UNDERSTANDING THE IMPACT OF TECHNOLOGY: DO ADVANCED DRIVER ASSISTANCE AND SEMI-AUTOMATED VEHICLE SYSTEMS LEAD TO IMPROPER DRIVING BEHAVIOR?

INTRODUCTION

The ultimate goal of advanced driver assistance systems (ADAS) is to increase traffic safety and driving comfort. Despite their potential safety benefits, there are concerns about unintended consequences associated with intermediate levels of automation. In these scenarios, speed control and/or steering are automated, but the driver is still required to monitor traffic and be ready to resume control. A key concern is that drivers may become inattentive due to engagement in non-driving-related tasks or become drowsy while driving using these systems.

In this study, the Virginia Tech Transportation Institute leveraged data from two previous naturalistic driving studies (NDS):

- The Virginia Connected Corridors (VCC) Level 2 Naturalistic Driving Study, in which researchers observed participants' driving for one year as they drove their personal vehicles
- The Level 2 Mixed Function Automation (MFA) NDS, during which participants were provided with a study vehicle to drive for one month

These data sets were used to investigate driving behavior while in vehicles that offer simultaneous control of speed (adaptive cruise control [ACC]) and steering (lane-keeping assistance [LKA]), both while using the automation and when they were driving manually.

KEY FINDINGS

The study examined driver behavior, various measures of driving performance, engagement in secondary (non-driving) tasks, driver drowsiness and involvement in safety-critical events. A subset of the most salient results are described below (see full report for complete results).

Secondary task engagement

The results from the VCC data set indicate that the simultaneous use of ACC and LKA systems was associated with a 50% increase in the odds of engaging in any form of secondary task and an 80% increase in the odds of engaging in visual and/or manual secondary tasks, compared with the same drivers who were not using the automated system. Drivers using both systems simultaneously also took more frequent and longer glances at non-driving-related tasks and spent less time with their eyes on driving-related tasks.

Drivers from the MFA group did not display the same tendency toward distracted driving behaviors when automation systems were active. Instead, they were more likely to engage in a secondary task and take their eyes off the road during manual driving, possibly indicating a lack of trust in the automated systems.

ABOUT

Established in 1947 by AAA, the AAA Foundation for Traffic Safety is a not-for-profit, 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.

MORE INFORMATION

AAAFoundation.org

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

Unsafe driving behaviors and safety-critical events

In the VCC data set, speeding-related performance errors were observed in 11% of sampled time periods in which ACC and LKA were used together, significantly fewer than when driving under similar conditions with the automation available but not in use (17.5%). However, drivers in the MFA data set showed the opposite trend, with speeding being more prevalent when both systems were active compared to when no systems were active (19% versus 16%, respectively).

There were 147 safety-critical events (SCE) in the VCC data set. Although there were nominally more SCE when ADAS were available but not active (N = 92) compared to when systems were active (N = 45), the differences were not significant once they were adjusted for exposure. There were 54 SCE in the MFA study (N = 24 when systems were active; N = 30 when systems were available but not active). When adjusted for exposure, SCE rates were found to be significantly higher when ADAS was active compared to when it was available/inactive, possibly indicating that participants in the MFA study were more actively exploring the system function and boundaries. SCE rates were not impacted significantly by the occurrence of secondary tasks in either data set.

Drowsy driving

The baseline prevalence of drowsy driving in the VCC data set was low (0.6% of trips indicating signs of observable driver drowsiness). In contrast, drowsy driving was present in a higher percentage of MFA time periods, most notably when both ACC+LKA systems were active (5.4%; versus 3.4% when no system was active), indicating a possible detrimental effect of automation use associated with driver arousal. When looking specifically at possible drowsiness-related SCEs, the number of valid events was too low to form any conclusions based on the available data.

IMPLICATIONS

The current analysis showed that drivers in the VCC study using personal cars were more likely to engage in secondary tasks while using combined ACC and LKA features compared to manual driving. This pattern did not emerge for the MFA drivers. These results, and the differences between the data sets used, indicate the possibility of different phases of driver interaction with the automated systems. Drivers in the MFA using issued cars may have been in a "novelty" phase in which a driver first acquires a vehicle equipped with advanced automation features. Over the course of the 4-week study, MFA drivers might have still been learning and testing the systems.

Once drivers move from the novelty phase to the post-novelty operational phase, behavioral adaptation may begin to occur and overreliance and over-trust in the automation features potentially develop, including a greater willingness to look away from the forward road (as shown in the VCC data set).

Because the MFA drivers were provided with leased vehicles, they received detailed training regarding the systems. This also could have led to differences with the VCC vehicle owners who did not receive any formal orientation to the systems and their function, although they likely received at least some information pre- or post-purchase.

MORE INFORMATION

AAAFoundation.org

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

The different patterns of results underscore the need to better understand the progression and raise awareness among drivers of the potential pitfalls they may experience throughout all phases of ADAS operation, from inexperience and initial system use to experienced use. More research is needed regarding driver understanding and use of systems over time and in the evaluation of what types of information, consumer education or training promote the safest interactions with ADAS at all points in their lifecycle.

METHODOLOGY

Data for this study were derived from two naturalistic driving study (NDS) data sets: 1) the Virginia Connected Corridors (VCC) Level 2 NDS, and 2) the Level 2 Mixed Function Automation (MFA) NDS. Vehicles in both data sets were equipped with different ADAS features, but all vehicles allowed drivers to activate longitudinal (ACC) and lateral automation systems (LKA) simultaneously. The vehicles were also equipped with a data acquisition system, using unobtrusive video cameras and vehicle sensors to collect driver and driving-related data continuously.

Drivers in both data sets were recruited from the Washington, D.C. metropolitan area. For the VCC, owners of vehicles equipped with ADAS features were specifically recruited. Data from 30 study participants were used for this study. Data were collected from November 2016 to June 2018, with approximately one year of data collected for each participant. Participants in the MFA study were provided a study-owned vehicle equipped with ADAS for a period of four weeks. A total of 120 participants completed the study. Data were collected from September 2016 to December 2017.

Video and other data were sampled to identify time periods of interest. Established kinematic algorithms were used to identify potential safety-critical events (SCEs). Baseline driving samples of 10 or 15 seconds were selected based on ADAS status (e.g., system active, system available but not active). For each time period, trained data reductionists used video and kinematic data to annotate the driver, vehicle and environmental factors present. Eye-glance locations were classified as on-road/off-road and driving-related/non-driving-related for the purposes of analysis.

Driver drowsiness was also assessed on both NDS data sets using PERCLOS, which uses a one-minute-long video of the driver's face to determine the percentage of time a driver's eyes are closed. Data were analyzed using either a mixed-effect logistic regression model, a Poisson mixed-regression model or generalized linear mixed models, depending on the measure.

REFERENCE

Dunn, N., Dingus, T., & Soccolich, S. (2019). *Understanding the Impact of Technology: Do Advanced Driver Assistance and Semi-Automated Vehicle Systems Lead to Improper Driving Behavior?* (Technical Report). Washington, D.C.: AAA Foundation for Traffic Safety.

MORE INFORMATION

AAAFoundation.org

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

VIEW REPORT