suggest that if reliability of FAVs is ultimately ensured and is demonstrated to the older adults, their acceptance of fully automated vehicles is generally high, particularly if the FAV is operated in a style similar to their own.

Biography: Shabnam is a Ph.D. Candidate in Biomedical Engineering at University of Toronto, a graduate research trainee at KITE Institute – Toronto Rehabilitation Institute, and a postgraduate affiliate of Vector Institute of Artificial Intelligence. In her Ph.D. project, Shabnam is utilizing a state-of-the-art driving simulator to better understand the implications and system requirements of using automated vehicles to extend the safe driving of older adults with and without dementia. Shabnam's current research interests lie broadly in questions related to the human compatibility of artificial intelligence to expand the abilities of people living with impairments.

Alex Hwang, Ph.D.
Schepens Eye Research Institute
Boston, Massachusetts

Impact of Cataract Surgeries on Pedestrian Detection with and without Oncoming Headlight Glare

Objectives: Oncoming headlights cause veiling glare on the retina. Because cataracts increase light scattering within the eye, it is expected that the headlight glare (HLG) will have larger effects on cataract patients' visual performance. Although cataract surgery on one eye restores binocular visual acuity and contrast sensitivity to normal levels, it is still unknown if the remaining cataracts in the untreated eye impair binocular function, especially in the presence of HLG. To study this, we measured pedestrian detection performance of cataract patients in a driving simulator with our custom HLG simulator, with and without HLG, before and after their first-eye cataract surgery (B1 and A1), and after the second-eye cataract surgery (A2).

Methods: Fourteen bilateral and three unilateral cataract patients scheduled to undergo cataract surgeries were recruited (68.4±8.9yrs, 8 females). Three bilateral cataract patients did not undergo the second-eye surgery. All patients drove all four-night driving scenarios with and without HLG. Each scenario contains 24 pedestrian encounters (i.e. a pedestrian appearing either on the left or right sidewalk, and then either walking along or crossing the road while an oncoming car approached). Subjects were asked to honk the horn when they detected the pedestrian. The distance to the pedestrian at honk was analyzed with respect to the stopping distance at the time of honk, and then categorized as *timely* (subject's response was early enough to avoid collision) vs. *untimely* (too late), or *missed* (did not respond at all).

Results: Significant main effects of HLG ($F(1, 86)=79.74$, $p<0.001$) and cataract surgery ($F(2, 86)=10.93$, $p3.34$, $p<0.001$) were found. The mean percent timely responses with HLG (B1: 41±2%, A1: 58±2%, A2: 64±1%) increased significantly after the first-eye surgery and increased further after the second-eye surgery all $ts(14)>3.34$, $ps>0.03$). The percent missed responses with HLG (B1: 44±2%, A1: 27±8%, A2: 23±3%) decreased after each cataract surgery (all $ts(14)=3.34$, $p<0.01$). No significant improvement was found without HLG.

Biography: Alex D. Hwang received B.S. in mechanical engineering from the University of Colorado Boulder (1999) and received M.S. (2003) and Ph.D. in computer science from the University of Massachusetts Boston (2010). Since then, he has worked at Schepens Eye Research Institute in Boston, MA, as a postdoctoral fellow. He became an investigator and is appointed as an Instructor of Ophthalmology at Harvard Medical School (2015). His work has focused on bioengineering and low vision rehabilitation. He has been working on the headlight glare project from its initiation and has reported findings such as the impact of unilateral/bilateral cataracts, the effectiveness of yellow "night driving" glasses, at various conferences and journals. He also has been working on head-mounted display (HMD) software development for low vision patients. The prototype software has been developed and demonstrated on their feasibility on the Google Glass and showed the potential of the newly available vision rehabilitation device platform. In addition to the low vision rehabilitation studies, visually induced motion sickness (VIMS) has been another branch of his research interest that he has been diligently trying to identify potential causes of motion sickness particularly in stereoscopic 3D display systems. Throughout the theoretical and geometrical analysis, he was able to identify potential causes of VIMS in VR and construct a hypothesis based on optic flow distortion.

Elizaveta Igoshina, M.A., Ph.D. Student
University of Toronto
Toronto, Canada

Motion Sickness in Driving Simulators: A Challenge for the Assessment of Driving Performance?

Objectives: Driving simulators are highly valuable tools in the assessment of driving abilities and performance. A common side-effect in many users of driving simulators is simulator sickness, a phenomenon similar to motion sickness characterized by a variety of symptoms such as dizziness, eyestrain, fatigue, or nausea. To date, it is not well understood how experiencing simulator sickness may affect driving behavior and whether it jeopardizes the validity of driving simulators in general. Thus, the goal of the present study was to investigate the relationship between simulator sickness and driving performance in a simulated driving task.

Methods: Twenty younger adults (11 females) participated in a single driving session using DriverLab, Canada's most advanced driving simulator, housed at KITE-Toronto Rehabilitation Institute (Fig 1). Participants performed a 25.5km long drive containing urban, rural, and highway sections. Driving performance was measured throughout the drive and included common metrics such as the standard deviation of lane positioning, speed measurements, response time, number of steering reversals, and following distance to leading vehicles. Simulator sickness was measured during the drive using the Fast Motion Sickness Scale (FMS) and after the drive using the Simulator Sickness Questionnaire (SSQ).

Results: Three participants stopped the drive prematurely due to severe simulator sickness. Overall, only weak to moderate, non-significant Pearson correlations were found between the severity of simulator sickness and the different driving performance measures. No differences in any of the driving performance measures were found between participants who reported strong sickness and those who reported minimal sickness.

Conclusions: Our results suggest that simulator sickness does not strongly impact driving performance, as convincing evidence for a relationship between simulator sickness and driving behavior could not be identified. This finding is crucial as it indicates that the usefulness of high-fidelity driving simulators for various domains such as research or training is not diminished by the presence of simulator sickness.

Biography: Elizaveta Igoshina is a Psychology Ph.D. student, studying at the University of Toronto. Her research focuses on evaluating and preventing ill effects of visually induced motion sickness (VIMS), such as nausea and oculomotor discomfort provoked by virtual reality use. Specifically, her master's thesis investigated the effect of VIMS on driving performance in a high-fidelity driving simulator using Canada's most sophisticated VR driving simulator, the Toronto Rehabilitation Institute's KITE DriverLab. Her research intends to validate the real-world transferability of driving simulator studies and establish an accessible prophylaxis to VIMS.

Fig 1. External view of DriverLab at KITE-Toronto Rehabilitation Institute.

Enes Karaaslan, Ph.D.
Connected Wise
Orlando, Florida

Assisting Connected and Autonomous Vehicles in Rural Areas Using Smart Traffic Signs for Improved Healthcare Access

Objectives: Connected and autonomous vehicles have important benefits to transportation safety, optimization and accessibility. With the Covid-19 pandemic, it was understood that they can also play a critical role in the healthcare industry by transporting patients and medical supplies without human supervision. However, safer mobility of these vehicles in the rural areas where the accessibility to healthcare is particularly challenging depends on the availability of necessary vehicular communication infrastructure. The objective of this study is to use smart traffic signs to support the vehicular communication in the rural areas by enabling the connected and autonomous vehicles to stay connected to travel safely under the challenging roadway conditions.

Methods: The vehicular communication infrastructure consists of wireless devices that are broadcasting high-frequency signals (cellular or dedicated short-range communication) to send roadway data and safety messages to connected and autonomous vehicles. However, establishing and maintaining the wireless infrastructure in the rural areas is very difficult and costly. This study introduces a machine vision-based communication between the visual identifier on the traffic sign and the camera-based system in the vehicles. These visual identifiers are essentially unique images generated by a visual hashing algorithm that associates each sign to a preloaded message. When the vehicle recognizes the sign, the message is activated, and the autonomous vehicle localizes itself with respect to the roadway geometry data without relying on wireless communication.

Results: The machine vision-based infrastructure-to-vehicle communication was tested in harsh environments including heavy weather conditions, bright sun and nighttime environment, as well as at high traffic speeds. Since the system benefitted from the power of recognition instead of using an encoding/decoding technique commonly seen in the matrix barcode systems (e.g. QR code), the system correctly matched images 87% of time and did not activate any false vehicular communication message. The SIFT algorithm used in the image feature matching showed the highest matching score among all tested feature extractors.

Conclusions: The performance of the proposed technological application relied on a variety of factors including camera quality and resolution, minimum size of the blocks on the visual identifier, and contrast difference of these blocks. However, the system overall showed promising results for reliable deployment in the real-world scenarios that could potentially become a viable solution to assist connected autonomous vehicles in the rural areas.

Biography: Dr. Karaaslan is an expert in smart transportation infrastructure, automated vehicle technologies and machine vision systems. He has previously led large scale transportation projects at major multinational companies that focus on transportation design. He has also conducted interdisciplinary research projects during his Ph.D. program at the University of Central Florida. He has in-depth experience in developing decision support systems, machine learning applications for connected automated vehicles and mixed reality applications for transportation structures. He has published numerous scientific articles in respected journals and presented at many civil engineering conferences. Aside from his academic accomplishments, he also has put great efforts in technology transfer and has commercialized numerous technology products. He co-founded Connected Wise and brought up to a $1M federal grant to develop a unique technology for the U.S. Department of Transportation.

Vasiliki Kondyli, Ph.D. Student
Örebro University
Örebro, Sweden

Towards an Evaluation Schema for Naturalistic Perception and Interaction in Autonomous Driving

Autonomous Driving / Benchmarking Naturalistic Human-Factors

The development of autonomous driving technologies bring to the fore issues relevant to human-centered design and human-machine interaction from the viewpoint of aspects such as ethically driven standardization and regulated socio-legal acceptability, e.g., pertaining to aspects such as visual sensemaking [Bhatt, 2018, Suchan et al., 2019]. Towards this, ecologically valid human-centered datasets for training and testing technology components and a systematic evaluation process for reproducibility of visual perception and interaction studies in naturalistic embodied driving conditions will be necessary.

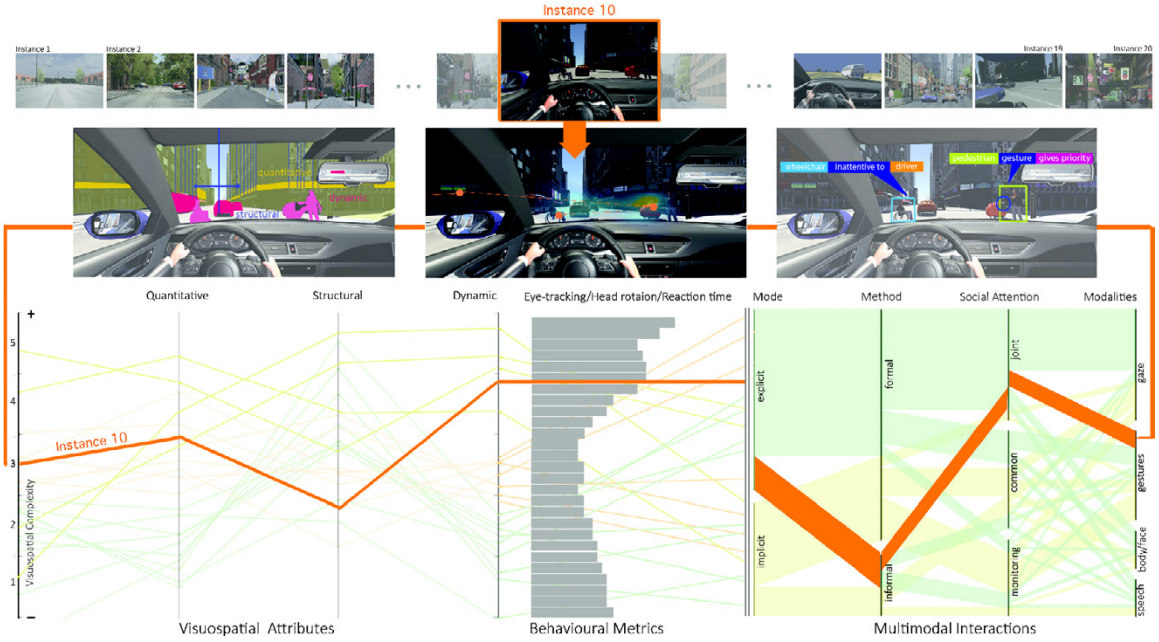


Figure 1. Prototypical illustration of the human-centered evaluation schema, based on the Visuospatial Complexity model [Kondyli et al., 2020] and a systematic analysis of embodied multimodal interactions in the streetscape [Kondyli and Bhatt, 2020]. The highlighted (orange) line represents one instance from the sample dataset.

Towards an Evaluation Schema: A Cognitive Characterization

We introduce a systematic evaluation schema concerning naturalistic driving situations that involves metrics related to:

(a) the characteristics of the driving scene (Fig.1 - visuospatial attributes involving e.g. clutter, motion

(b) the characteristics of the multimodal interactions between roadside stakeholders (Fig.1 - involving e.g. formal-informal, implicit-explicit)

(c) the effect of the attributes in (a) and (b) on people's behaviour (Fig. 1 - measured e.g. by eye tracking).

The scene characteristics refer to the analysis of the dynamic naturalistic driving scene based on our cognitive model of visuospatial complexity [Kondyli et al., 2020], that includes a combination of quantitative, structural, and dynamic attributes. Multimodal interactions are analyzed based on the modalities involved, the mode and method of interaction, as well as the level of social attention achieved [Kondyli and Bhatt, 2020]. Human evaluation through physiological measurements (e.g. eye-tracking, head rotation) is part of our ongoing work aiming at the establishment of an evidence-based evaluation schema.

Prototypical Application and Outlook

As a proof of concept for the application of the developed evaluation schema, we demonstrate a sample dataset consisting of real-world and virtual reality scenes (Fig. 1 includes one example). We posit that the proposed evaluation schema is able to (cognitively) characterize the diversity and descriptive complexity of an arbitrary (experimental) dataset vis-a-vis the scale of visuospatial complexity and the nature of multimodal interactions represented within the respective stimuli contained within the given dataset. We claim that from the viewpoint of characterizing the multi-faceted nature and complexity of everyday driving situations, the proposed evaluation schema promises to centralize human factors a crucial aspect for the design, evaluation, and deployment of human-centered visual sensemaking technologies within autonomous driving systems [Suchan et al., 2019].

Biography: Vasiliki Kondyli is a Ph.D. candidate at the Center for Applied Autonomous Sensor Systems (AASS) at Örebro University (Sweden), and a member of the DesignSpace Group (www.design-space.org). Her research work is at the interface of visual perception, spatial cognition, and environmental psychology. Her Ph.D. project focuses on multimodal human behavioral studies with an emphasis on the visuo-locomotive perception of humans, and aims to extract precedents that can be embedded into assistive technologies in a range of applications such as autonomous driving, HRI design, user experience design, etc. Within architecture design, her research interest involves human perception and cognition in the built environment, inclusive design principles, as well as the development of a cognitive technological framework for people-centered parametric design.

Joseph Lappin, Ph.D.
Vanderbilt University
Nashville, Tennessee

Measuring the Rate of Human Perception and the Cost of Spreading Attention

Problem: Driving occurs in a complex and rapidly changing environment. Multiple events occur in multiple parts of the environment, inside and outside the vehicle, involving multiple sensory modalities. Environmental changes sometimes require rapid comprehension, decisions, and actions. Unfortunately, the rate at which we recognize such changes and the likelihood of even detecting them are reduced as the number of potential events increases. Increasing numbers of potential events include the numbers of vehicles and their speeds, highway design (e.g., number of lanes), sensory competition between events both outside (e.g., traffic, signals/signage) and inside the vehicle (e.g., conversation, children, and driving aids such as navigation systems and alerts). Our perception of information is evidently limited and increases in potentially relevant information inevitably cause failures to detect salient events.

Motivated by these issues, we sought to (1) measure the rates at which trained observers detect salient changes in visual displays of moving objects, and (2) evaluate the potential costs of visually monitoring more potential target objects.

Method: Observers responded to sudden changes in the color or motion direction of any one of a set of moving objects. (See illustration below.) The set size of moving objects was a primary variable. A simple detection task required a detection response to any display change, and a selective task required a detection response to a subset of the changes (those designated as "threats"). The temporal process of target detection was measured by response time (RT) hazard functions — quantifying detection rates in bits/sec at successive moments following a target change in the displayed scenario.

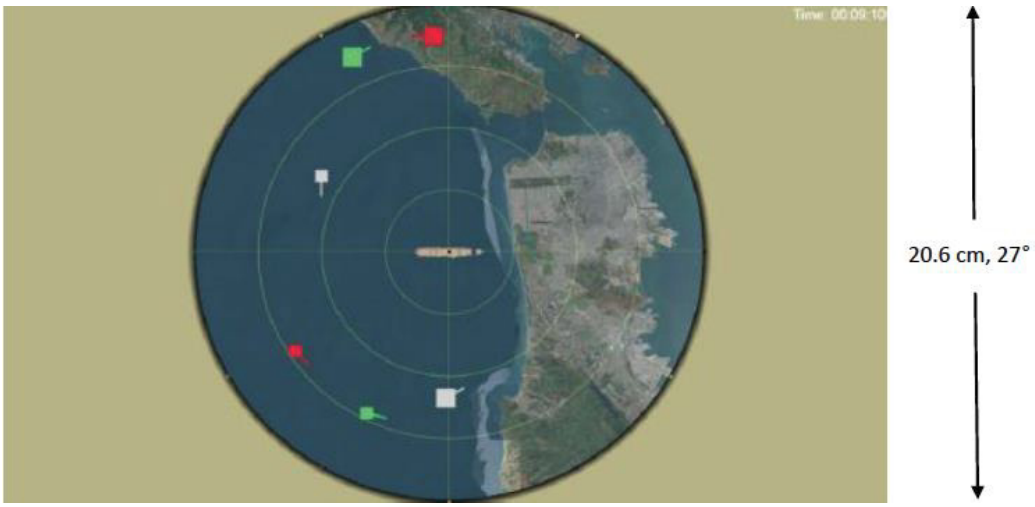
Findings:

(1) Increases in set size divided perceptual process rates. This divisive effect of spreading attention was constant over time and over the changing influence of other factors (changes in color vs direction, and simple vs selective detection responses).

2) Detection rates for these momentary display changes rose and fell rapidly over a time window of about 1/4 sec. Detection rates for color changes were greater than those for direction changes, and rates for simple detection responses are greater than those for selective detections.

3) Three component processes had continuous independent influence on detection rates at any given time: *set size x target signal x detection task*.

4) Results of this and other experiments have indicated a limited channel capacity, C, of conscious awareness. C 20 bits/sec in this experiment.
Detection rate at a given time = *C / (parameters for set size x target signal x detection task).*



A one-frame example of the moving visual displays. The depicted scene represented a naval air warfare scenario, in which the moving icons symbolized planes posing potential threats to a stationary ship-like icon in the center.

Biography: Joseph Lappin received his B.A., 1962, University of Cincinnati; Ph.D., 1966, University of Illinois, Experimental Psychology. He has held faculty positions at Carnegie Institute of Technology, 1966-1968; Vanderbilt University, 1968-2005. He is currently: Professor Emeritus & Research Professor, Vanderbilt University, Dept. of Psychology & Vanderbilt Vision Research Center; Co-founder and Senior Scientist, Discerning Technologies, LLC. His research aims to identify the form and quantity of information acquired by vision. The experimental and theoretical objectives are to identify optical patterns that carry information about the visual world and to measure visual sensitivities to those patterns. Specific areas of research (> 100 publications) have focused on the span of selective attention, the role of prior knowledge, motion perception, perception of surface shape from motion and stereopsis, perception of 3D space, visual acuities for coherent motion and binocular disparity, visual motion mechanisms, peripheral motion perception in normal and low vision, and the speed of visual processes. In a contract from the Office of Naval Research, we recently discovered that visual information awareness operates at a limited and quantifiable rate in parallel with other visual processes. The limited capacity of visual awareness surely underlies distracted driving.

Gang Luo, Ph.D.
Schepens Eye Research Institute
Massachusetts Eye and Ear
Harvard Medical School
Boston, Massachusetts

Which is More Important for Automobile Driving: Eye or Brain?

Purpose: Many people stop driving due to visual or cognitive impairment. Whether driving cessation is voluntary or involuntary, the decision should be informed by understanding of the impacts of multiple factors that can impact driving safety, ideally before driving cessation is forced due to significant events, such as motor vehicle crashes. This paper discusses the impacts of visual and cognitive impairments based on the findings from four studies we have conducted.

Method: Two naturalistic driving studies were conducted with 44 drivers with mild Alzheimer's disease (AD), 20 drivers with central vision loss, and 19 normal controls. Daily driving activities were recorded for 2-8 weeks. Near-collision events were extracted from the videos and three groups were compared according to Cox hazard regressions. In the third study, 20 normally sighted participants were tested for driving hazard perception when they watched real world driving videos in four different conditions: with/without motion interruption (using inter-frame mask) and with/without simulated low vision (using diffusing filter to degrade visual acuity to 20/120 on average). Hazard perception was scored using UK driving license bureau's method, which combines response time and accuracy. In the fourth study, 14 cognitively impaired patients and six normal controls were assessed for collision perception in a virtual environment. Their judgment uncertainty was quantified by the standard deviation of the psychometric function fitted to binary responses.

Results: In the naturalistic driving studies, cognitive impairment was a significant predictor of near collisions (hazard ratio=3.86, p=0.036), but visual acuity was not (hazard ratio=0.47, p=0.317). In the third study, the motion mask caused a significant reduction in hazard perception scores by 17.8% (p=0.006), but low visual acuity did not affect the scores (p=0.195). In fourth study, cognitively impaired drivers had significantly higher judgment uncertainty than the normal controls (p=0.03).

Discussion: Motion perception plays an important role in driving collision avoidance. Since motion perception primarily relies on low spatial frequency, low visual acuity may have little impact on hazard perception. On the other hand, dysfunction in the frontal and parietal lobes, which may negatively affect spatial perception of dynamic scenes, may be one of the mechanisms placing AD patients at higher risk for crash, even though they have normal static visual function.

Biography: Gang Luo received his Ph.D. degree from Chongqing University, China in 1997. In 2002, he finished his postdoctoral fellow training at Harvard Medical School. He is currently an Associate Scientist with the Schepens Eye Research Institute, and an Associate Professor with the Department of Ophthalmology, Harvard Medical School. His primary research interests include vision science, image processing, and technology related to driving assessment, driving assistance, low vision, and mobile vision care.

Laura Mikula, Ph.D.
University of Montreal
Montreal, Quebec, Canada

Increased Visual-Cognitive Demands in Driving Simulator Result in Modifications of Eye Head Coordination and Dynamic Visual Scanning

Objectives: Driving is a complex task which requires interaction between vision and cognition. As a consequence, the inability to meet increasing visual and/or cognitive needs can result in mental overload and therefore compromise drivers' safety. Previous research has shown that eye and head movements are related to visuo-cognitive demands and contribute to attention reallocation (Doshi et al., 2012; Fang et al., 2015). The goal of this study is to investigate how eye-head coordination and visual scanning are affected by a visual perturbation when performing a demanding task in a driving simulator.

Methods: Twenty-one participants (22-34 years old) took part in a driving task where they had to maintain their speed constant on a highway in a driving simulator while doing a visual search task on a navigation device in periphery. Pictures of several road signs were presented seven times throughout the driving scenario and participants were asked to report the number associated with a target city name. Each participant did the experiment twice: with corrected-to-normal vision and with contact lenses in order to reduce visual acuity. Eye and head movements were recorded at a sampling rate of 120 Hz through video motion capture. Visual scanning was examined thanks to entropy which provides an estimation of complexity and randomness of scan paths.

Results: We found that eye-head coordination was modified in the presence of a visual perturbation. Indeed, the slope of the linear regression between eye and head yaw rotations was steeper in degraded vision than in optimal vision ($p = 0.03$), showing that more head movements were recruited for horizontal gaze shifts. Furthermore, the analysis of the temporal dynamics of visual scanning revealed that eye and gaze movements were less explorative and more stereotyped when vision was degraded (both $p < 0.05$).

Conclusions: These findings show a reorganization of eye and head movements as well as changes in the visual scanning strategy when vision is degraded. This suggests that eye-head coordination and visual scanning dynamics could be used as indicators of the visuo-cognitive demands associated with complex and more naturalistic tasks. Ultimately, these measures seem to be good candidates to estimate the mental workload, better characterize drivers' behavior and potentially address road safety concerns.

Biography: Laura Mikula is a postdoctoral researcher at the University of Montréal (Canada) trained in cognitive neurosciences and vision sciences. Starting in 2019, she is conducting research on how eye and head movements are modified depending on vision quality and mental workload, in the context of driving.

Amigale Patoine, M.S.
University of Montreal
Montreal, Quebec, Canada

Reduction of Vision Quality Impact Driving Behaviors When Facing Increased Cognitive and Visual Demands

Purpose: The arrival of new technologies on the automotive market calls for putting comfort and safety at the forefront. However, this significant increase stimulation in intermediate vision by the several user interfaces, challenge drivers' habits in its maneuvering capacities and induced new cognitive and visual demands. Worldwide, far visual acuity is the most used criterion to obtain or renew driver's license, but modern cab may raise the importance to meet all visual distances particularly for securing the mental resources. Our goal was to examine the impact of several artificially reduced visual acuity levels on driving behavior.

Method: Twenty-one subjects (21 to 34 years-old) had to drive in a simulator over a 12-minute rural driving scenario including hazardous events and over a six minute highway driving scenario while performing a visual search task on a navigation device. Visual acuity was either normal/corrected-to-normal or artificially reduced by positive power contact lenses inducing a myopic defocus and binocular issues. Two groups of 10 and 11 subjects had reduced visual acuity equivalent to 4/10 at 3m or to 4/10 at 1m20. Driving behaviors were assessed in the rural scenario by the help of seven driving metrics and in the highway scenario by examining the success rate at the navigation task, the standard deviation to the line position (SDLP), the speed and its variability.

Results: In the rural scenario, no alteration was measured. In the highway, the navigation tasks gave rise to an increased SDLP ($F(1,79) = 84.87$, $p < 0.001$), an increased speed variability ($F(1,79) = 74.68$, $p < 0.001$) and under reduced visual quality a more important speed variability ($F(1,79) = 5.34$, $p = 0.023$). Besides, an increase in speed ($F(1,79) = 4.44$, $p = 0.038$) and its variability ($F(1,79) = 3.971$, $p = 0.050$) was demonstrated when vision was more severely altered. The success rate at the navigation task was always around 84%.

Conclusion: Induced visual acuity degradations impact driving behavior when combined with a high mental workload such as navigation device task. These results emphasize the importance of meeting all visual demands to ensure an optimal interaction between vision and cognition notably in an era where technology is taking over the interior of our vehicles.

Biography: Amigale Patoine is a master's student at the School of Optometry of the University of Montréal (Canada) who studied psychology and vision sciences. Since 2019, she has been conducting research on how driving behaviors are modulated depending on vision quality and mental workload.

Derrick Redding, M.S.
BioSense
Ann Arbor, Michigan

Evaluation of a Non-contact ECG System in a Moving Vehicle with Basic Driver Motions

Summary: In this presentation, I'll describe how non-contact ECG works and how it can be used in a vehicle. I'll evaluate how well it works during basic driver movements and responds to motion artifact from the driver and vehicle. Videos of a working system will be shown comparing the signal accuracy and visibility to a predicate ECG device.

Objectives:
1. Explain why ECG is important for driver monitoring and how non-contact ECG works
2. Evaluate how non-contact ECG works in a moving vehicle during basic driver movements

Methods:
1. Lab and road tests of non-contact ECG during the following basic driver movements:
   a. static position, b. acceleration and braking, c. steering changes, d. head turns
2. A to B equivalency comparisons of non-contact ECG in a lab and on road tests of non-contact ECG versus an FDA cleared predicate ECG device

Results:
1. Lab: a. During basic driver movements, the ECG signals were detected with good and clear signals during static, acceleration and head turning. Brief motion artifact was detected during braking and turning
   b. Static test: R peak position correlation was 99.9%
   c. Static test: R-R interval correlation was 99.4% (R to R is used to calculate HR)
2. Road test – during a nine-minute test that included city road, parkway and highway sections
   a. Overall accuracy was high: R-R interval correlation was 99.8%
   b. Overall R peak visibility was 94% during the road test

Conclusions:
1. Non-contact ECG can be used to reliably detect R peaks during the most common driving movements
2. With accurate and visible R peaks during driving, HR and HRV are easily derived
3. If non-contact ECG collects HR and HRV data for driver monitoring, it will be easy to collect other ECG biomarker data that is used for predictive analytics of the driver's health

Biography: Derrick Redding has had automotive experience at Toyota, JCI, EG Transpire and start-ups to develop new products and processes based on defining customer value, developing technical talent, increasing go-to-market productivity, and improving operations. He has led companies and organizations with sales ranging from start-up to $1B. His key accomplishments include:

- Developed installation and training process for largest DOT-funded Connected Vehicle Project
- Created and executed go-to market plans at multiple startups
- Recovered innovation product launch after major supplier disruption
- Implemented cost reduction processes that achieved 3% of sales/year on over $1.5B in sales
- Received three awards at JCI from Toyota for successful development and launch of seat programs
- As CFO, played major role in the turnaround of JCI Japan Automotive. Margins improved by over 10%
- Led implementation of two key manufacturing strategies and two launches in Toyota Assembly

Derrick Redding, M.S.
BioSense
Ann Arbor, Michigan

The Vehicle as a Medical Device

Summary: In this presentation, I'll describe how the vehicle can be used to feed forward health information to a workplace, to reduce virus transmission risks and increase the safety of workplaces.
I will discuss previous animal research on how coronavirus change the ECG and recent evidence which suggests similar ECG changes in humans from COVID-19. I will also explain how diagnostic methods with even low Positive Predictive Values can be very effective for daily, worker health monitoring. Finally, I will explain how a feed forward system of information from a vehicle can solve the logistics constraints of worker monitoring at workplace entrances.
Note: this abstract describes an application of non-contact ECG that is described in the abstract titled, "Evaluation of a non-contact ECG system in a vehicle."

Objectives:
1. Review previous research in animals on changes in the ECG from coronavirus infection
2. Present recent data that suggests human ECG changes from COVID-19 are similar to changes observed in animals and how ECG may be used as an early indicator of viral infection
3. Describe how daily monitoring of viral infections may work to help keep workplaces safer and explain the role of in-vehicle health monitoring

Methods:
1. Research review
2. Clinical trial
3. Modeling of the congestion effects from worker monitoring at a workplace entrance

Results:
1. In animals, coronavirus infection caused the following changes in the ECG: elevated HR, QTc prolongation, T wave depression, and R wave depression
2. Case study data on COVID-19 in humans is showing elevated HR, QTc prolongation and R wave depression
3. If available by December, we'll share clinical trial data from daily Healthcare Worker ECG Monitoring at a research hospital
4. Using an advanced health check in a vehicle prior to arriving at work, could eliminate wait times of more than 15 minutes at workplace entrance health checks for ECG

Conclusions:
1. Recent case data suggests that changes in the ECG from viral infections like SARS-COV2, can be an early indicator of infection
2. Low cost, rapid diagnostic tests do not need to have high Positive Predictive Values, especially if secondary controls and tests are in place
3. Daily monitoring of specific health conditions can be performed in a vehicle, fed forward to a workplace to eliminate potential testing wait times at entrances. This will lead to safer workplaces

Biography: Derrick Redding has had automotive experience at Toyota, JCI, EG Transpire and start-ups to develop new products and processes based on defining customer value, developing technical talent, increasing go-to-market productivity, and improving operations. He has led companies and organizations with sales ranging from start-up to $1B. His key accomplishments include:

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- Led implementation of two key manufacturing strategies and two launches in Toyota Assembly

Jiali Song, B.Sc.
McMaster University
Hamilton, Ontario, Canada

Visual Perception Can be Affected by Distance: Implication for Heads-up Displays

Objectives: A driver's visual world is complex and dynamic, and attention is required for drivers to select behaviourally relevant information. Understanding how drivers allocate attention may inform how driver behaviour can be improved and minimize accidents. However, most previous research on visual attention has focused on a fronto-parallel, 2D plane within reaching distance, whereas driving involves events located at various distances in 3D space much farther away than reaching distance. Relatively little is known about how attention is affected by 3D distance. Previously, we assessed visual attention with a peripheral target detection task at a near and far distance in a simulated driving context, while participants maintained a constant following headway to a lead car. We found a tunnel vision effect for detecting peripheral targets at far distance, compared to a near distance. However, in that experiment, near targets also appeared at the same distance as a lead car. In this study, we examined whether the effect of distance depends on the car-following headway.

Methods: Participants were asked to follow a lead car at a constant distance along a straight trajectory in a virtual 3D environment at an average speed of 40km/hr (11m/s).
Target distance was simulated by pictorial cues and optical flow. Fixation distance was manipulated between subjects by randomly assigning participants to follow a lead car at one of three car-following headways (9.25, 18.5, 37 m). Attention along the depth axis was assessed with a target detection task where targets could appear at one of two eccentricities (12, and 24 degrees) and three target distances (9.25, 18.5, 37 m). Crucially, the retinal characteristics of targets were constant across distances. Divided attention costs were examined in both tasks by testing each task alone under focused attention, and both tasks simultaneously under divided attention.

Results: Detection did not vary with car-following headway. Participants consistently detected targets at 18.5m most accurately and responded slower to farther targets. Dividing attention worsened car-following performance but not detection. Car-following performance did not differ among car-following headways, suggesting that participants in different car-following headway groups did not employ different strategies to complete the task.

Conclusions: Car-following headway did not affect peripheral attention. Participants' distribution of attention along depth may reflect a strategy learned in real world driving for predicting and preparing for events in the near future. These results suggest that heads-up displays may be useful for drivers as their ability to attend to what may happen ahead is not affected by the distance they are already attending, and that it may be beneficial to use augmented reality to place important information at some distance ahead.

Biography: Jiali Song is a Ph.D. Candidate in the department of Psychology, Neuroscience & Behaviour at McMaster University. She completed her B.Sc. in Psychology at the University of Toronto Scarborough, where she developed an interest in perception and cognition. She is currently investigating how drivers distribute their attention to different distances ahead, under the supervision of Drs. Allison Sekuler, Patrick Bennett & Hong-jin Sun. Her research interests also include applying psychological and cognitive theories of vision and attention to driver behaviour, changes in attention & cognition with driving experience, as well as the mechanisms and capacity of attention modulation in 3D space. When she is not doing research, she is passionate about student experience and co-operative multiplayer games. She is seeking post-doc opportunities to further explore and broaden her research interests.

Judith Ungewiss, Ph.D.
Aalen University
Aalen, Germany

Ulrich Schiefer, M.D.
Aalen University
Aalen, Germany

Michael Woerner, Ph.D.
Aalen University
Aalen, Germany

Driving Simulator as a Highly Standardized Tool for Benchmarking the Quality of Refractive Care

Objectives: Refractive care is usually evaluated by questionnaires that are subjective tools without a direct link to an activity and with an inherent lack of standardization. The aim of this approach was to develop a psychophysical test set-up to record an individual's visual performance at different distances within the highly standardized environment of a driving simulator.

Methods: The Aalen Mobility Perception & Exploration Lab (AMPEL) provides a virtual research environment, which allows for nighttime driving experiments and for benchmarking the quality of refractive care such as spectacle lenses, contact lenses, intraocular lenses (IOL), or other (surgical) refractive procedures. An example is the JJ-EYHANCE study *(ClinicalTrials.gov identifier: NCT04059289)*. Patients were divided into two groups and implanted with monofocal IOLs either with (IOL/w) or without (IOL/wo) enhanced optical properties for intermediate distances. High (HCVA) and low contrast (LCVA) distant visual acuity (VA) and mesopic contrast sensitivity (CS) were examined (inclusion criteria: VA > 20/25, ophthalmologically normal, except cataract surgery). All patients completed a driving simulator parcours. VA, CS and halo size (measured with a new, patented approach, *patent DPMA – DRN_201908091643800DE)* were assessed binocularly during the nighttime driving task using Landolt Cs in four different (far and intermediate) locations and distances.

Results: Eleven subjects were enrolled in the JJ-EYHANCE study; 5 (median age 69.6, interquartile range [IQR] 8.3 years) were implanted with IOL/w and 6 (median age 71.1, IQR 13.0 years) with IOL/wo. According to clinical testing, nighttime driving fitness could be assumed in 4/5 (80 %) of the patients with IOL/w and 5/6 (83 %) of those with IOL/wo. In the nighttime driving simulator environment, IOL/w exceeded IOL/wo in median logMAR (VA) and logCS by ≥ 0.1 log unit at intermediate distances. Halo sizes tended to be larger for IOL/w than for IOL/wo.

Conclusions: A night time driving simulator turned out to be an excellent tool for benchmarking the quality of IOL-related refractive care under highly standardized driving conditions.

Biographies:

Judith Ungewiss received an M.Sc. in Ophthalmic Optics and Psychophysics and a Ph.D. (Dr. rer. nat.) in Cognitive Science and is a scientific employee at the Aalen University of Applied Sciences, Germany and the head of the driving simulator at the Aalen Mobility Perception & Exploration Lab (AMPEL). She is a member of the Competence Center "Vision Research" (Head of the Competence Center: Prof. Dr. Ulrich Schiefer) at this institution. This Research Group is mainly focused on the

detection and follow-up of circumscribed visual pathway lesions in order to evaluate their functional and morphological interrelationship as well as to facilitate statements regarding indication and prognosis of therapeutical methods and their impact on visual exploration and on mobility.

Michael Wörner received an M.Sc. (Dipl.-Inf.) in software engineering and a Ph.D. (Dr.-Ing.) in computer science from the University of Stuttgart. In 2016, he co-founded the spin-off startup Blickshift, which specializes in the visual analysis of eye tracking data and is one of its managing directors. Michael Wörner joined the Vision Research group at the Aalen University of Applied Sciences in 2018, where he handles the IT aspects of system integration, data acquisition, and evaluation. His research interests include visualization and data analysis with a focus on the eye tracking domain.

Ulrich Schiefer holds a W3 Full Professorship at the Aalen University of Applied Sciences, Germany and is the Head of the Competence Centre of "Vision Research" at this institution. In addition, he is Senior Resident at the Department & Research Institute for Ophthalmology, University of Tuebingen, Germany. His Research Group is mainly focused on the detection and follow-up of circumscribed visual pathway lesions in order to evaluate their functional and morphological interrelationship as well as to facilitate statements regarding indication and prognosis of therapeutical methods and their impact on visual exploration and on mobility.

Research activities of this group are funded among others by the German Ophthalmological Society (DOG), Allergan, Pfizer, MSD, Alcon and Haag-Streit.

Dr. Schiefer is Board Member of the International Perimetric & Imaging Society (IPS) since 2000. He holds several patents with regard to perimetric examination techniques. He is Member of the Commission for Quality Assurance of Neurophysiological Investigation Procedures and Instruments of the German Ophthalmological Society (DOG) since 2007.

Dr. Schiefer is recipient of the Elfriede Aulhorn Award of the German Ophthalmological Society (DOG) in 1996, the Federal Teaching Award (Ministry of Science, Research and Arts, Baden-Württemberg) in 2002, the Award of the Tuebingen medical students: Best teachers (rank 1 of 1134 evaluated Medical University lecturers) in 2010 and was nominated "Ophthalmologist of the Year 2010" (Board of the Journal "Ophthalmologische Nachrichten").

Olivia Wanless, B.S.
Kettering University
Flint, Michigan

Accessibility Standardization for Cognitively and Visually Impaired Drivers

Abstract: Autonomous vehicles can present the opportunity to increase access to transportation, and therefore healthcare, for individuals with varying disabilities. In order to ensure that disability-diverse users can take advantage of modern mobility, however, many accessibility requirements are necessary. Standardization of accessibility requirements for autonomous vehicles must be developed similar to those for non-autonomous vehicles. Systems such as verbal and touch-based routing and destination selection interfaces, audible reports on accidents or collisions that take place while moving or parked, and audible reports on driving conditions and intended or previously conducted vehicle actions can be implemented to aid users with visual impairments. Measures to password-protect key functions such as routing and destination selection will ensure that cognitively impaired users cannot reroute to unsafe destinations, and only authorized personnel can select their destinations. Perhaps most importantly, emergency response contact methods must be accessible. In the event of a medical emergency or a vehicular crash, occupants who are visually impaired must be able to contact emergency response via a verbal interface, while deaf users must be able to use a tactile interface. For individuals who are unable to make emergency response calls manually in the event of a vehicular crash, including cognitively impaired users and users who are unconscious or otherwise unresponsive, the vehicle must also be capable of automatically contacting emergency response services. By standardizing these and other important accessibility features, it can be ensured that disabled users can access transportation with minimal or no dependence on other individuals. With increased access to safe transportation, disabled users will be better able to travel to receive healthcare.

Biography: Olivia Wanless is a master's student at Kettering University Online seeking a M.S. in Electrical and Computer Engineering with an Advanced Mobility focus and a recent graduate of Kettering University, where she graduated with a B.S. in Electrical Engineering. As a Kettering student, Wanless was a Team Captain in the school's AutoDrive Challenge (TM) team, a collegiate competition in which students work to produce an autonomous Chevy Bolt. Wanless now works as a manufacturing controls engineer at Nexteer Automotive. Her academic research focuses on the social and ethical impacts of autonomous vehicles, with specific attention to the transportation needs of diverse groups.

Juho Wedenoja, M.D., Ph.D.
University of Helsinki
Helsinki, Finland

The Role of Vision-Related Problems in Fatal Road Accidents in Finland

Objectives: Sufficient vision is a crucial component of driving fitness. Despite the rigorous testing criteria, it is controversial whether there is any association between visual acuity screening and motor vehicle accidents. Additionally, the incidence of poor visual acuity as a causative factor for fatal motor vehicle accidents (FMVAs) remains undetermined. In Finland, a Nordic country with population of 5.5 million, the current law demands that the driving fitness should be estimated in all health care contacts. If the criteria are not met, physicians are required by law to submit an official notification to the police, most of which are submitted by ophthalmologists.

Methods: The Finnish national law states that all road traffic accidents should be investigated by Road Accident Investigation Teams (RAITs) which consist of delegates from the police force, road specialists, vehicle engineering specialists, physicians, and behavioral scientists. They follow a standardized VALT investigation method, and one task of the RAIT physician member is to collect all relevant health data from the patient registries from diverse health care sources. The resulting road accident data is openly available for research, and in this retrospective registry-based study, we determined the role of vision-related problems contributing to all FMVAs during years 2012-2016 in Finland.

Results: There were a total of 968 FMVAs. While an observational failure of 23.6% was the leading cause of FMVAs, in none of the FMVAs had a vision-related condition been assessed as an immediate risk, and in only 1.3% of them could it be considered as a background risk. Substance abuse was statistically lower in observational failure (8.8%, $P<0.0000001$) than overall (24.4%), but it was significantly higher in cases with speeding (41.5%, $P<0.0000001$), and once a driver did not have a valid driving license (69.3%, $P<0.0000001$). Deliberate or willful acts accounted for 16.2% of all FMVAs.

Conclusions: Vision-related reasons seem to have only a marginal direct impact on FMVAs. The current regulations to control vision seem to be effective in Finland and making current visual standards more stringent would unlikely be effective in FMVA prevention. Committing suicide and other intentional risk-taking make up a high proportion of all FMVAs. Therefore, more attention should be targeted to other somatic, cognitive and especially psychiatric conditions causing FMVAs as well as substance abuse prevention.

Biography: Dr. Wedenoja is currently a professor of ophthalmology at the University of Helsinki and is an ophthalmologist in the cornea and anterior segment surgery unit at the Helsinki University Hospital. He is also the Director of the Traffic Medicine Unit. He received his M.D. and Ph.D. from the University of Helsinki and was a Fellow on the European Board of Ophthalmology in Paris, France.

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ZF
Northville, Michigan

Interior Monitoring Systems: The Next Evolution in Vehicle Occupant Health and Safety

Abstract: Interior Monitoring Sensor systems are the next frontier for Advanced Driver Assist Systems (ADAS) and offer great potential to enhance driver and occupant safety today and help enable the evolution toward automated driving systems. In addition, these systems are a platform to monitor the real-time state of driver and passengers for a variety of measures, including alertness, awareness and overall health using both optical camera-based monitoring and tactile monitoring through advanced technologies that can be integrated into the steering wheel. Camera-based 2-D systems are already in use for monitoring driver drowsiness, which led to crashes that NHTSA estimates caused over 50,000 injuries and almost 800 fatalities in 2017, and 3-D systems are being developed that will allow for more precise and expansive interior data to be captured on occupant position and pose. As new seating and occupant positioning are enabled by autonomous vehicles, the sensing of occupants will be critical in determining how to best protect them in the event of an accident.

Biography: As vice president of Product Planning for vehicle systems and special projects for the ZF group, Whydell is responsible for identifying new market trends and product requirements, as well as guiding the company's systems development strategy to best meet those needs. Mr. Whydell is based at ZF's North American Headquarters in Livonia, Michigan. His current responsibilities include product planning and strategy development across the ZF group's broad portfolio of chassis, electronics and occupant safety products. Before assuming this role Whydell was Product Planning director responsible for the Global Electronics product line and served as Product Planning senior manager for the TRW Driver Assist Systems product line, located in Shirley, England. Mr. Whydell joined ZF in February 2007, having progressed through several Engineering, Business Planning and Program Management positions within the Ford Motor Company Electronics and Visteon organizations. A graduate of Leeds University in England, Mr. Whydell holds a master's degree in Mechanical Engineering.

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Machine Vision System for Reading Barcode Signs to Support Vehicle to Infrastructure (V2I) Safety (RB3S)

Purpose: There is an urgent need for machine vision-based technology to perform functions, such as navigation assistance in areas where GPS or detailed maps are not available, caution and warning systems that can recognize unsafe conditions, and timely notification of changing road conditions. Compared with conventional road signs, barcode signs are more suitable for use by robots because they contain error correction codes more suitable for machine reading.

Method: We provide a low-cost technical solution, a RB3S system, which makes V2I and CV technology economically viable in most parts of the country with limited access to Information Communication Technology (ICT) / Roadside Unit (RSU). RB3S uses an on-board machine vision system to read roadside bar code signs and interpret the contents of the signs to obtain information for subsequent vehicle maneuvers. As shown in Figure 1, RB3S consists of three parts: (1) data augmentation, (2) transfer learning and (3) a ruggedized barcode sign reading/notification box.

Figure 1. RB3S architecture

Results: We augmented the barcode dataset by leveraging replacing signs in a well-known dataset BDD100K that covers different weather conditions at different times of the day. We covered some of the signs in the images with synthesized barcodes. Different techniques are used, such as color adjustment and affine transformation, to make the synthesized barcodes as realistic as possible.

We customized YOLO-v4 (You Only Look Once) to detect synthesized barcodes. 8,576 training images were used for training and 2,144 test images for testing. As shown in Table 1, the detection accuracy of the YOLO-v4 barcode detector reaches 98%.

Table 1. Detection result of YOLO-v4 full model compared with YOLO-v3 tiny model

Total # of barcodes in testing images: 2972	New Yolo-v4 full model	Previous YOLO-v3 tiny model
True detection	**2843**	**2081**
Mis detection	**59**	**822**
False alarm	**79**	**91**

Once the barcode is detected, it is passed to a barcode decoder for decoding the messages. We cooperated with DELDOT TMC to conduct tests on public roads (Figure 2) under various lighting conditions at different speeds. RB3S achieved real-time performance. We are continuing to improve the results and are developing hardware to be installed in vehicles.

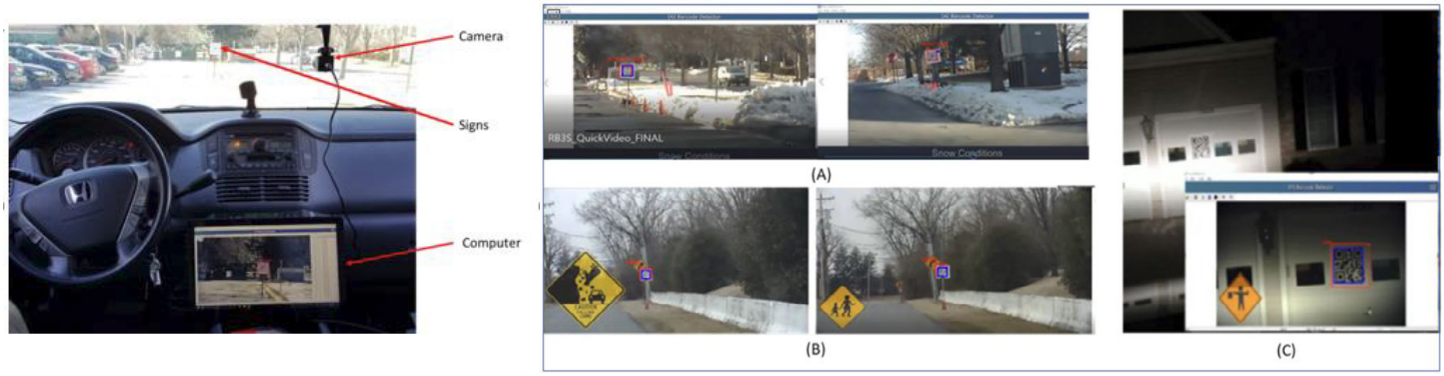

Figure 2. Prototype device and testing

Biography: Ms. Lemin Xiao is a Senior Research Engineer at Intelligent Automation, Inc. Ms. Xiao received her B.E. in 2011 in Control Science and Engineering from Zhejiang University, and her M.S. in 2012 in Electrical and Computer Engineering from Northwestern University. Ms. Xiao has over seven years Research & Development experience in the fields of machine learning, deep learning, computer vision, data mining, and natural language processing. She has strong engineer skills in developing machine learning/deep learning algorithms to solve real-world problems including transportation areas.

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The Future of Shared Autonomous Vehicles: Effects of the COVID-19 Pandemic

Objectives: How much would the COVID-19 pandemic increase Shared Autonomous Vehicle (SAV) fatality rates? Are there practical interior design changes in passenger vehicles that would reduce virus transmission?

Methods: The relative crash fatality rates of autonomous vehicles (AVs) and conventional vehicles (CVs) are estimated. The increased AV fatality rate for SAVs is assessed for COVID-19 transmission from 1) droplets or aerosol from co-passenger(s) in a pooled trip, and 2) surface virus left by prior passenger(s). Changes in Uber and Lyft ridership data during COVID-19 are presented. Interior design changes to reduce virus transmission are evaluated.

Results: For 2014-18, the estimated fatality rates of major AV test fleets were lower than CVs in the same Operational Design Domain. Fatality incidence rate ratios were 0, 0, and 0.53 respectively for Waymo in Mountain View and vicinity, GM Cruise in San Francisco, and Tesla in the U.S. assume the current number of infected people in the U.S. and present COVID-19 death rates. Estimates are then made of the increase in COVID-19 fatalities from contact with infected SAV strangers from shared rides or previous rides. Fortunately, even with the added COVID-19 fatalities, SAVs would still have a lower fatality rate than CVs. Unfortunately, survey data and real-world declines in Uber and Lyft ridership during COVID-19 indicate that the perceived COVID-19 risk from shared ridership is likely to be higher than the actual risk. Virus transmission is challenging to mitigate in a passenger vehicle because passengers are tightly nested. Barriers may reduce droplet transmission, but installation and the required additional crash tests are costly. Also, even transparent barriers may be perceived by some passengers as a "cage," possibly causing claustrophobia. Current automotive HVAC systems promote transmission because they do not filter out aerosols. The use of HEPA filters and UV air sterilization would increase cost. However, SAV riders could reduce virus transmission at low cost with masks, gloves, and open vehicle windows.

Conclusions: These results suggest that the fatality reduction from SAVs would be offset to some degree by increased COVID-19 fatalities, but that there would still be a lower overall fatality rate for SAVs than conventional vehicles. SAV interior design changes to reduce transmission are impractical, but the usual personal protection equipment would improve safety.

Biography: Richard Young received a Ph.D. degree with highest honors from New York University, with post-doctoral research at Harvard and UC Berkeley. His area is cognitive neuroscience, with a specialty in primate vision. He worked at the University of Oregon, Apple, GM, and Wayne State University in various R&D positions concerning human vision and visual distraction. At Wayne State School of Medicine, he received contracts from the State of Michigan and automotive companies worldwide. In June 2016, he formed Driving Safety Consulting, where he has received government and legal consulting contracts, most recently as an expert witness in legal cases involving driver distraction. His current primary research interest is in the driving safety of automated vehicles. His talk on that topic two years ago at this conference was expanded into a book that has been recently accepted for publication.

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