RESEARCH BRIEF

Use, Learning and Perceptions of In-Vehicle Technologies, and Vehicle Adaptations among Older Drivers: A LongROAD Study

This research examined older drivers' use of and attitudes toward 15 in-vehicle technologies and 12 aftermarket vehicle adaptions designed to make driving safer. Baseline questionnaire data were used from the AAA Foundation for Traffic Safety's Longitudinal Research on Aging Drivers (LongROAD) study focusing on older drivers. Overall, 57% of participants had at least one advanced technology in their primary vehicle. Less than 9% of respondents had at least one aftermarket vehicle adaptation present. Overall, 43% of respondents said they always used these technologies, although the percentages varied depending on the system used. In general, males and people with higher incomes and education levels tended to have more technologies in their vehicles. Eighty three percent of respondents learned to use these technologies on their own. A large majority did not work with a professional to make or learn about the aftermarket vehicle adaptation. Across all technologies, nearly 70% of respondents who had these technologies believed that the systems made them a safer driver.

METHODS

Data for the study were collected from the vehicle technology questionnaire, which was administered to LongROAD participants at baseline. The LongROAD study is a multisite, prospective cohort study designed to collect data on the medical, behavioral, environmental and vehicle technological factors influencing older adults in driving safely. The following in-vehicle technologies (i.e., technologies that were installed by the vehicle manufacturer either as standard or optional equipment) included:

Technology	Text Used in Questionnaire to Describe the Technology
Adaptive cruise control	Conventional cruise control systems allow you to maintain a constant vehicle speed without keeping your foot on the accelerator pedal. Some vehicles also have adaptive cruise control; adaptive cruise control adjusts your vehicle speed automatically to maintain a constant gap or headway between your vehicle and the vehicle ahead.
Adaptive headlights	Adaptive (or "active") headlights can automatically change the direction of the light beam when you steer left or right on curved roads. On your vehicle, these headlights may be called "steerable headlights" or something similar.
Backup/parking assist	A backup/parking assist system helps the driver back up/park by either providing audible proximity alerts that sound to warn the driver when the front or rear of the vehicle is near an object, or by providing a rear-view camera with a grid, sounds, lights or symbols to assist the driver in avoiding obstacles while reversing.
Blind spot warning	A blind spot warning system uses sensors to detect objects, such as other vehicles, that are to the left and right of the lane in which you are driving. The system can provide a warning when you are changing lanes or parking that there is a vehicle or other object next to your vehicle that you may not be able to see.
Cross traffic detection	A cross traffic detection system helps the driver back up by detecting traffic coming from the left or right and providing a warning and/or automatically stopping the vehicle if traffic is detected.
Emergency response	An emergency response system automatically calls emergency personnel when your vehicle is involved in a crash. Other systems will try to contact you first before calling emergency personnel.
Fatigue/drowsy driver alert	A fatigue/drowsy driver alert system uses various technologies to determine if you are getting fatigued or drowsy while driving and provides an alert that you may be getting too tired to drive safely.
Forward collision warning	A forward collision warning system uses sensors to detect objects, such as other vehicles, that are in front of your vehicle when you are driving. The system can provide a warning when you are about to collide with an object and, in some systems, apply the brake for you so that you do not hit the object.
In-vehicle concierge	An in-vehicle concierge system allows you to press a dashboard control button and connect with a person who can answer your questions, provide information and provide other services while you are in your vehicle.

Integrated Bluetooth cell phone	An integrated Bluetooth cell phone system automatically connects with your cell phone and allows you to make and receive phone calls using the vehicle's speakers and dashboard interface without having to handle your cell phone.
Lane departure warning	A lane departure warning system uses sensors to detect your vehicle's position in the lane and provides a warning to you if you drift out of your lane.
Navigation assistance	A navigation system shows maps on a screen and/or provides step-by-step driving directions to help the driver get to a chosen destination.
Night vision enhancement	A night vision enhancement system uses infrared sensors to "see" objects such as people and animals at night and displays this information to the driver on a video screen in the vehicle.
Semi-autonomous parking assist	A semi-autonomous assistive parking system can steer the vehicle into a parking space by itself with little input from the driver, and in some cases this system can also detect a parking space automatically before self-parking.
Voice control	A voice control system allows you to control vehicle features such as the radio or navigation system, using commands that you speak out loud.

The following vehicle adaptations (i.e., aftermarket modifications or additions made to the vehicle by the owner) were also included in the questionnaire:

Adaptation	Description of the Vehicle Adaptation
Convex/multifaceted mirrors	A convex mirror increases the field of vision of the driver, potentially eliminating blind spots.
Custom armrests	Custom armrests provide comfort and support for the driver while driving the vehicle.
Driver seat cushions	The driver seat cushion adaptation provides comfort and support for the driver's posture as well as allowing for a better view of the road.
Gas pedal block	The gas pedal block raises the height of the brake and accelerator for ease of use
Hand controls	The hand control allows the driver to operate both the brakes and accelerator in one lever.
Left foot throttle	The left foot throttle allows the driver to comfortably use their left leg to operate the accelerator for those who have impairments on the right leg.
Modified secondary controls (wiper, horn, turn signal, cruise control, headlights)	A modified secondary control adjustment allows easier access to wiper, horn, turn signal, cruise control and headlights, which is especially helpful for individuals using hand controls.
Pedal extension	The pedal extensions allow for an easy reach of the throttle and the brakes for the driver.
Push button ignition	After market push button ignition allows for an easier start of the vehicle. This is especially helpful for older drivers who suffer from arthritis.
Seat belt extension	Seat belt extensions assist drivers, especially older drivers with limited mobility to fasten their seatbelt.
Steering wheel modification	Steering wheel modifications address a variety of issues facing older drivers. Some modifications reduce the strength needed to operate power steering, other modification allow for one handed steering.
Upper body support	Upper body support provides assistance in keeping posture and comfort for the elderly drivers who may have back and shoulder problems.

Questionnaires examined the prevalence of in-vehicle technologies and vehicle adaptions, how older drivers learned to use them, their perceived safety benefits and demographic characteristics (e.g., sex, age, education level and household income).

RESULTS

In-Vehicle Technologies

2,990 respondents completed the questionnaire at enrollment in the LongROAD study between July 2015 and March 2017. Overall, 57% of participants had at least one advanced technology in their primary vehicle. On average, participants had two technologies in their vehicle, but the number of systems in participants' vehicles ranged from zero to 14. Males tended to have higher numbers of technologies in their vehicles, as did respondents with higher incomes and education levels. Age group was not significantly correlated with the number of technologies. Figure 1 shows the prevalence of each technology among LongROAD participants.

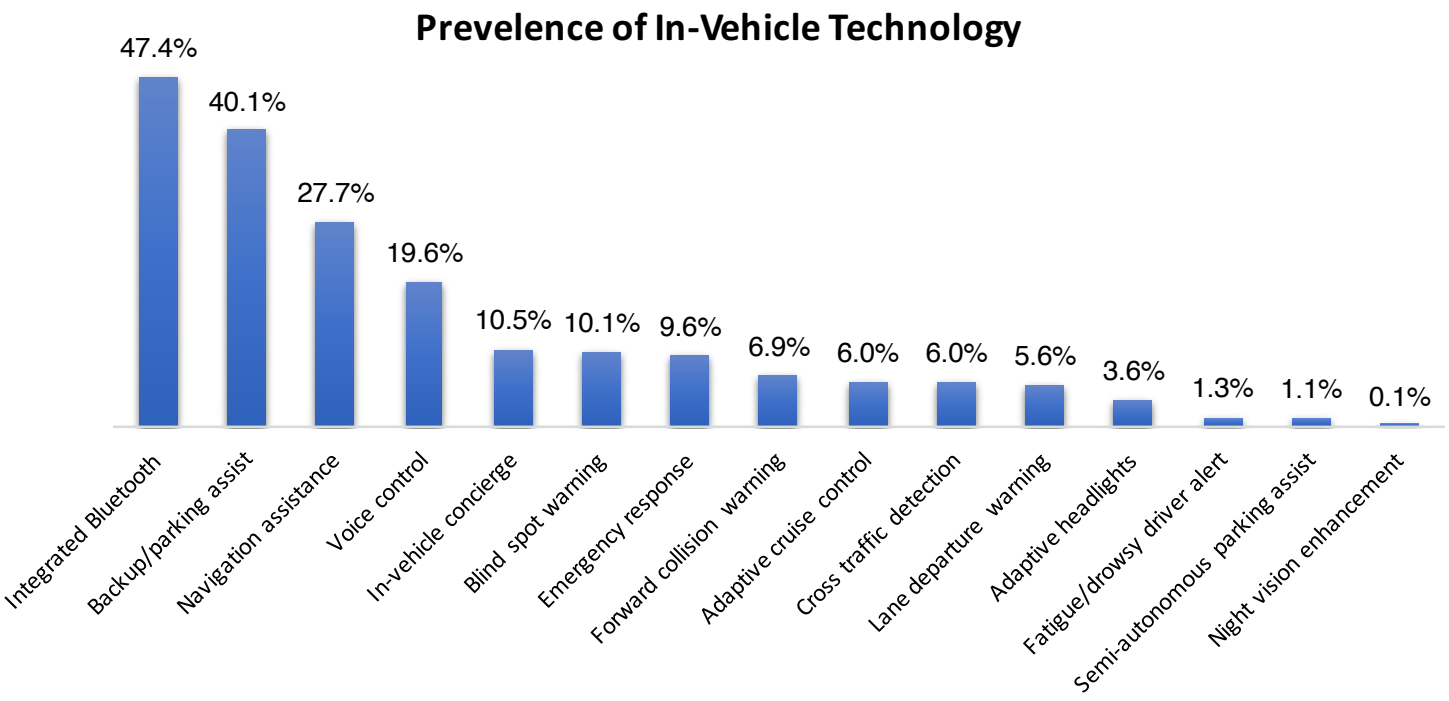

Figure 1. Advanced in-vehicle technology prevalence among LongROAD participants.

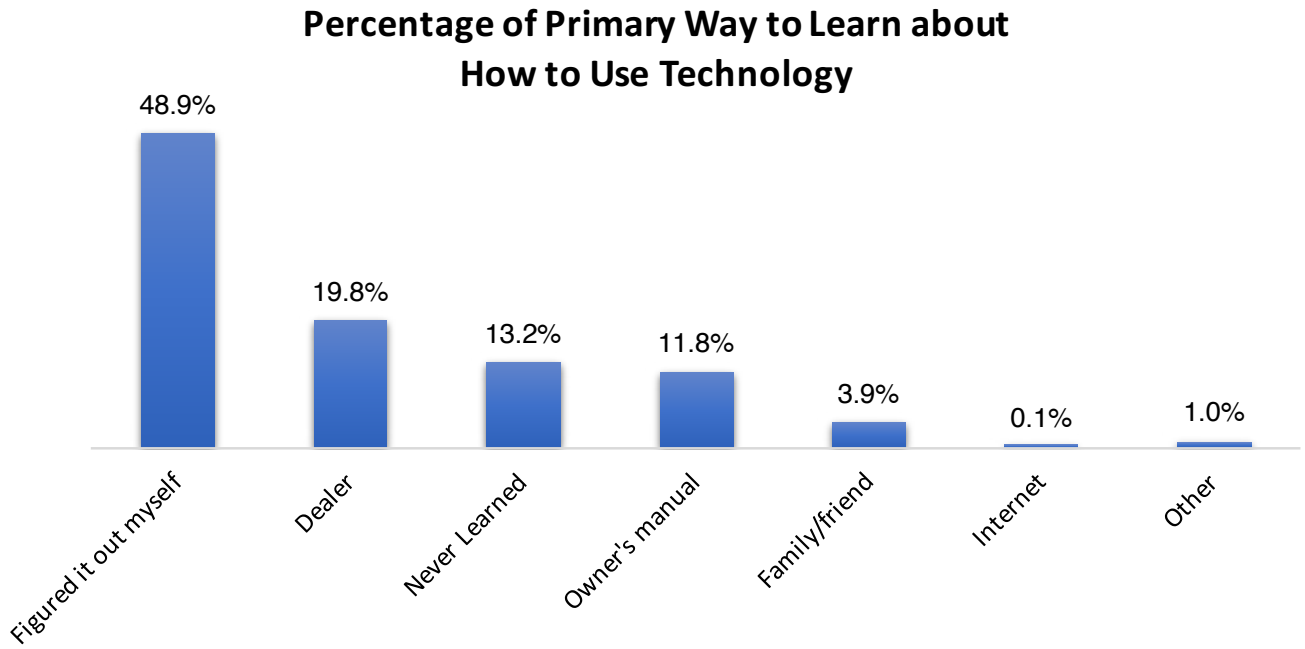

Figure 2. Reported percentages of methods for learning to use technologies averaged across technologies.

As seen in Figure 2, almost half (48.9%) of the respondents said they learned to use these technologies on their own, while 19.8% said they learned from the automotive dealer. About 13% said they never learned to use the technologies. Answers varied by system. The question was asked for 12 of the 15 technologies, but not for adaptive headlights, emergency response and in-vehicle concierge.

Age did not appear to have an effect on how people learned the technologies, but for six of the technologies, gender was associated with the method of learning. These technologies were adaptive cruise control, forward collision warning, integrated Bluetooth cellphone, navigation assistance, semi-autonomous parking assist and voice control. Women were more likely than men to report having never learned these technologies or having learned them from the dealer; they were less likely than men to report having used the owner's manual or having figured it out themselves. Learning varied by income level for three of the technologies—cross-traffic detection, blind spot warning and lane departure warning.

For cross-traffic detection:

- The lowest-income group, with incomes of less than $20,000, was more likely to report having used an owner's manual than others.
- The lowest-income group was also less likely to report having figured out the technology themselves compared with other groups.

For blind spot and lane departure warnings:

- Both the lowest and highest income groups were more likely than others to report having figured out the technology themselves.
- The highest income group, with incomes of $100,000 or more, was less likely than others to report having learned from a dealer.

Learning about three technologies—navigation assistance, adaptive cruise control and voice control—differed by education level.

For navigation assistance systems:

- Respondents with no more than a high school education were more likely to report having never learned how to use these systems compared with other more highly educated respondents.
- This lowest-educated group was also less likely to report having used the owner's manual.
- The most educated group, with advanced degrees, such as a master's degree or doctorate degree, was less likely than others to report having never learned the technology and more likely to report having learned from a dealer.

For adaptive cruise control:

- Respondents with the least education were more likely to report having learned through the dealer and the internet compared with the other groups.
- The most educated group was less likely to have reported having never learned the technology than the other groups, and were more likely to report having figured it out themselves.

For voice control:

- The groups with no more than a high school education and the group with advanced degrees such as a master's or doctorate degrees were likely to have never learned or to have figured the technology out themselves as compared with the two middle groups, who had some education after high school or college degrees, but not advanced degrees.

Respondents with certain technologies in their vehicles were asked how often they used them.

As seen in Figure 3, more than half of respondents—50.8%—said they either always or frequently used these technologies. Almost a quarter—24.9% —said they never did.

Responses varied by type of technology. Blind spot warning, fatigue/drowsy driver alerts, forward collision warnings and lane departure warnings were used frequently, with 79% of respondents saying they often or always used them. On the other end of the scale, in-vehicle concierge, semi-automated parking assist and voice control were used much less frequently, with more than 60% of respondents reporting they never or rarely used them.

The remaining technologies had a range of frequencies of reported use. Use of adaptive cruise control, integrated Bluetooth cell phone and navigation assistance varied significantly by gender, with women reporting less

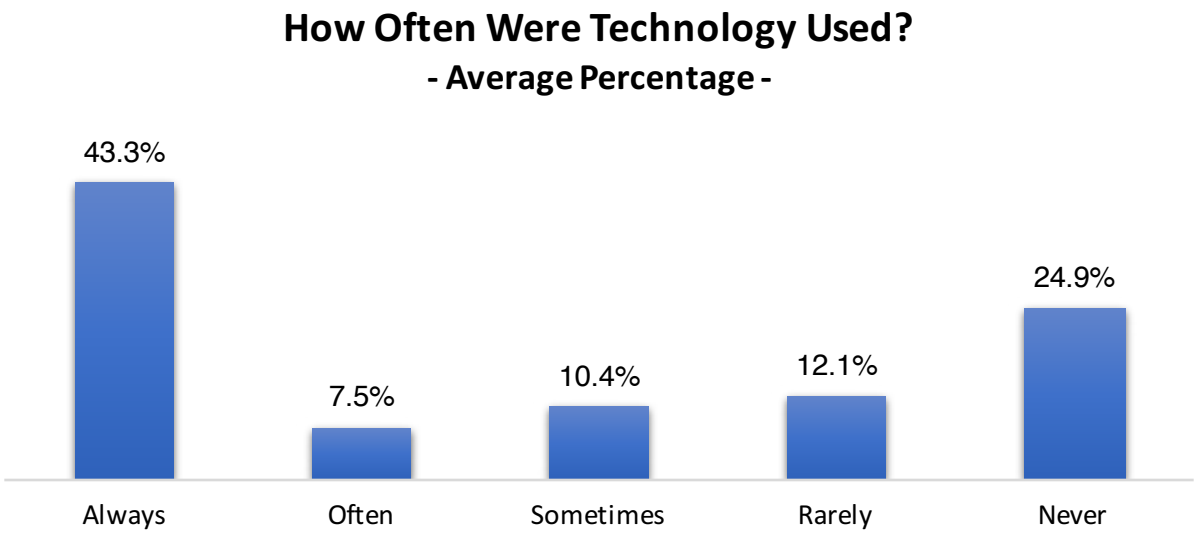

Figure 3. Average percentage across technologies on how frequently technologies were used.

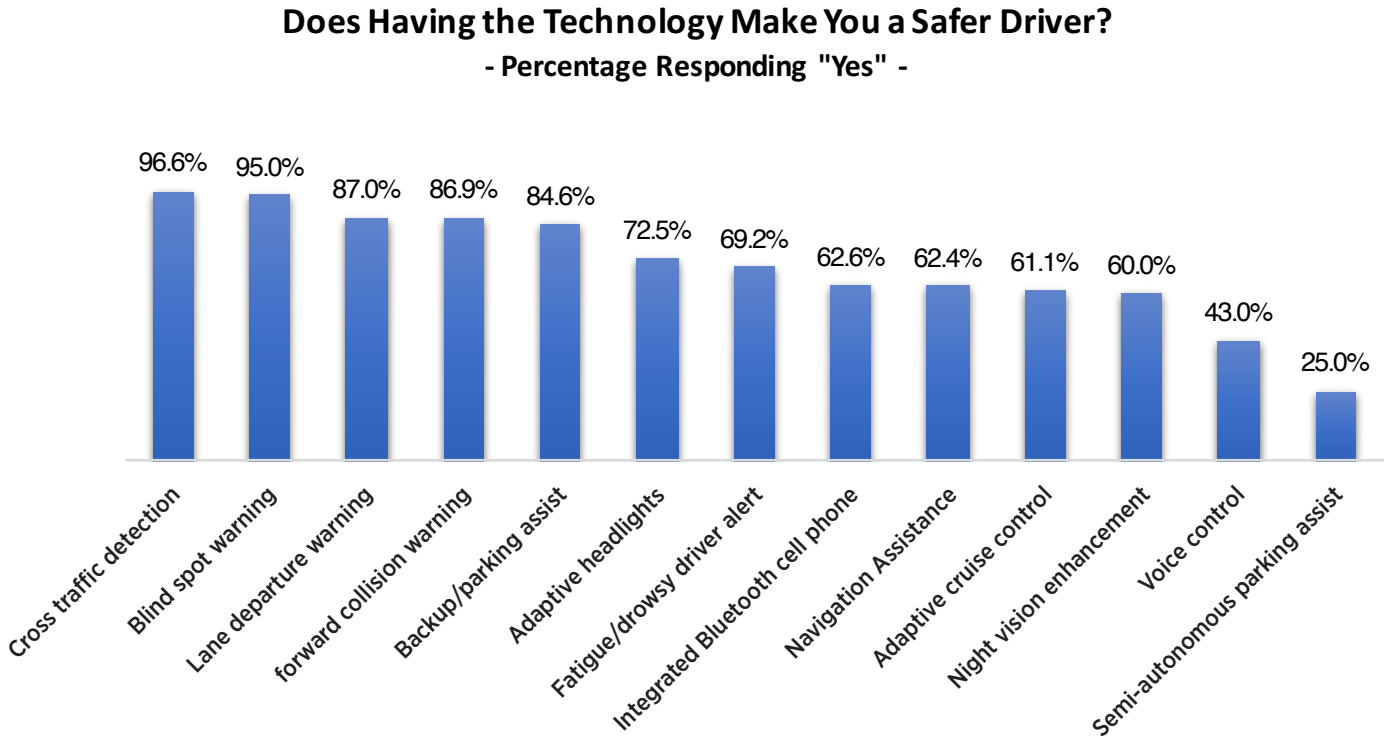

Figure 4. Percentages of people by technology reporting that the technology makes them a safer driver.

frequent use than men. Use of integrated Bluetooth cell phone varied significantly by age group, with frequency of use decreasing with increasing age. Use of integrated Bluetooth cell phone and lane departure warning varied significantly by income level, with use generally increasing as income did.

As seen in Figure 4, the percentage of people indicating that the technologies in their vehicle made them safer drivers varied widely by the type of system. More than 96% of respondents said they think cross traffic detection makes them a safer driver, while only 25% reported thinking semi-automated parking assist did so. Bluetooth cell phone safety perceptions varied between groups, with fewer females reporting that the technology made them a safer driver compared with males. In addition, safety perceptions decreased for Bluetooth cell phone use as age increased. Reported feelings of safety associated with voice control varied by income; middle-income drivers were less likely to think that technology made them a safer driver when compared with both lower- and higher-income drivers. With adaptive cruise control, blind spot warning and navigation assistance, more highly educated respondents were more likely to report the technology contributing to safety.

Aftermarket Vehicle Adaptations

Overall, 8.96% (n=268) had at least one vehicle adaptation present, with the number of adaptations per vehicle ranging from zero to four. In order of frequency, the percentage of aftermarket vehicle adaptations among those who reported at least one adaptation were: driver seat cushions (44.8%); convex and/or multifaceted mirrors (38.8%); safety belt extensions (6.0%); upper body support (4.8%); aftermarket push button ignition (3.0%); steering wheel modification (2.6%,); custom armrests (1.1%,); pedal extensions (1.1%); hand controls (0.4%); left foot throttle (0.4%); gas pedal block (0%); and modified controls for wiper, horn, turn signal, cruise control or headlights (0%). There were no statistically significant differences in these percentages by any of the demographic variables. Excluding seat cushions, which do not require technical installation or learning, a large majority of respondents who had vehicle modifications reported they did not work with a professional to determine the proper adaptation or to make the adaptation. When asked how they primarily learned to use the modification, 83% reported that they taught themselves.

DISCUSSION

Analysis reported in this work found that advanced in-vehicle technologies were present in nearly 60% of vehicles driven by LongROAD study participants. Given that prevalence was greater among those with higher income levels, we expect that the prevalence of in-vehicle technologies among older drivers will increase in the future as more of these technologies become standard on new vehicles.

The study further examined how older drivers learned to use advanced in-vehicle technologies. Across these technologies, nearly one-half of older drivers reported that they figured out by themselves how to use the systems, with another 20% reporting the dealer showed them, 13% reporting that they never learned to use the systems and only 0.1% saying they used the internet. As stated by several researchers (Coughlin, 2009; Eby & Molnar, 2014; Reimer, 2014), there is a clear need to develop better approaches for teaching older adult drivers (and all drivers) about the capabilities and use of advanced, in-vehicle technologies. One particular approach is to make better use of the internet, not only by providing greater information to drivers but also by better advertising the sources that are currently available, such as Smart Features for Older Drivers (AAA, 2017) and My Car Does What? (National Safety Council, 2017). The promotion of these and other resources for older adults will also help reduce the age disparity in access to and utilization of the internet for improved health and well-being. Results from this study also suggest that special efforts should be targeted to women, who were more likely to report never having learned how to use these technologies.

About 70% of respondents reported that using the technology made them a safer driver and 19% said the technologies did not make them a safer driver. The two technologies with the lowest safety perceptions were semi-automated parking assist and voice control. It can be argued that although semi-automated parking assist can help prevent crashes during parallel parking maneuvers, this system is more likely to be considered one that makes driving (parking) easier rather than safer. On the other hand, voice control systems can have significant safety benefits as compared with manual controls, so the lack of perceived safety with this technology is of concern. It is likely that one factor underlying the safety perception outcome for this technology is related to difficulties in learning to use the system, but other factors, such as

perceptual (e.g., hearing difficulties) or cognitive declines (e.g., declining short-term memory) may also play a role.

This study also found that fewer than 9% of participants used in-vehicle adaptations. Further, respondents did not work with professionals to determine the appropriateness of adaptations or to install/make them, but rather learned on their own how to use them. These results show that, at least among the LongROAD participants, older drivers are not following the NHTSA (2007) recommendation to work with occupational therapists who are trained in driver rehabilitation and with other appropriate practitioners to make appropriate vehicle adaptations that can help overcome the specific declines being experienced by drivers. By not working with professionals to make in-vehicle adaptations, older drivers run the risk of making inappropriate and/or unneeded adaptations and may not get proper training on how and when to use them.

Collectively, these results show that there is a need to continue to develop materials and programs that further promote awareness of the types of vehicle modifications and in-vehicle technologies that are available, as well as utilize professionals for the installation of and training about vehicle adaptations. There is also a need to increase awareness among traffic safety professionals about how vehicle adaptations and technologies can help maintain safe driving among older adults.

REFERENCES

AAA. (2017). Smart Features for Older Drivers. seniordriving.aaa.com. Accessed September 2017.

AARP, AAA, & AOTA (2017). CarFit: Helping Mature Drivers Find Their Safest Fit. www.car-fit.org. Accessed October, 2017.

Coughlin, J.F. (2009). Longevity, lifestyle, and anticipating the new demands of aging on the transportation system. Public Works Management & Policy, 13(4), 301-311.

Eby, D.W. & Molnar, L.J. (2014). Has the time come for an older driver vehicle? Journal of Ergonomics. S3: 002.

Eby, D.W., Molnar, L.J., Zakrajsek, J., Ryan, L., Zanier, N., St. Louis, R.M., Stanciu, S., LeBlanc, D, Kostyniuk, L.P., Smith, J., Yung, R., Nyquist, L., DiGuiseppi, C., Li, G., Mielenz, T.J., Strogatz, D. and the LongROAD Research Team. (Under review) Prevalence, attitudes and knowledge of in-vehicle technologies and vehicle adaptations among older adults. Manuscript under review.

Reimer, B. (2104). Driver assistance systems and the transition to automated vehicles: A path to increase older adult safety and mobility? Public Policy and Aging Report, 24, 27-31.

National Highway Traffic Safety Administration. (2007). Adapting Motor Vehicles for Older Drivers. Report No. DOT HS 810 732. Washington, DC: US Department of Transportation.

National Safety Council (2017). My Car Does What? mycardoeswhat.org. Accessed September 2017.

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