FOUNDATION FOR TRAFFIC SAFETY

A Multi-Method Approach to Understanding Drivers' Experiences and Behavior Under Partial Vehicle Automation

INTRODUCTION

Automated vehicles have the potential to improve safety and mobility. At lower levels of automation (Level 2), drivers are required to supervise the automation and be prepared to intervene as needed to maintain safety. The consequences of these technologies on driver behavior are not yet fully understood, especially as real-world testing has been less common in research studies.

The current study sought to evaluate how drivers respond and adapt to vehicle automation systems in real-world scenarios. Drivers with no prior experience with vehicle automation were exposed to different experimental protocols and measurements, including several weeks of driving exposure in real-world settings.

METHODOLOGY

Three methods—experimental, naturalistic, and survey—were implemented as part of a single longitudinal study. This innovative approach allowed for a more comprehensive investigation of how drivers interact with and adapt to vehicle automation systems in real-world scenarios. Participants (N = 30, 12 females, 18 males) between the age of 18 and 55 (M = 35.7, SD = 9.3) were trained on one of five research vehicles that supported Level 2 automation (i.e., Adaptive Cruise Control and Lane Centering Assist).

In a controlled experimental trial, participants drove under manual and automation modes on two sections of highway with varying driving demands. Behavioral (i.e., Detection Response Task) and physiological measures (i.e., electroencephalogram) of driver cognition were gathered. After the experimental session, participants took the vehicle home to use on their regular commute to work. Driver behaviors and systems usage were continuously monitored through video recordings over a 6- to 8-week period of naturalistic driving. Through the deployment of multiple control conditions, the naturalistic study was designed to systematically control environmental differences that could influence automation use, such as varying road conditions, weather, traffic density, and infrastructure.

TECHNICAL REPORT:

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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.

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Drivers were also surveyed periodically regarding their perceptions, beliefs, and trust in the technology. Following the naturalistic driving period, participants returned to the lab and the protocol used in the first experimental session was repeated in a second experimental session.

KEY FINDINGS

Experimental Study

- Results from the behavioral indices of workload (i.e., Detection Response Task) suggested that driving under Level 2 automation was associated with an increase in driver workload compared to conditions without automation. That is, drivers in the experimental study may pay more attention to the driving environment under partial automation compared to manual mode.

- The experience of driving a vehicle for a period of 6 to 8 weeks impacted driver workload differentially across road environment, suggesting that practice with vehicle automation decreases driver workload while using the system over time, at least when driving on roads with relatively low demand. That is, after a 6-week familiarization period, there was a significant decrease in attention paid to the driving task under partial automation—at least in the simpler driving environment.

- The physiological measures of workload were less sensitive to discriminating differences in workload and engagement between driving conditions and did not show the same patterns as the behavioral indices.

Naturalistic Study

- Drivers used Level 2 vehicle automation more than 70% of the time, an amount that stayed relatively consistent over the 6- to 8-week observation period. Drivers were less likely to use vehicle automation when driving demands were higher.

- Over the 6- to 8-week period of automation use, there was an increase in the frequency of system warnings as drivers become more experienced with the Level 2 vehicle automation, suggesting that drivers were becoming increasingly comfortable with the automation and exhibited a tendency toward a more relaxed automation monitoring strategy over time.

- As drivers grow more familiar with the system, they are more likely to engage in secondary tasks over time; however, the lack of interaction between secondary task engagement and condition suggests that these behaviors may not be a direct consequence of over-reliance on the automation system. Instead, they might reflect a general trend of drivers becoming more comfortable with multitasking in these specific research vehicles over time, regardless of automation capabilities.

Survey Study

- Experience with automated systems had a positive impact on drivers' perceptions and attitudes, including reduced stress and increased enjoyment.

- As their experience grew, drivers felt increasingly willing to relinquish control of the vehicle and comfortable driving with the automation without monitoring it closely—an outcome that aligns with the naturalistic study where more system warnings were observed as participants became more experienced with the Level 2 vehicle automation.

- Drivers were also more likely to report engaging in more activities unrelated to driving when the automated systems were operating as their experience with the systems grew—in line with outcomes from the naturalistic study.

- Unexpectedly, trust in automated systems did not appear to have influenced evaluations of the automation, automated driving experiences and attention, and usage and purchase intentions.

- While drivers may have reported to be less attentive when automated systems are operating, they were also less likely to report using the automation in roadway conditions in which the risks of driving were elevated.