DRIVER'S AROUSAL AND WORKLOAD UNDER PARTIAL VEHICLE AUTOMATION

INTRODUCTION

Advanced driver assistance systems (ADAS) can assume some of the driving tasks and responsibilities, which may increase traffic safety or enhance driver comfort. For example, vehicles equipped with Level 2 (L2) automation can maintain lateral (i.e., lane keeping) and longitudinal (i.e., speed and headway) control, thereby reducing the demand on drivers to perform these tasks.

Yet, a critical requirement with these systems is that drivers remain engaged with the driving task and monitor the traffic environment at all times. In the case of automated control system failure, the driver must be able to regain control of the vehicle safely. A key concern is that drivers using these systems may become inattentive or become drowsy while driving using these systems.

Researchers at the University of Utah carried out a study commissioned by the AAA Foundation for Traffic Safety to compare and contrast drivers' experiences when operating a vehicle under L2 automation with that of operating the same vehicle when automation was not engaged (i.e., under manual control). Drivers were largely inexperienced with L2 systems and were provided with training and instruction regarding their use. Physiological measures of workload and arousal were gathered for drivers in different age groups, different L2-equipped vehicles and different types of traffic environments.

KEY FINDINGS AND IMPLICATIONS

When driving under L2 automation, parietal alpha (EEG) and DRT hit rates were lower and DRT reaction time was longer, suggesting that participants paid more attention to the driving environment compared to when driving under manual conditions. This pattern of results was generally consistent across the different vehicle types and the age groups. Drivers also tended to pay more attention to the road when driving on the curvy Interstate compared to the straight Interstate.

Participants reported driving under partial automation to be more exciting but resulting in more nervousness compared to manual conditions. It was also revealed that:

- Nearly 68% said they would use the automated systems as much as possible while driving. However, more than 80% said they would not feel comfortable using it without monitoring the vehicle closely.
- Furthermore, 65% of the drivers indicated that they were not comfortable relinquishing control of the vehicle to the automated systems on curvy and hilly roads. Similarly, 54% reported that they were not comfortable relinquishing control of the vehicle to the automated systems in heavy traffic.

VIEW REPORT

ABOUT

Established in 1947 by AAA, the AAA Foundation for Traffic Safety is a nonprofit, publicly funded, 501(c)(3) charitable research and educational organization. The AAA Foundation's mission is to prevent traffic deaths and injuries by conducting research into their causes and by educating the public about strategies to prevent crashes and reduce injuries when they do occur. This research is used to develop educational materials for drivers, pedestrians, bicyclists and other road users. Visit www.AAAFoundation.org for more information.

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AAAFoundation.org

AAA FOUNDATION FOR
TRAFFIC SAFETY
607 14th Street, NW, Suite 201
Washington, DC 20005
202-638-5944

Under L2 automation, although the vehicle can control functions like acceleration and steering, the driver must remain engaged with the driving task and monitor the environment at all times. In light of these requirements, the current outcomes are promising, showing that drivers, early in their experience with the L2 systems, were able to maintain their attention to the road and vehicle while using the L2 systems. They also expressed appropriate attitudes concerning the use of the systems and their responsibilities as drivers.

It is important to note that drivers in the study were relatively new users of the technology, were provided ample training and practice with the systems, and drove under the supervision of a university investigator. Many owners of vehicles do not receive or seek complete information about the use and limitations of their L2 systems. Recent AAA Foundation work has shown that drivers, once beyond an initial novelty phase, can begin to show increased engagement in non-driving (distracting) tasks. More research is needed regarding driver use of these systems over time and what approaches, consumer education, or training may promote the continuation of safe interactions with technology, such as those observed here. AAA Foundation is currently engaged on these topics.

METHODOLOGY

Four vehicles from different manufacturers were tested (model years 2018-2019). Each vehicle was equipped with a L2 automated system that, when engaged, centered the vehicle within the lane (lane-keeping assist) and maintained following distance and speed (adaptive cruise control). Testing was conducted on two different roads, driving with and without L2 automation, and with two age groups, yielding an experimental design that included the four factors: Vehicle Type, Age Group, Automation Level and Road Type.

Participants included 71 active and licensed drivers who had normal or corrected-to-normal vision and a clean driving history. Drivers were divided into two age groups: 39 younger drivers between 21-42 (M= 28.8 yrs; 13 females) and 32 older drivers between 43-63 (M = 52.7 yrs; 12 females). A total of 24 drivers from each age group were tested in each vehicle in the study (48 total per vehicle), and the majority of drivers were tested on multiple vehicles on separate occasions. Prior to and during the experimental session, drivers were provided with detailed information regarding the L2 systems, including written and video presentations about their function.

Two routes were used for data collection. One (Interstate-80) was a 27-mile long curvy road with relatively low traffic volume. The other (Interstate-15) was a 21-mile relatively straight road with higher traffic volume. A study investigator was present in the passenger seat during the entire session for safety monitoring and data collection. After placement and calibration of the measurement equipment, participants drove a training route to familiarize themselves with the vehicle and the L2 system. Following this, participants travelled to the test road to begin the experimental trials. Drivers were not allowed to use their phones or engage in any behavior that could have been a distraction or otherwise moderate arousal.

A number of objective and subjective measures were gathered during and after each drive, in order to assess the workload and arousal of the driver. These included the vibrotactile variant of the Detection Response Task (DRT, International Organization for Standardization No. 17488), heart rate (electrocardiography, ECG), parietal alpha brain activity (electroencephalography, EEG), as well as subjective ratings of nervousness, inattention and excitement. In this study, the DRT and other measures were used to characterize the drivers' investment of attentional resources to the driving task, as opposed to distracting tasks (as done in other studies).

REFERENCE

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