CHANGE IN MENTAL MODELS OF ADAS IN RELATION TO QUANTITY AND QUALITY OF EXPOSURE

INTRODUCTION

Advanced Driver Assistance Systems (ADAS) support drivers with some driving tasks. However, drivers may lack appropriate knowledge about ADAS (referred to as their mental model), which can translate to drivers misusing or mistrusting the technologies, especially in situations beyond the capability of the system (i.e., edge cases). Past research suggests that mental models may be improved through exposure to ADAS-related driving situations, especially those related to the system capabilities as well as limitations.

The goal of this project, based on a cooperative agreement between the AAA Foundation for Traffic Safety and the SAFER-SIM University Transportation Center, was to examine the impact of different numbers and types of edge-case events on drivers' understanding of Adaptive Cruise Control (ACC), their trust, their workload, and their use of the systems after driving with ACC. This research employed an experimental longitudinal study to expose drivers to ADAS technologies as well as associated edge cases across four sessions in a driving simulator. Drivers in the study were assigned to one of two groups: one whom encountered only routine edge-case events (Regular Group) or one whom also experienced rare events (Enhanced Group).

KEY FINDINGS

Drivers' understanding of ACC improved as they gained more experience and exposure to the system. That is, mental model scores continued to improve for both groups of drivers from the first through the fourth session. These findings underline the importance of experience and familiarity with ADAS for safe operation. Importantly, drivers who experienced rare ACC edge cases in addition to routine events (i.e., the Enhanced Group) showed higher levels of understanding compared to those who experienced only routine events (Regular Group)—a trend that persisted across all four sessions. It is possible that the rare edge case events provided drivers with richer information about system limitations, which translated to improved knowledge.

It is also important to note that the group differences were observed as early as the end of the first session, suggesting that exposure to rare and routine events could fast-track mental model development in drivers who are newly exposed to the system. For example, it took the Regular Group until the fourth session to match the level of system understanding exhibited by the Enhanced Group after the first session.

ABOUT

Founded in 1947, the AAA Foundation for Traffic Safety in Washington, D.C., is a nonprofit, publicly supported charitable research and educational organization dedicated to saving lives by preventing traffic crashes and reducing injuries when crashes occur. Funding for this research was provided by voluntary contributions from AAA/CAA and their affiliated motor clubs, individual members, AAA-affiliated insurance companies, and other organizations or sources.

MORE INFORMATION

AAAFoundation.org

AAA FOUNDATION FOR
TRAFFIC SAFETY
607 14th Street, NW,
Suite 701
Washington, DC 20005
202-638-5944

FOUNDATION FOR TRAFFIC SAFETY

IMPLICATIONS

Results from this study have positive implications in terms of ADAS usage and exposure and the resulting impact on drivers' mental models. Since accurate mental models promote safe operation of in-vehicle technology, one practical implication that can be drawn from this study is that when introducing ADAS-equipped vehicles to new users, an effective strategy should consider targeted exposure to different situations either through direct experience or through training. Prior driver training studies have adopted similar error-feedback approaches to provide a controlled and safe exposure to risky situations, where drivers can safely make mistakes and learn from them. Such approaches could form an important pillar in terms of future training or consumer education research about ADAS and other advanced vehicle technologies.

The study provided exposure to different driving and edge-case situations using a driving simulator in a laboratory setting, which presented almost no safety-related risks. However, exposure to the same situations in the real world may not be practical or safe; future work should explore alternative methods or platforms to provide novice ADAS users with information about routine and rare edge-cases to support the development of their mental models.

METHODOLOGY

Sixteen drivers, aged between 21 to 54 years (mean = 29.6; SD = 4.2) were recruited for this longitudinal driving simulator study. The participants were pre-screened for the study through an online survey; only drivers that indicated that they have never used ACC or were not familiar with the technology were chosen to participate in the study. They were also required to hold a valid U.S. driver's license to be eligible for participation.

The study utilized a fixed-base driving simulator, consisting of a mid-sized sedan situated in front of five projection screens giving the driver a 330-degree field of view. The simulator also utilized a software package to simulate an Adaptive Cruise Control system. A variety of edge cases were developed, including a mixture of routine events (e.g., the driver encounters slow moving vehicles ahead) and rare events (e.g., the driver encounters a lead vehicle that is straddling two lanes). Drivers were randomly assigned to one of two groups – the Regular Group, which encountered only routine edge-case events as well as non-events, and the Enhanced Group, which encountered the same set of routine events, but also included rare events.

Each participant undertook four different simulator sessions, each separated by about a week. Each session comprised a simulator drive featuring five events. Following each session, surveys measured drivers' trust, workload, and system knowledge (i.e., mental model).

REFERENCE

Pradhan, A. K., Roberts, S. C., Pai, G., Zhang, F., & Horrey, W. J. (2023). *Change in Mental Models of ADAS in Relation to Quantity and Quality of Exposure* (Technical Report). Washington, D.C.: AAA Foundation for Traffic Safety.

MORE INFORMATION

AAAFoundation.org

AAA FOUNDATION FOR
TRAFFIC SAFETY
607 14th Street, NW,
Suite 701
Washington, DC 20005
202-638-5944

VIEW REPORT

FOUNDATION FOR TRAFFIC SAFETY