New Findings on Distracted Driving
Developing an Attention Management Perspective & Solution

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Panel on Understanding the Science of Distracted Driving
Lifesavers Conference
Louisville, KT
March 31, 2019
A Note on Interpretation & Views

The interpretation of data and the views expressed during this talk are those of the speaker and do not necessarily represent the views of organizations that have contributed to the support of this work.

Principle Scientific Leads:
Bryan Reimer, Bobbie Seppelt, Bruce Mehler, Lex Fridman, Linda Angell, Sean Seaman

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Aishni Parab, Alea Mehler, Aleksandr Patsekin, Anthony Pentanato, Benedikt Jenik, Daniel Brown, Hillary Abraham, Jack Terwilliger, Li Ding, Luca Russo, Michael Glazer, Spencer Dodd, William Angell
Background: Measuring Stress / Workload / Cognitive Demand during Driving

Self-reported workload, physiological arousal, and DRT response time reliably change with increasing cognitive workload (n-back task)


Background: Visual Demand in Voice-Based vs. Visual-Manual HMIs

Bars represent mean visual demand in terms of total glance time eyes are off the forward roadway (TEORT). Standard error shown as horizontal line. Dots show the 85% point in the sample distribution for each task.
TEORT Address Entry & POI Across Multiple Voice-Based Multi-Modal HMIs

Is a simple metric such as TEORT the last word on demand in modern MHIs?

The solid horizontal line represents the NHTSA TEORT threshold. The dot above each bar represents the 85% point in the sample distribution for each task. Bars represent individual address entry tasks (e.g. 1st bar is 177 Massachusetts Ave. Cambridge, 2nd bar is 293 Beacon Street Boston etc.)
The AHEAD Consortium  Advanced Human Factors Evaluator for Attentional Demand

Formal project start: June 2013

Focus on broadening scientifically valid perspectives and methodologies for the objective measurement of demand placed on drivers by in-vehicle systems and technologies

Early emphasis on:

- Developing a framework in which HMI designers could evaluate demand across multiple dimensions, i.e. visual, auditory, haptic, vocal, manual, etc., by taking into consideration the relative cost / benefit interactions of various input, output and processing modalities to find an optimal balance to minimize impact on the primary driving task
- Understanding the role of spatial and temporal characteristics of a task
- Considering interactions between non-driving tasks and the broader operating environment

An evolving aim of AHEAD has been to move the language of assessment from one focused on distraction, to one that emphasizes driver attention management and safe operation, such that demands on the driver, active safety systems, and other higher order forms of automation can be considered as a whole.
Off-Road vs. On-Road Glance Duration & Crash Risk

Reanalysis of the 100-car naturalistic driving dataset comparing mean single glance duration for:

- off-road glances (left) and on-road glances (right), and
- crash (black) and non-crash events

(Error bars represent 95% CIs.)

Measuring Attention over Time

An Attentional Buffer

The concept of an ‘attentional buffer’ can be used to describe both visual allocation and attention.

Figure adapted & extended from Kircher & Ahlstrom (2009). AHEAD efforts have extended the base rules shown here. See Seppelt et al. (2017, 2018).

Depth of buffer reflects sampling rate required to keep vehicle in lane (every 1.8-2s; cf. Senders, 1967) – potential changes with automation etc.

Driver’s focus away from road - awareness of road situation declining

Driver needed to look back at the road and attend to it in order to refresh their awareness of the road situation.
A larger loss of situation awareness (SA) precedes crash vs. near-crash epochs as measured by the buffer.

**The Advanced Vehicle Technology Consortium**

**Founded:** 2016 by MIT AgeLab, Touchstone Evaluations & Agero

**Focus:** To collect and analyze objective data that characterizes the behavioral and safety benefit of advanced driver assistance systems, higher levels of automation, and other production in-vehicle technologies under real-use conditions.

**Membership:** Agero, Aptiv, Consumer Reports, Google, Insurance Institute for Highway Safety (IIHS), Jaguar Land Rover, J.D. Power, Liberty Mutual Insurance, Progressive, Toyota, TravelCenters of America, Veoneer, & Volvo

A collaborative undertaking by OEMs, suppliers, insurance industry, and consumer advocacy entities.

**Looking Beyond the Technology Towards Consumer Understanding**

To develop: An understanding of system performance and how drivers adapt to, use (or do not use), and behave with advanced vehicle technologies.
Investigating Advanced Technology Use in the Wild

- Two pronged study:
  - Users in their own cars (1 year+)
  - MIT owned vehicles (1 month)

- Current vehicles
  - Tesla models S & X
  - Range Rover Evoque
  - Volvo S90 (Pilot Assist)
  - Cadillac CT6 (Super Cruise)

- Total miles currently in dataset: 511,638

- Approximately 1000 miles of multi-camera HD video, audio, GPS, accelerometer and CAN data is being added per day.
AN ATTENTION EPIDEMIC?
Drivers have long multi-tasked, but perhaps what appears on our roads now is pushing boundaries we would not have imagined even a few years ago.
The Value of Observing How Drivers Use an Interface in the “Wild”

Are voice interfaces inherently “safer”? - Perhaps an open question based on task type & HMI?

Video Removed for Participant Privacy
SELECTED INSIGHTS FROM AVT
Technologies can create customer distraction, confusion and frustration
Key Takeaways

• Distraction is the new normal - What do we do about it?
  • Need to shift to some extent from a focus on distraction to a greater emphasis on attention management & support

• Distraction is more than the classic eyes-off-road time
  • Taking into account how glance behavior is threaded together both off and on the road over time is likely to provide a more accurate measure of risk than just off-road glance metrics used in current guidelines.
  • Attention Buffer metrics are being refined for both HMI assessment & future deployment in real-time monitoring

• Automated systems offer the promise of increased safety, but...
  • Increased display of system state information and increasing number of controls to support multiple modes of operation are increasing supervisory demand on the “driver” – impacting the amount of time eyes are off the road
  • Close attention needs to be paid to driver mental models, understanding, and interface design so that these technologies provide net positive benefit and don’t become distraction sources themselves

• Banning types of interfaces and tasks likely only a partial answer
  • Active monitoring of driver attention may be the solution / cost for the “right” to operate a vehicle
  • Ironically, the need for monitoring & driver support will likely increase as ADAS technology becomes more reliable
  • Driver monitoring should not be used primarily to penalize the driver, but to actively support and cue better attention
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Appendix
Appendix: Selected References


Appendix: References on MIT Work with Production Voice Systems


