How does Training Influence Use and Understanding of Advanced Vehicle Technologies? A simulator evaluation of driving behavior and mental models

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Introduction

- Advanced Driver Assistance Systems (ADAS) are designed to improve drivers' safety and comfort.

- With advancements in technologies, there are also changes in how the role of a driver changes in the presence of ADAS technologies.

- Giving control of part of the driving task to ADAS decreases drivers' responsibilities of control and increases monitoring.

- These ADAS features are inherently complex and difficult to understand.

- The ADAS features available for use today do not have the capabilities to maintain control of the car for long and continuous durations of time.

- Drivers need to remain aware and be ready to take back control of the car if necessary.

- However, due to incomplete knowledge and understanding, drivers may not always understand the conditions and limitation in which ADAS are meant to be used.

Introduction (Contd.)

- This understanding of using and operating ADAS can be called as Mental Model of the system.

- Training has been known to help drivers develop better and complete mental models.

- We conducted a simulator study to study and understand the impact of training on the mental models of drivers for Adaptive Cruise Control (ACC).

Methods

- Participants were pre-screened for age, licensure, and understanding of ACC functionalities and limitations.

- Participants with valid licenses, 3+ months of driving experience, were aged 18 - 65 and self-reported novice users of ACC were eligible for the study.

- We developed three different training methods:

  - **Visualization** (V) - Visualizes unique states of ACC using a schematic diagram and provides information about limitations and warnings.

  - **Text-Based** (M) - Describes functionalities and limitations of ACC using text from current Owner's Manuals.

  - **Sham** (S) - Provides text-based information regarding other ADAS features.
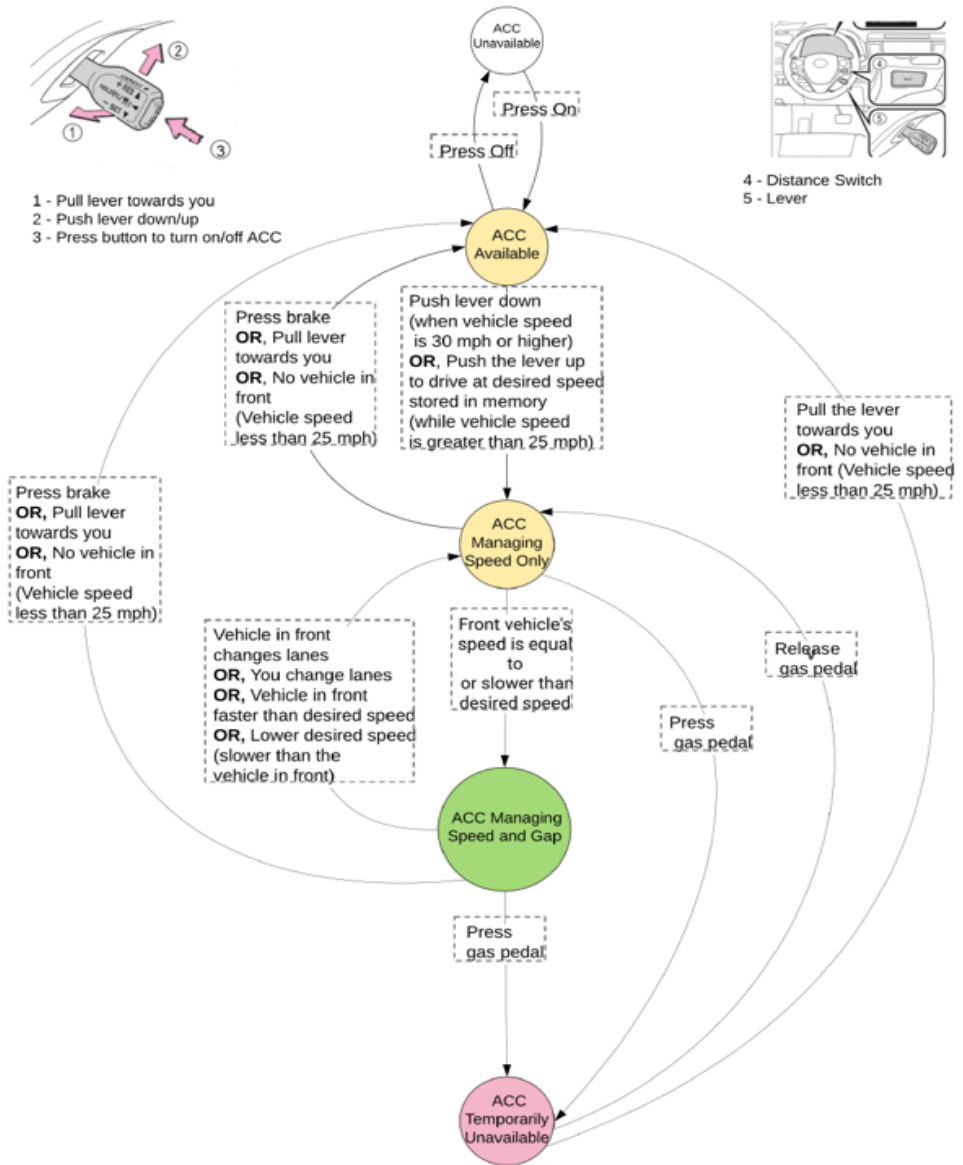
Visualization State Diagram

Methods (Contd.)

- The dependent variables can be broadly discussed as survey measures and simulator measures.

- Survey Measures:
  - Mental Models (Completeness and Accuracy of Mental Models) Survey

- Simulator Measures:
  - Accuracy of drivers' real-time verbal responses to probes about ADAS status.
  - Accuracy of drivers' real-time manual responses to instructions to operate ADAS
 - Reaction time for drivers' manual responses

Results

- 24 participants were recruited (Mean age = 24.8 years; SD = 8.57 years).

- Drivers understanding of ADAS, as measured by ADAS, did show a positive effect of training.

- The analysis showed a significant difference between Pre and Post Training, specifically for groups V and M.

Pre vs Post Training CAMMS Scores - Overall & by Groups
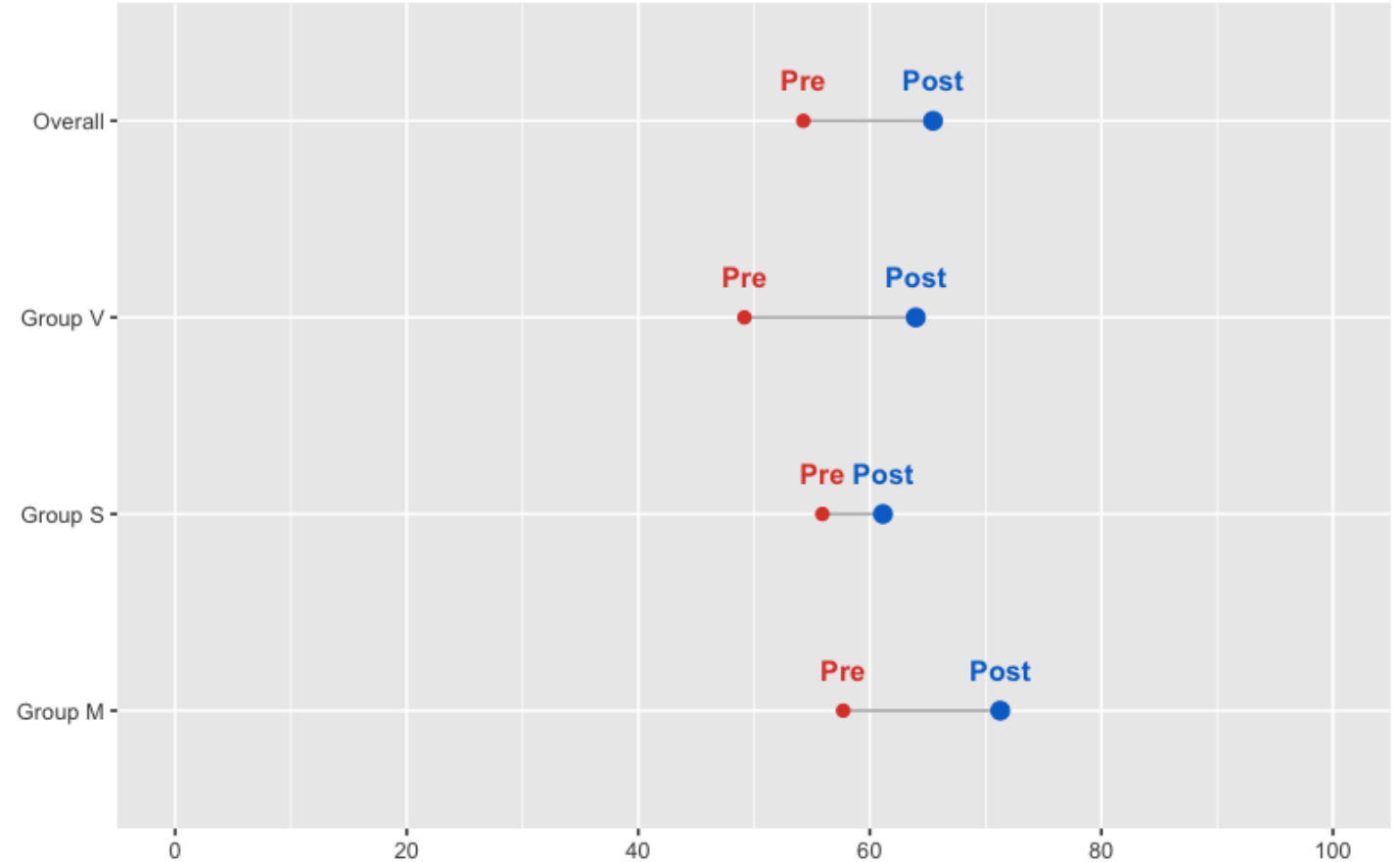
Results (Contd.)
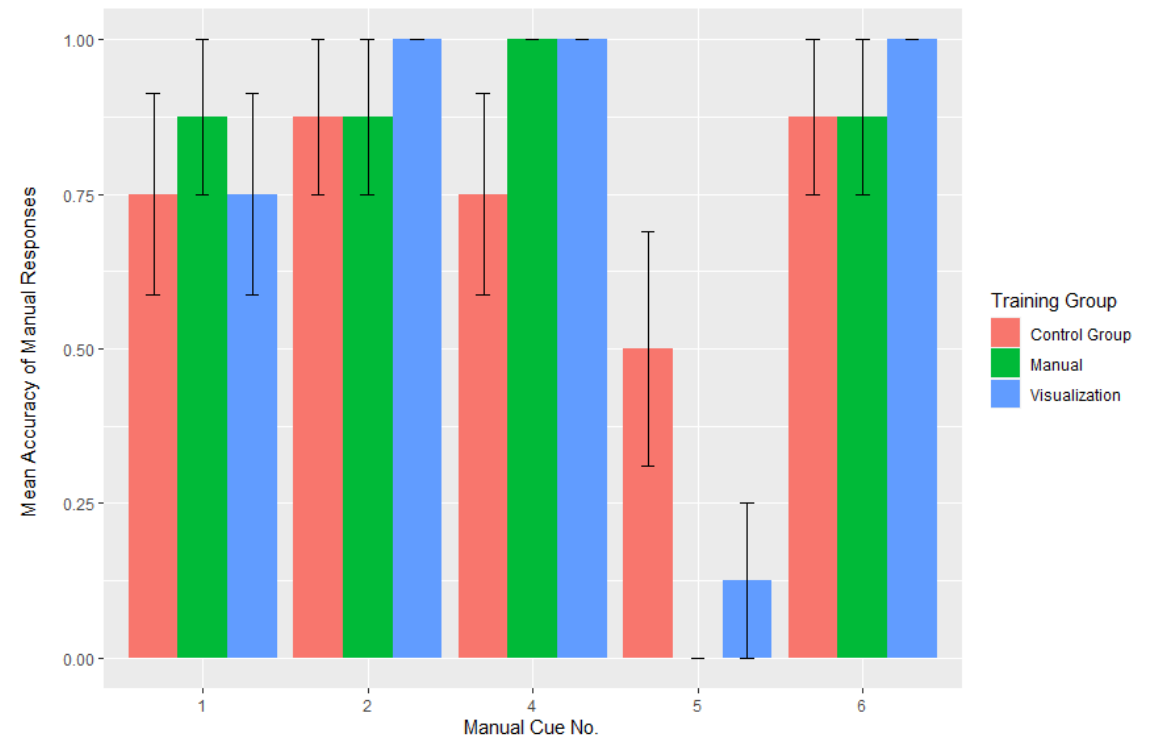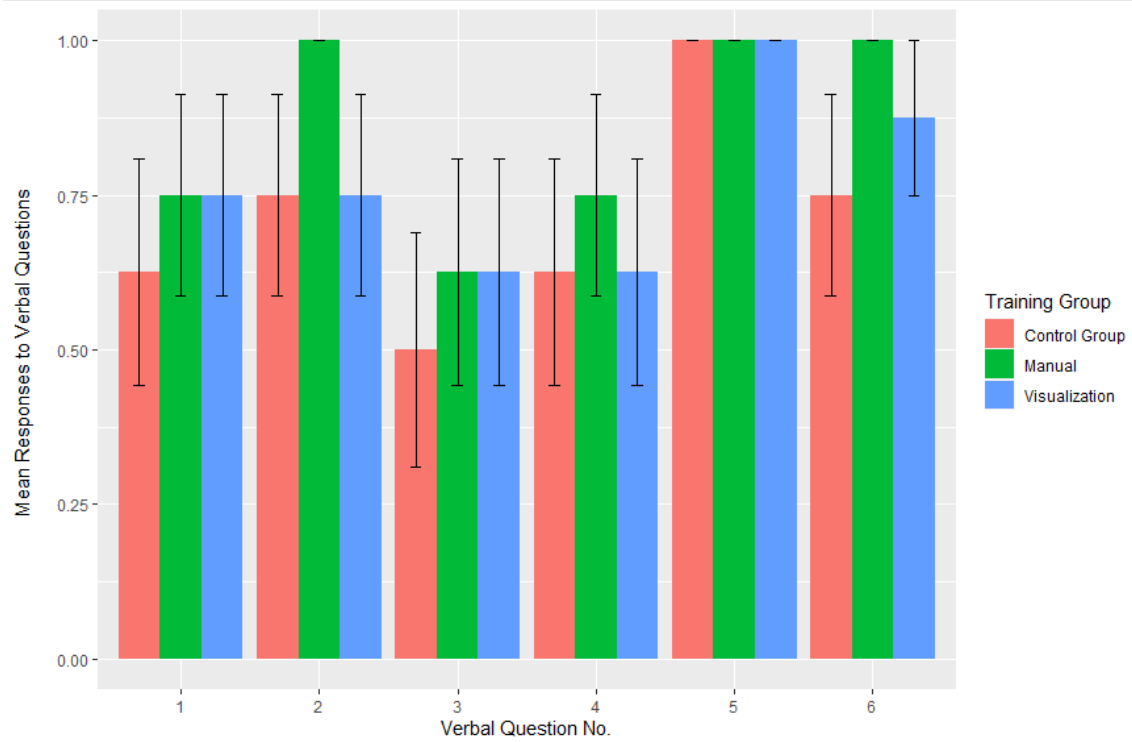
Discussion

- Significance testing revealed increased knowledge and understanding post-training.

- Specifically, methods V and M increased knowledge significantly more than method S.

- Groups V and M had better verbal response accuracy.

- Group V had a better manual response accuracy.

- Group S had a higher mean reaction time overall.

- No significant effect of training on accuracy of verbal or manual responses.

- This indicates a need for more specific or sensitive questions to accurately measure response times.

Conclusion

- This study examines the the effects of training on drivers' use and understanding of vehicle technologies, namely Adaptive Cruise Control (ACC).

- Participants were randomly administered one of three training approaches and the impact of training was examined by comparing mental models before and after training.

- We also measured system use of real-time responses about system state across three training types.

- Significance testing shows training is useful in developing complete mental models of a system.

- This knowledge was not transferrable to manual and verbal responses, so further research with more sensitive questions and probes may be needed.

- Training and other education approaches can help improve drivers' understanding of the systems, resulting in more appropriate and thus safer use of these systems.

- Shorter and more accessible and focused training may hold advantage over denser text-based manuals, but more work is needed to understand the differences in content and delivery.

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Questions?