Driver Training for Vehicle Automation

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Collaborators on Safe-D UTC Project

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Current Practice: Vehicle Manual

- If you were to ask a safety professional *how likely it is that an individual would read the owners manual upon getting an automobile*, the answer would probably be ***"very low."*** (Leonard, 2001)

Respondents	All	None	Special Topics	Until Tired	Total
Age 25+	10 (20.00%)	2 (4.00%)	27 (54.00%)	11 (22.00%)	50
Age < 25	12 (6.74%)	13 (7.30%)	115 (64.61%)	38 (21.35%)	178
Total	22 (9.65%)	15 (6.58%)	142 (62.28%)	49 (21.49%)	228

Current Practice: Trial-and-Error

- Practice does not make perfect, practice makes habit.

- Trial-and-Error may be useful in certain aspects of AV training and in certain situations (e.g. when the vehicle is stationary)
  - System Activation/Deactivation

- Safe operation of AVS requires a deeper understanding of the technology

How do drivers want to learn?

Younger Drivers

- Want to learn:
  - In-vehicle video
  - Gamification
  - Vehicle training mode
  - Video at Dealership
- Do not want to learn:
  - Classroom setting
  - DMV
  - Training during purchase
  - In-person training

Older Drivers

- Want to learn:
  - Hands-on Demo
  - Training during purchase
  - Test drive training
  - Training at popular locations
- Do not want to learn:
  - Classroom setting
  - DMV
  - Online videos
  - In-person explanation

Research Questions

- What is the optimal method to train drivers on the use of automated vehicle technologies?
  - Do drivers of different ages require different training methods?

- How can we detect behavioral and physiological measures that indicate successful training?

VTTI Test Track Study – Research Objectives

- To understand if presenting ADAS information in a multimedia format would improve driver understanding/comprehension as well as driving performance.
  - Multimedia vs. digital owners manual

Dependent Measures:

- Operator knowledge of automated vehicle systems
- Performance (skill and behavior) when using the automated vehicle system
- Attitudes toward automated vehicle systems
- Attitudes toward the training program

Study Overview

	Conventional Training	Multimedia Training	Total
Younger Participants (18 – 25)	10 (M = 21.4, SD = 1.58)	10 (M = 21.1, SD = 1.37)	20 (M = 21.25, SD = 1.45)
Older Participants (55 – 75)	10 (M = 59.7, SD = 5.64)	10 (M = 66.2, SD = 7.63)	20 (M = 62.95, SD = 7.33)
Total	20 (M = 40.55, SD = 20.06)	20 (M = 43.65, SD = 23.74)	40 (M = 42.1, SD = 21.75)

- Training Protocols:
  - Participant completed one of two training protocols while sitting in the parked research vehicle.

Study Divisions

Training module: each participant will receive one of two training protocols

Pre-Training

- Knowledge
- Attitude – AVS

Post-Training

- Knowledge
- Attitude – Training
- Attitude – AVS

Test Track Drive

- Performance
- Behavior

Post-Drive

- Knowledge
- Attitude – Training
- Attitude – AVS

Metrics

- Knowledge
- Number of inadvertent system deactivations (Skill)
- Hands on Wheel Alert (Behavior)
- Mean Off Road Glance Duration (Behavior)
- Trust (Attitude toward AVS)
- Attitudes toward Training

Methods - Training

Research Environment

- Virginia Smart Road Highway
  - A 1 mile section of the Smart Road was used
  - 2 × 0.3 mile secondary task section
  - 0.3 mile transition area, no secondary tasks to be completed
- Confederate vehicle on the test track that was either lead or following vehicle

Smart Road Study

- AVS State
  - Systems On: Lateral and longitudinal control of the vehicle is managed by the automated systems
  - Systems Off: Lateral and longitudinal control of the vehicle is managed by the human operator

- Secondary Task
  - None: No secondary task was performed
  - Task: Secondary tasks of varying complexity were performed continuously on specific segments of road

Results - Operator Knowledge

- Where it works:
  - Older participants were **more likely** to identify the roadway environments where it would be appropriate to use ACC and Lane Keeping than younger participants.

- Situations where it may not work as expected:
  - Most participants (both age groups) were unable to correctly identify all situations where systems may not work as expected.

Results - Operator Knowledge

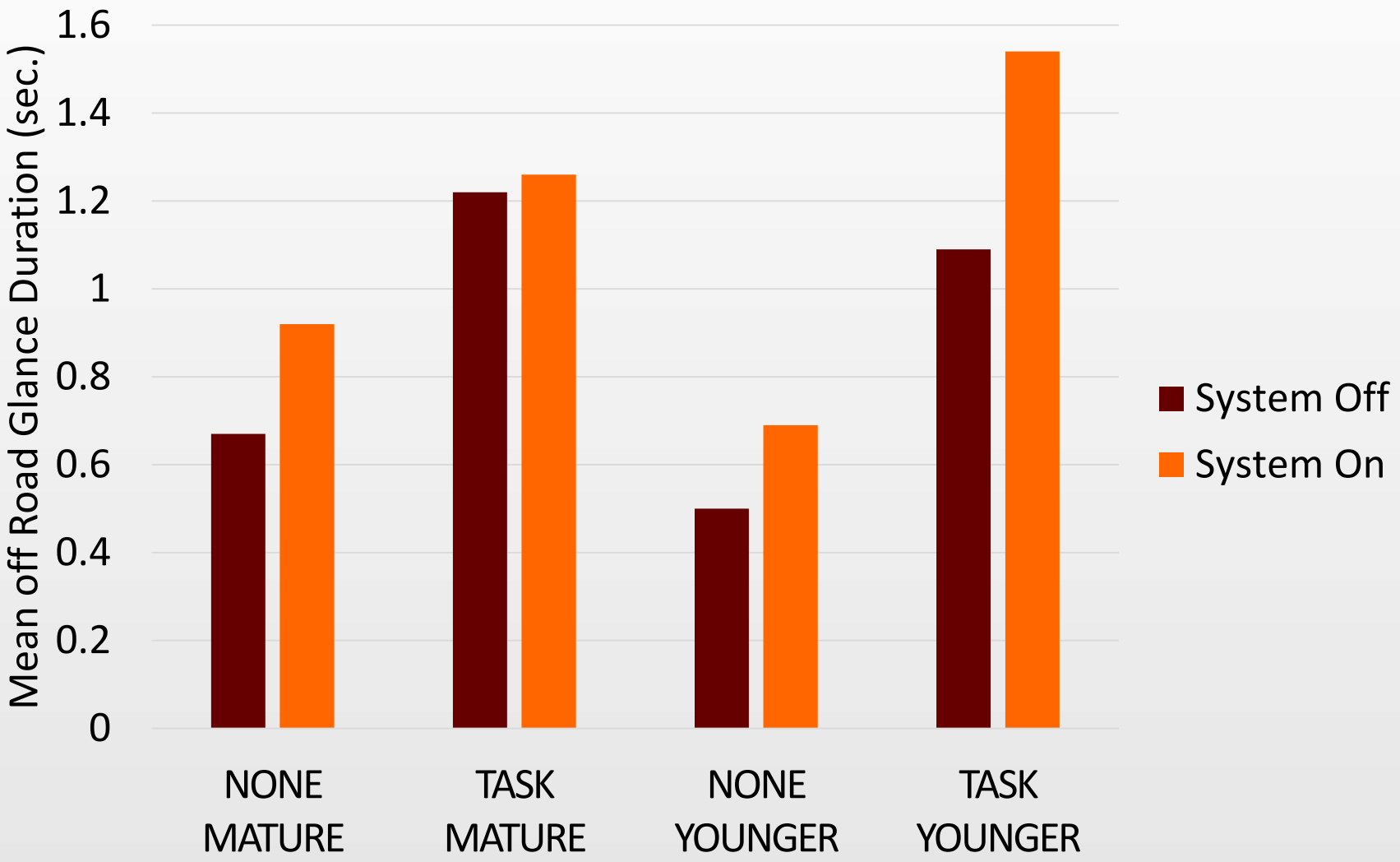
- Sensors used:
  - ACC: No main effects were found to contribute. Many participants responded correctly to this question.
  - LKA: Participants who completed multimedia training were approximately 3 times as likely to respond correctly than those who completed conventional training (OR: 2.97, CI: 1.07, 8.23).

Results – Deactivations & Alerts

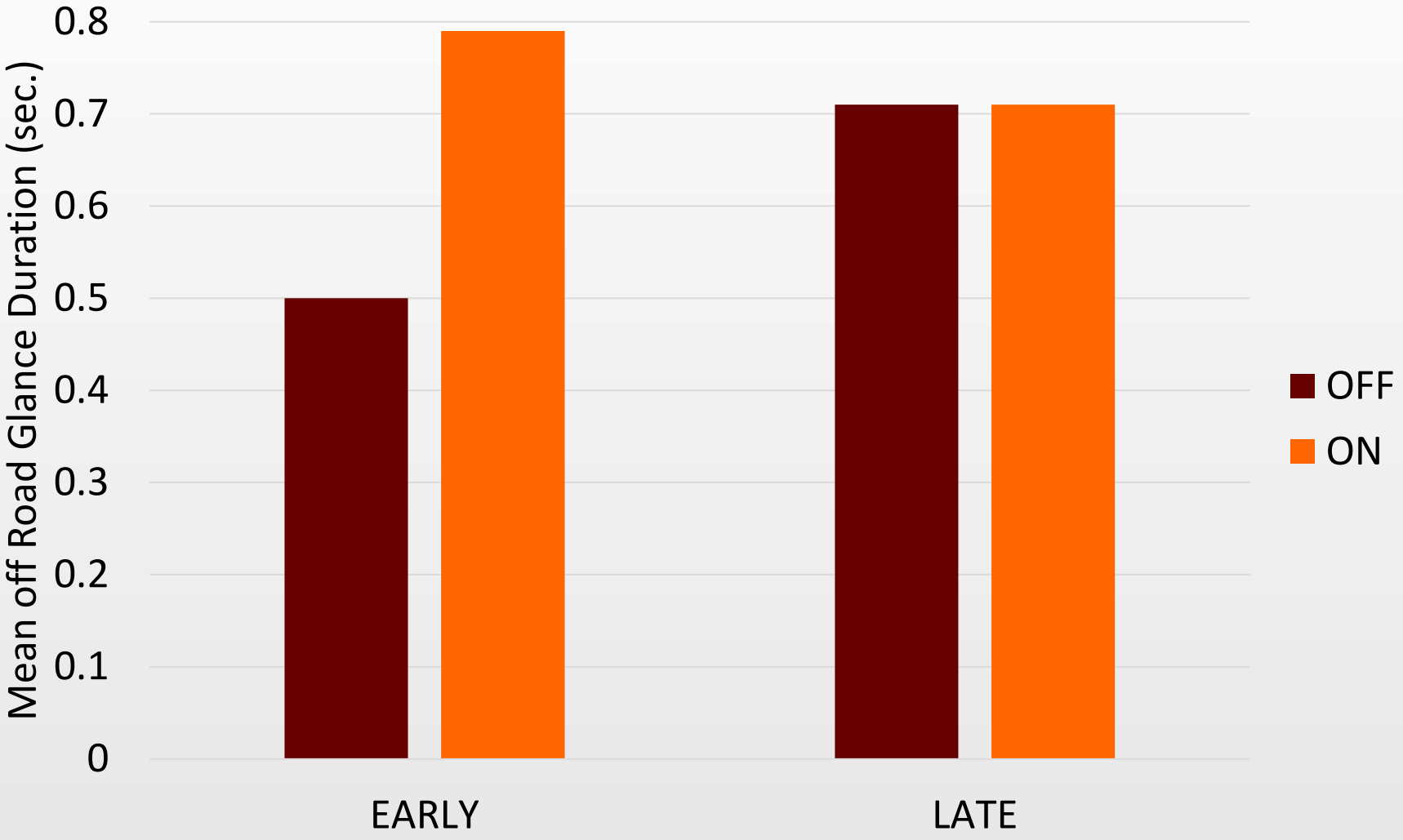
- Number of System Deactivations
  - Younger operators had a lower incident rate of system deactivations than operators in the mature demographic (IR: 0.24, CI: 0.10, 0.55).

- Number of Hands on Wheel Alerts & Severity
  - 15 participants received 41 hands on wheel alerts
    - 53.7% of alerts were Visual + Audio

Results – Mean Glance off Road



Results – MGOR Over Time



Results – Attitudes toward AVS

- I would rely on vehicle automation to function properly while I am doing something else.
  - Younger participants tended to have a higher numeric response to the reliance on automation to function properly while doing something else (M = 4.1, SD = 1.8), participants in the mature demographic were less inclined to rely on the vehicle automation to function properly while performing other tasks (M = 3.15, SD = 1.4).
- Vehicle automation gives false alerts.
  - Participants who received multimedia training were more inclined to believe that vehicle automation provides false alerts compared to participants who received conventional training.
- Vehicle automation is dependable
  - Participants were **more inclined to agree** with the statement "Vehicle automation is dependable" after driving the vehicle.

I am familiar with vehicle automation.

I trust vehicle automation

Results – Attitudes toward Training

- Age Group
  - Most older participants reported the training and driving experience equally helpful (N=11)
  - Many younger participants reported experience with driving as most helpful (N=14).
- Training
  - Recipients of the conventional protocol most frequently reported experience with driving as most helpful (N=12). There was an even split for those with multimedia training.

Conclusions

- We did not find a significant effect of training type; however, same material was presented in different formats.
- Mean glance off road were longer with systems active and indicated that this may increase over time.
- Driver's understanding of ADAS will continue to change over time through driving experience.
  - Thus there should be ways to enhance learning through experience with feedback
  - Current monitoring protocols may not be sufficient feedback (i.e. hands on wheel)
- Trust and confidence increase post-drive.
- Training materials need to be developed that address the needs of adult learners.

Overall Conclusions

- We will need to develop a variety of training options
  - A one size fits all approach will probably not work
- Will require the buy in from multiple stakeholders
  - Responsibility for training can't be dropped on one agency/stakeholder's lap
- May need to provide incentive/motivation for drivers to obtain training

Future Work

- Examine driver interaction with the vehicle automation over time (short term and long term) in order to:
  - Determine driver proficiency as a result of unstructured self-guided learning
  - Identify safety critical incidents/behaviors that could be corrected through training
- Develop novel *in-vehicle* training materials and assess effectiveness
  - In-vehicle monitoring and feedback has been shown to improve driving performance in teens…could apply this to in-vehicle training mode.
  - Another option to train drivers on system failures vs specific scenarios

Questions??

Next Steps, Funding Needs, Timelines

- Conduct an on-road study assessing novel in-vehicle training protocols.
  - Partner with Safe-D UTC (50/50 split)
- Total project $400,000 ($200K UTC/$200K Auto Alliance)
- Timeline: 18 months with preliminary results at 12 months