RESEARCH BRIEF

# Older Drivers and Advanced Driver Assistance Systems

December 2020

Automotive technologies and advanced driver assistance systems (ADAS) have the potential to assist older drivers in becoming more confident behind the wheel and extending their safe mobility. However, these technologies vary widely in complexity and scope, and questions remain about drivers' perceptions and learning methods, as well as the mental workload required to operate these systems. This research brief describes the efforts to address these questions using data from the AAA Longitudinal Research on Aging Drivers (AAA LongROAD).

## METHODS

It has been hypothesized that ADAS, such as forward collision warning, automatic emergency braking, blind spot detection, and lane departure warning may reduce the risk of crashes and increase driving comfort among the older driver population. However, these technologies have different degrees of complexity and capability, and questions about how older drivers would use these technologies have arisen.

LongROAD studies have examined in-vehicle technologies owned and used by older drivers and have begun to shed some light on this topic (Eby et al., 2018; Zanier et al., 2019). The LongROAD study recruited 2,990 participants, aged 65 to 79 at baseline, from five health-care locations. Data collected from the LongROAD study includes information obtained from vehicle inspections, participants' self-reported surveys on the presence and perceptions of in-vehicle technology, and objective data on cognitive functioning obtained from clinical assessments (Li et al., 2017). Questions addressed in this research brief include the following:

- How aware are older drivers of these systems in their current vehicles?
- What is the user acceptance of these technologies among older adults?
- How do older drivers learn about system functions and limitations?
- How do demographics impact use and understanding of these systems?
- How does cognitive function impact acceptance, use and understanding of these systems?

# RESULTS

## How aware are older drivers of these systems in their current vehicles?

To address the question, self-reported responses from participants completing the LongROAD Vehicle Technology Questionnaire (VTQ) were compared with vehicle inspection reports conducted by survey staff. Results showed high agreement between which technologies participants reported were present in their vehicles and which were found during vehicle inspection, with the exception of voice control technologies (Zanier et al., 2019).

For voice control technologies, a discordance of 25-percentage points was found between drivers reporting to have the technology and its actual presence in their vehicles. Only 19.6% of participants reported that they have voice control technology, while vehicle inspections found 44.6% have this system on their vehicle. This discordance, however, may be due to the confusion between voice control technologies (which allow drivers to operate vehicle systems with their voices) and integrated Bluetooth technologies (which allow drivers to connect cellular phones with their vehicle). Figure 1 shows a comparison between the self-reported technology and the technology identified through the vehicle inspection.

## What is the user acceptance of these technologies among older adults?

Using responses from the VTQ, Eby et al. explored user acceptance, prevalence, and attitudes towards in-vehicle technologies (2018). Results from the VTQ showed overall, more than half (57.2%) of the LongROAD participants had at least one advanced in-vehicle technology in their primary vehicle, and on average, they had two such technologies. Participants commonly reported having integrated Bluetooth (47.4%), backup/parking assist (40.1 %), and navigation assistance systems (27.7%). Overall, a majority (70%) of participants who had one or more of these systems reported that the technology makes them a safer driver. Figure 2 shows the percentage of participants reporting on how each technology makes them a safer

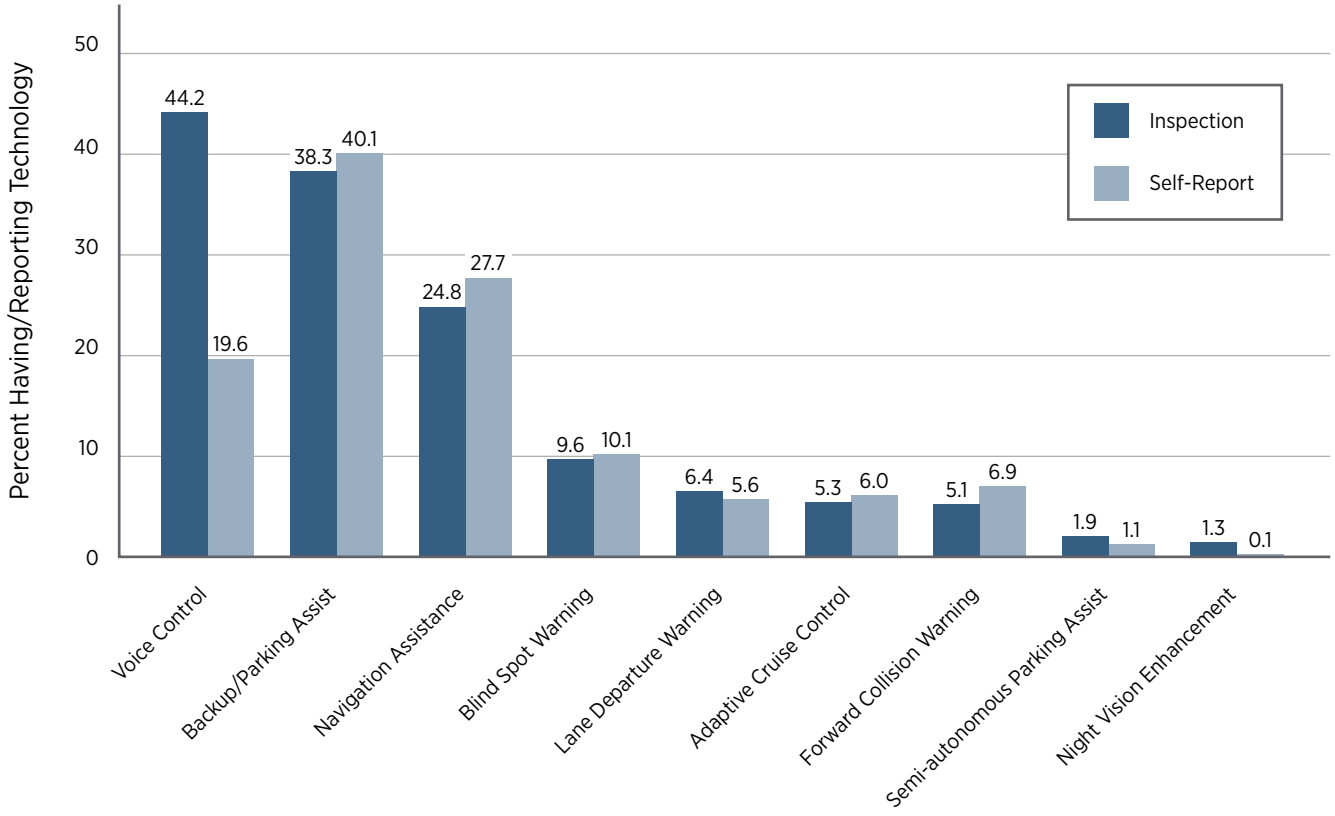


**Figure 1. Advanced in-vehicle technology presence: visual inspection and self-report.**

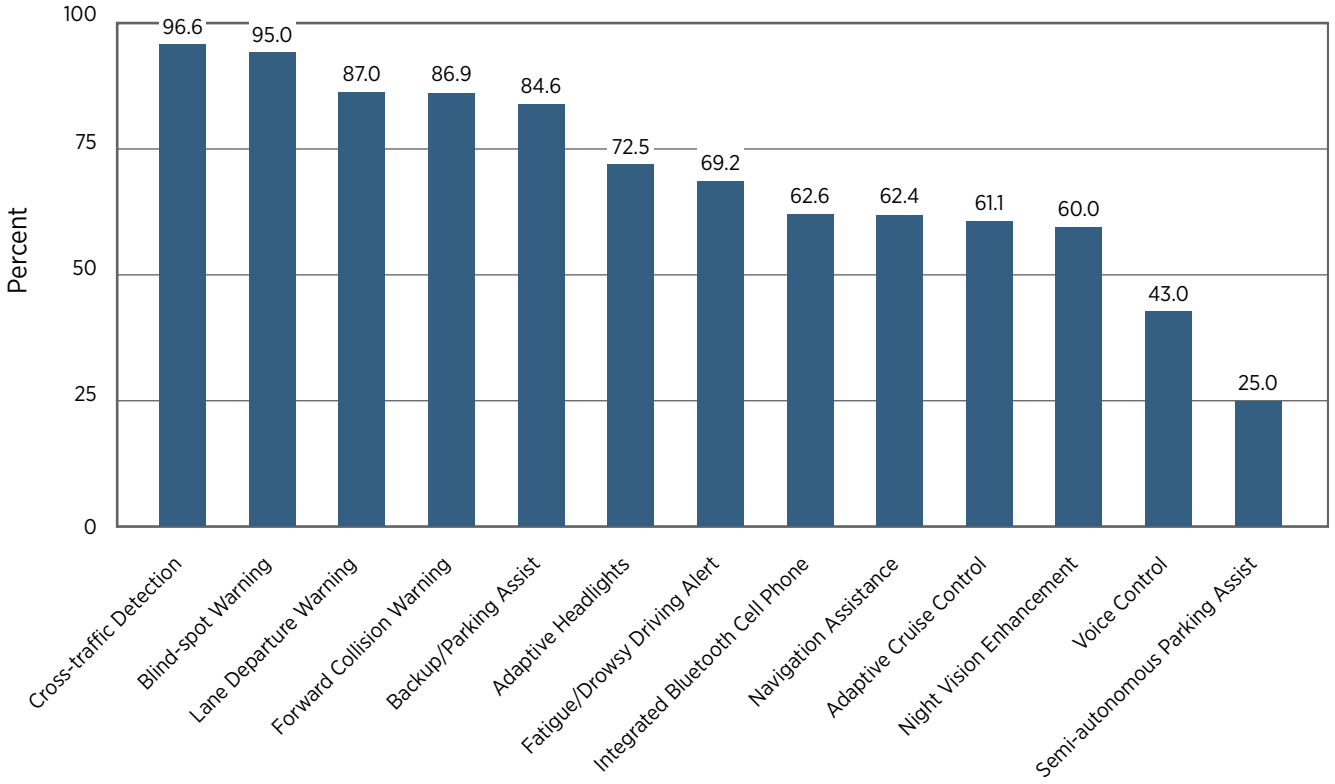


**Figure 2. Percentage of people reporting that the technology makes them a safer driver, by technology.**

driver. For example, cross-traffic detection systems were reported to provide the greatest safety benefit by 96.6% of participants who had the system. Shortly behind is blind spot warning at 95% and lane departure warning at 87%.

## How do older drivers learn about system functions and limitations?

How older drivers learn to use these advanced in-vehicle technologies was also investigated (Eby et al., 2018). Participants learn differently depending on the technology. Figure 3 shows reported percentages on the learning methods. Most commonly, participants reported learning how to use advanced in-vehicle technology by "figuring it out themselves" (48.9%), followed by through the dealer (19.8%). Another 13.2% noted they never learned how to use the technology, while 11.8% stated that they learned how to use the technology through an owner's manual.

## How do demographics impact use and understanding of these systems?

Gender and income had different impacts on how older drivers learned, accepted and used these systems. For six of the technologies (adaptive cruise control, forward collision warning, integrated Bluetooth, navigation assistance, semi-autonomous parking assist and voice control), women were more likely to report never having learned to use the technology and were less likely to report learning from the owner's manual or figuring it out themselves than men. Additionally, men tended to have a greater number of technologies in their primary vehicle (Eby et al., 2018).

Income also had an effect on the ownership of technology. As the incomes of older drivers increased, so did the number of advanced in-vehicle technologies. This finding may be expected as advanced in-vehicle technologies are typically more expensive options (Zanier et al., 2019).

## Cognitive functioning, cognitive workload, and advanced vehicle technologies

The LongROAD study used various standardized cognitive assessments to measure LongROAD participants' cognitive functioning in different domains, including: executive functioning, memory, attention, visuospatial skills, and psychomotor speeds. Baseline measures have

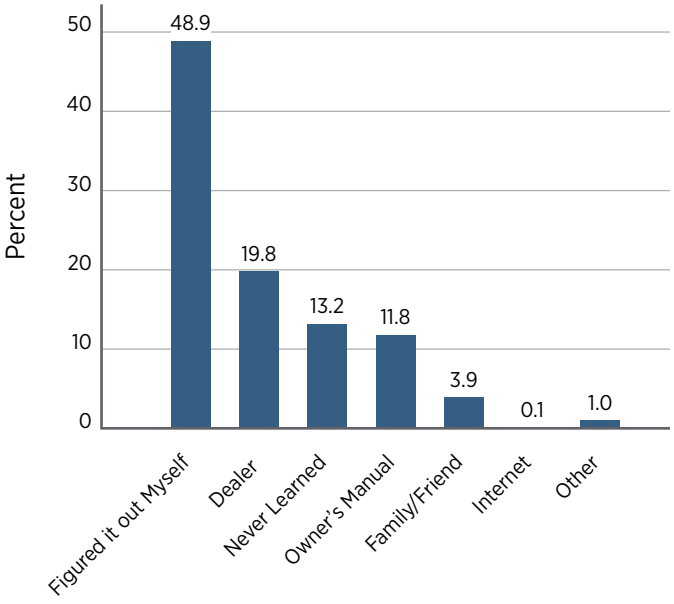


**Figure 3. Reported percentages of learning methods in how to use technologies, averaged across technologies.**

found LongROAD participants to be cognitively healthy. Recruiting through the healthcare systems may have introduced functioning biases as health care utilizers are typically healthier than those in the general population (Schneeweiss and Avorn, 2005). Ongoing analyses of the LongROAD data indicate that the LongROAD cohort is more affluent, more educated, and typically healthier than the general population.

It may be more meaningful to explain older drivers' traffic safety interaction with ADAS through the concept of cognitive workload, rather than through cognitive functioning. Cognitive workload has been defined differently by various researchers. However, in general it involves the mental effort needed to perform a task and the capacity of an individual for mental work (Proctor and Van Zandt, 2018; Hart and Staveland, 1988). It is the amount of attention allocated to execute a task and the management of an individual's limited mental resources to perform it. Cognitive functioning, on the other hand, refers to different mental abilities. These include memory, executive functioning, reasoning, problem solving, attention, and other aspects of mental processes and general intelligence (Fisher et al., 2019). In short, while cognitive functioning refers to an individual's mental capacity to execute a task (i.e. attention, memory, executive functions, etc.), cognitive workload on the other hand is the measurable mental effort required by the individual to execute it.

ADAS can potentially impact a driver's cognitive workload. The shift in responsibility of the driving task from the driver to the vehicle system may change the allocation of attentional resources to other activities. For example, a driver who has lane keeping assist and adaptive cruise control activated may allocate cognitive resources freed up by the technology to other tasks, such as scanning the road ahead or monitoring the road for hazards, or both (Llaneras, 2013).

However, interacting with these technologies may also be a cause of cognitive distraction that can lead to inattentive driving. A study commissioned by the AAA Foundation for Traffic Safety found that advanced in-vehicle infotainment systems affect older drivers' level of cognitive distraction when interacting with these systems. Compared with younger drivers, the cognitive workload that older drivers experienced with these systems was significantly greater (Strayer, 2016). It is possible that other types of technologies could produce similar effects.

The overall effect on older drivers' performance in using ADAS systems can be best explained through understanding older drivers' limited attentional resources and through cognitive workload. The LongROAD study was not designed to answer questions regarding the effect of vehicle technologies on older driver cognitive workload. With regards to in-vehicle technology and cognition, the LongROAD study aims to 1) explore the prevalence and user perceptions of these technologies among an older population and 2) investigate approaches that older drivers use to cope with cognitive or other functioning declines. Despite the LongROAD study not being able to directly address questions about the effects of these systems on older drivers' cognitive workload, it does provide a complementary source of data on how older drivers perceive these technologies.

## DISCUSSION

Findings from the LongROAD study have shown that older drivers are, more often than not, aware of the presence of advanced technologies in their vehicles. In addition, they typically view these technologies positively, providing most of them a feeling of increased safety. Most LongROAD participants taught themselves how to use the technologies they had in their vehicles. However, a fair number of them, particularly women, reported never having learned to work the technology they had. This is a significant limitation on adoption of these technologies. However, in order for these technologies to provide their full safety benefits, drivers need to be educated about how to properly use them.

The AAA Foundation's commitment to understanding driver's perception of ADAS and emerging technologies goes beyond that of older drivers. For example, the Traffic Safety Culture Index (TSCI), a nationally representative survey of U.S. drivers of all ages, was expanded in 2018 to include questions about people's perceptions and attitudes towards advanced vehicle technologies and automated vehicle technologies (Kim, 2019). Similar to LongROAD findings, data from the TSCI survey suggested that people generally tend to perceive higher levels of vehicle automation as an effective way to prevent crashes (Kim, 2019). The acceptance of these technologies paves the way for their adoption and use by drivers. It remains important, however, that drivers fully understand the limitations of these technologies and know when and how to properly use them.

### Lessons Learned and Framework for Future Research

In the process of understanding older drivers' perceptions of ADAS, there were a number of lessons learned that offer guidance for future research in this field.

1. **Addressing ambiguity between system naming conventions.** One explanation speculated for the 25-percentage point difference between participants saying they have voice control technology in their vehicles and actually having it, is their confusion about Bluetooth technology. The naming conventions for many of today's technologies can be ambiguous. A number of organizations, including AAA, have been advocating for common naming conventions on ADAS technologies, based on functionality (AAA, 2019).

2. **Using the right type of data to answer questions on cognitive distraction and ADAS.** The LongROAD study provides a rich source of data on aging drivers. This includes different standardized measures of cognitive functioning. Even though the LongROAD study was not designed to collect information specific to cognitive workload, future studies interested in addressing questions specific to cognitive workload and cognitive distraction with ADAS could leverage the LongROAD study as a complementary source of data.

3. **Moving beyond associations to uncover their underlying mechanisms.** The relationships between certain constructs, for instance cognitive function and ADAS use, are often complex and involve multiple underlying factors. To understand these relationships, more robust analytical methods should be used rather than relying on simple associations. Developing and testing models that look at how various factors influence or contribute to ADAS use would provide more robust results.

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## ABOUT THE AAA FOUNDATION FOR TRAFFIC SAFETY

The AAA Foundation for Traffic Safety is a 501(c)(3) nonprofit, publicly supported charitable research and education organization. It was founded in 1947 by the American Automobile Association to conduct research to address growing highway safety issues. The organization's mission is to identify traffic safety problems, foster research that seeks solutions, and disseminate information and educational materials. AAA Foundation funding comes from voluntary, tax-deductible contributions from motor clubs associated with the American Automobile Association and the Canadian Automobile Association, individual AAA club members, insurance companies and other individuals or groups.

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