RESEARCH BRIEF

Advanced Driver Assistance Systems and Older Drivers: Changes in Prevalence, Use, and Perceptions Over 3 Years of the AAA LongROAD Study

December 2021

This study had two overarching objectives: (a) examine changes in the prevalence of advanced driver assistance systems (ADAS) among a large sample of older drivers; and (b) examine changes in how older drivers learned to use and what they thought about ADAS. This study updates a previous research brief that investigated ADAS prevalence, use, learning, and perceived safety among older drivers at baseline participating in the AAA Longitudinal Research on Aging Drivers (AAA LongROAD) project (Eby et al., 2017). The present study analyzed 3 years of questionnaire data from 2,374 participants enrolled in the AAA LongROAD project. Changes in prevalence, use, learning, and perceived safety for 15 ADAS from enrollment (baseline) to the end of a 3-year period (Year 3) were investigated. During the 3 years of follow-up, the prevalence of having 1 or more ADAS in the vehicles of the study participants increased from 59.0% to 72.0% and the average number of ADAS per vehicle increased from 2.0 to 3.3. Backup/parking assist was the technology with the greatest percentage point increase (from 41.5% to 58.8%), followed by blind spot warning (from 7.6% to 24.6%) and integrated Bluetooth cell phone (from 49.2% to 62.4%). Significantly more participants reported learning to use ADAS in Year 3 by figuring it out by themselves. Reported frequency of use and perceived safety of ADAS among the participants, however, remained virtually the same during the 3 years.

METHODS

Data for the study were collected from a vehicle technology questionnaire that was administered to AAA LongROAD participants at baseline and then again each time the participant changed his or her vehicle over a 3-year period. Fifteen ADAS (i.e., technologies installed by the vehicle manufacturer either as standard or optional equipment) were included in this study as shown in Table 1.

Several types of analyses were conducted for the prevalence results. Fisher's Exact Test analyses were used to determine if there were significant prevalence differences in demographics within each technology at each time period (baseline and Year 3). Because the analyses of longitudinal changes in prevalence from baseline to Year 3 included matched pairs over time, McNemar's tests were used to test the significance of these differences. Changes in proportions of participants who answered questions about learning, frequency of use, and perceived safety between baseline and Year 3 were analyzed using chi-square tests.

RESULTS

Demographics

The AAA LongROAD project included 2,990 participants at enrollment (baseline) between July 2015 and March 2017. Because we were interested in changes in prevalence between baseline and the 3 years after enrollment (Year 3), the study only included participants who were still enrolled at the end of the Year 3 period (n = 2,374, representing 79% of the original participants enrolled in the project). Among the eligible 2,374 participants in the study, nearly 900 (38%) replaced the personal vehicle (buying or leasing) they had at baseline at some point during the following 3-year period and thus, provided the basis for any changes in ADAS prevalence, use, and perceptions between the two time periods. Note that this study could not capture changes in use or perceptions of participants who did not change vehicles between baseline and Year 3, since these people did not complete a second vehicle technology questionnaire.

Table 1. Description of ADAS included in the survey

ADAS	Text in Survey Used to Describe the ADAS
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 demographics of the sample at Year 3 are presented in Table 2. Note that for some of the demographics, participants could be classified in a different category in Year 3 compared to baseline (e.g., aging into the next age group), but for the most part the demographics were the same as for baseline.

Table 2. Demographics of Sample at Year 3

Demographic	% (n)
Sex	
Male	47.1 (1117)
Female	53.0 (2374)
Age	
65–69	15.3 (363)
70–74	42.9 (1019)
75 and older	41.8 (992)
Marital Status	
Married	60.8 (1439)
All other statuses	39.2 (927)
Education	
HS or less	10.4 (247)
Some college	17.1 (404)
Associate or Bachelor Deg	30.3 (718)
Master, professional, or Doc	42.2 (1001)
Race	
White	85.3 (2036)
Non-white	14.2 (336)
Income	
Less than $20,000	3.8 (32)
$20,000–$49,999	22.8 (193)
$50,000–79,999	25.5 (216)
$80,000–$99,999	14.5 (123)
$100,000 or more	33.5 (284)

Prevalence

At baseline, 59.0% of participants had at least one ADAS in their vehicle. In Year 3, 72.0% of participants had at least one ADAS in their vehicle. On average, participants had 2 technologies in their vehicle at baseline, with a range of 0 to 14, while in Year 3, participants had on average 3.3 technologies with a range of 0 to 14 technologies (no participants had all 15 technologies). At baseline and Year 3, having a higher number of ADAS in a vehicle was significantly related to being married, having a higher income, and having a higher education level. Age group, sex, and race were not significantly correlated with the number of technologies. Figure 1 shows the prevalence of each ADAS among AAA LongROAD participants for baseline and Year 3.

As shown in Figure 1, the prevalence of each ADAS increased in Year 3 as compared to baseline. The percentage increase ranged from 24% (in-vehicle concierge) to more than 300% (fatigue/drowsy driver alert), while the percentage point increase ranged from 0.8% (night vision enhancement) to 17.4% (backup/parking assist). Table 3 shows that the prevalence of each of the 15 ADASs increased significantly from baseline to Year 3.

The study examined the prevalence of each ADAS within and across baseline and Year 3 by sex, age group, marital status, education, race, and household income. These results are shown in the Appendix. As shown in these tables, the prevalence of all technologies significantly increased from baseline for nearly every demographic category and level. For many of the ADAS (adaptive headlights, blind-spot warning, emergency response, in-vehicle concierge, navigation assistance, night vision enhancement, semi-autonomous parking assist, and voice control), prevalence only increased in the high-income levels. No significant increase in prevalence from baseline was found for lower education levels for adaptive headlights, in-vehicle concierge, and night vision enhancement. Excluding night vision enhancement and semi-autonomous parking assist, which both had low prevalence overall, prevalence increased significantly across the other ADASs for both males and females, all three age groups, married and not married, and White and non-White.

Learning to Use Technology

The questionnaire asked participants about the primary method they used to learn about their ADAS that required some sort of learning. Participants could respond by indicating one of seven answers: never learned; dealer; owner's manual; friend or family; Internet; figured it out by myself; or other. Because adaptive headlights, emergency response, and in-vehicle concierge technologies do not generally require learning to use, this question was not

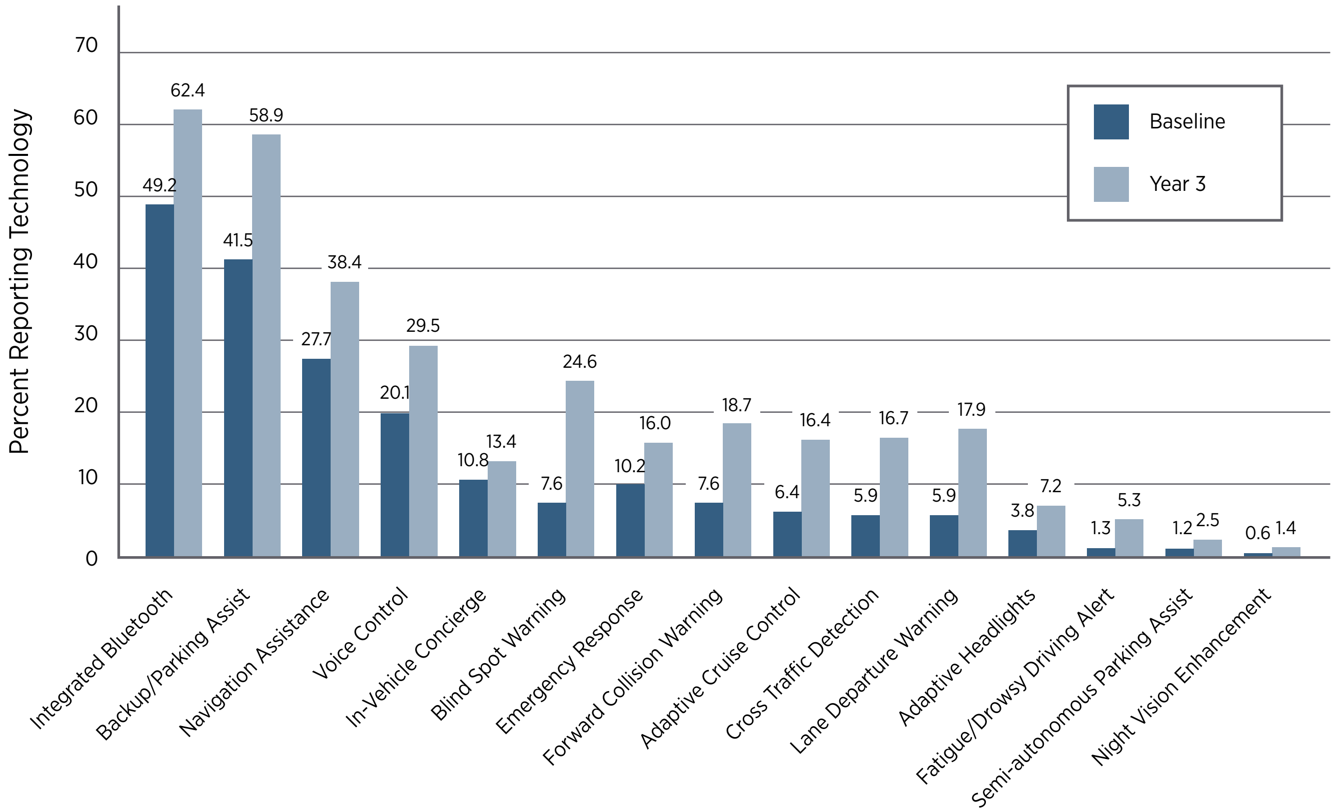

Figure 1. ADAS prevalence from baseline to Year 3 among AAA LongROAD participants

Table 3. Differences In Technology Prevalence from Baseline to Year 3

Technology	Baseline	Year 3	McNemar's Statistic
Adaptive Cruise Control	6.4%	16.4%	217.03; p<.0001
Adaptive Headlights	3.8%	7.2%	59.88; p<.0001
Backup/Parking Assist	41.5%	58.9%	388.54; p<.0001
Blind Spot Warning	7.6%	24.6%	321.33; p<.0001
Cross Traffic Detection	5.9%	16.7%	239.94; p<.0001
Emergency Response	10.2%	16.0%	97.59; p<.0001
Fatigue/Drowsy Driver Alert	1.3%	5.3%	91.04; p<.0001
Forward Collision Warning	7.6%	18.7%	244.69; p<.0001
In-Vehicle Concierge	10.8%	13.4%	27.00; p<.0001
Integrated Bluetooth Cell Phone	49.2%	62.4%	267.00; p<.0001
Lane Departure Warning	5.9%	17.9%	269.35; p<.0001
Navigation Assistance	27.7%	38.4%	168.47; p<.0001
Night Vision Enhancement	0.6%	1.4%	9.85; p<.01
Semi-Autonomous Parking Assist	1.2%	2.5%	21.36; p<.0001
Voice Control	20.1%	29.5%	180.50; p<.0001

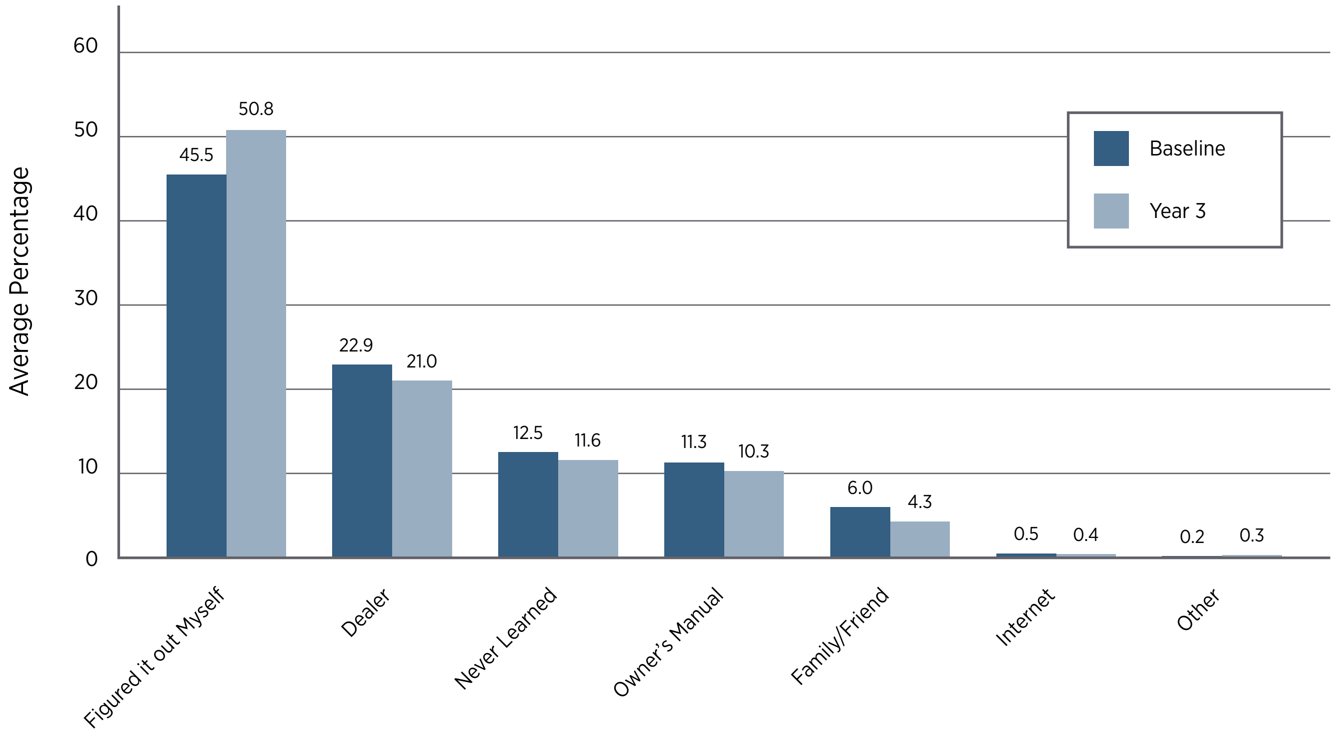

Figure 2. Reported percentages of primary methods for learning to use ADASs averaged across technologies for baseline and Year 3

asked for these technologies. Figure 2 shows the reported methods for learning to use technologies averaged across technologies. The largest proportion of participants in baseline and in Year 3 learned to use the technology on their own, with a 5.3 percentage point increase in Year 3. There was little change from baseline for the other ways of learning, with about one-fifth reporting that the dealer was the primary way in which they learned to use the technology and 12% in Year 3 reported having never learned to use the technology. Overall, analyses found a slight but significant difference in how people learned to use ADASs between baseline and Year 3 ($\chi^2[6]=44.4$; $p<.05$), driven primarily by the difference between time periods for figuring it out themselves.

Frequency of Use

The questionnaire asked respondents how frequently they used their ADAS. Participants could respond by reporting 1 of 5 answers: always; often; sometimes; rarely; or never. This question was not asked for backup/parking assist or cross traffic detection because these technologies are generally always on. This question was also only asked for forward collision warning, blind spot warning, lane departure warning, and drowsy driver alert technologies if the participant had previously indicated that the technology could be turned on and off by the driver. Figure 3 shows the reported frequency of use averaged across technologies for which the question was asked for baseline and Year 3. As can be seen, the frequency of use varied little for the often, sometimes, and rarely categories, with about 12% to 14% reporting these categories for both time periods. There was a 2.6 percentage point increase in Year 3 for respondents who reported "always" using the technologies and a 3.6 percentage point decrease in Year 3 for those reporting they never used the technologies, suggesting slightly more use of technologies in Year 3. These differences, however, were not statistically significant.

Perceived Safety

For each safety-related technology, respondents were asked whether or not use of ADAS made them a safer driver. This question was not asked for emergency response or in-vehicle concierge technologies, as they are not designed to impact driving safety. The percentages of people indicating that ADAS made them a safer driver, by ADAS and time period, are shown in Figure 4. Across all technologies, an average of 69% of participants at

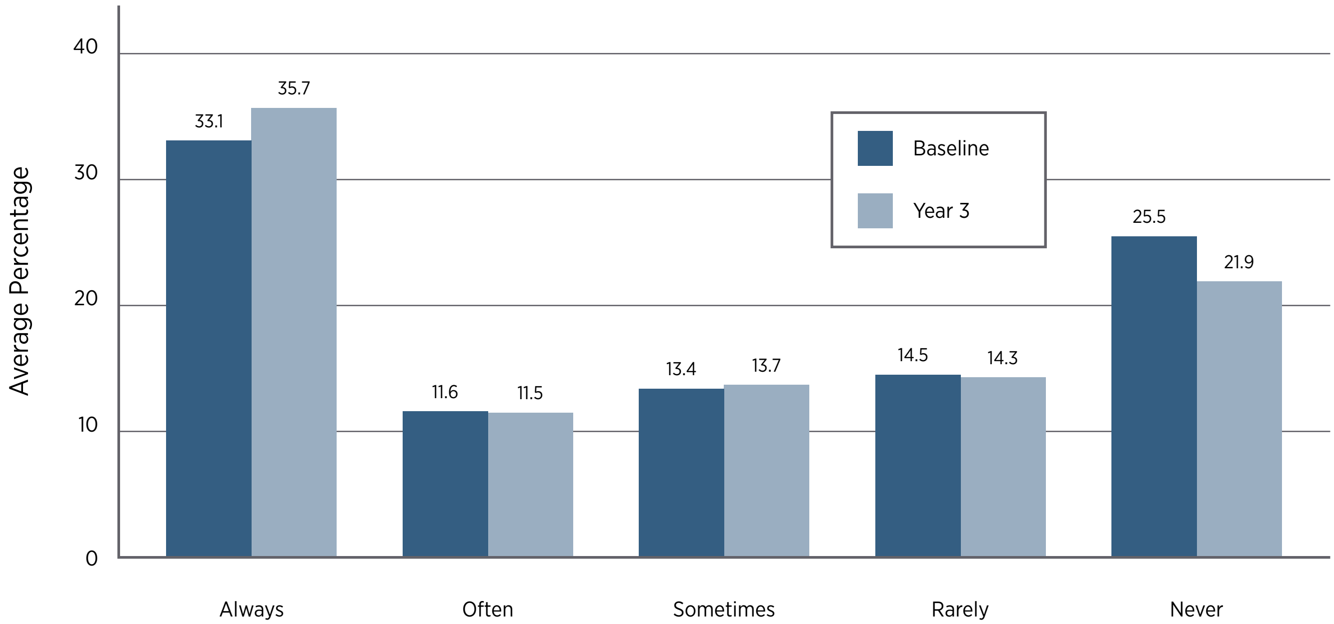

Figure 3. Average percentage across ADASs on how frequently technologies were used in baseline and Year 3

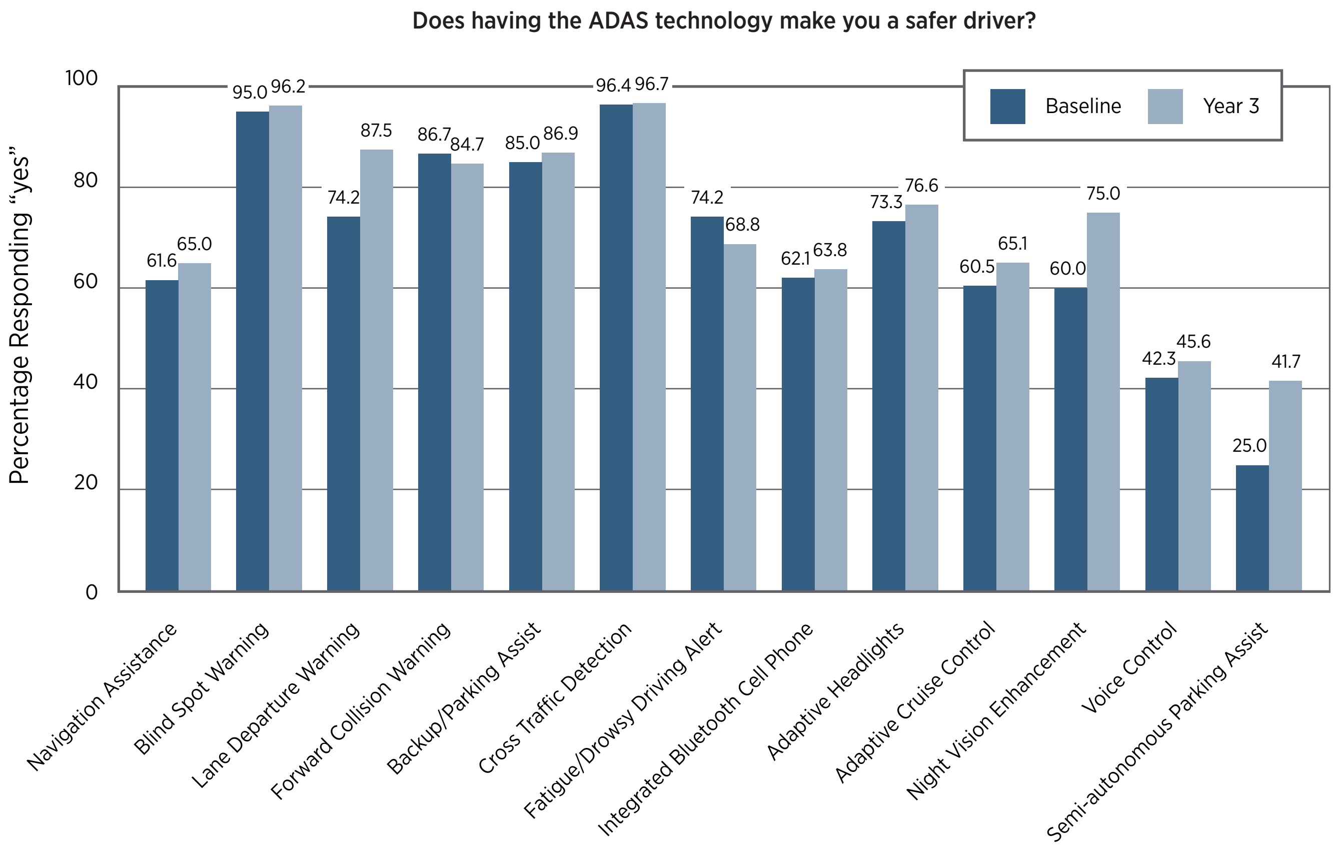

Figure 4. Percentages of people by ADAS reporting that the technology makes them a safer driver for baseline and Year 3

baseline reported that they thought the technologies made them safer drivers. This overall perception of safety increased among AAA LongROAD participants at Year 3 to 73%. Analyses of changes in safety perception from baseline to Year 3 separately for each ADAS technology showed that the changes were not statistically significant. However, as shown in this figure, cross traffic detection and blind spot warning systems were reported by nearly all participants to make them safer drivers in baseline and in Year 3. These systems were followed closely in reported safety by backup/parking assist, forward collision warning, and lane departure warning systems.

DISCUSSION

This study found a sizeable and statistically significant increase in the prevalence of ADAS in participants' vehicles over a 3-year period. The percentage of people having at least one ADAS in their vehicle increased from 59% at baseline to 72% in Year 3. It is clear that among AAA LongROAD participants, as they replace their vehicles they are getting vehicles that have more advanced technologies, as predicted in a previous research brief (Eby et al., 2017). It is not known if participants are seeking out these technologies for their new vehicles or these technologies are becoming standard on new vehicles, but both factors are likely contributing to the increased ADAS prevalence in this sample. The comparisons of prevalence changes from baseline to Year 3 showed that prevalence increased across all demographic categories; however, there was evidence that for some technologies, those in the lower income and education categories did not have an increase in prevalence at Year 3. These results may reflect limited statistical power in low income and education strata, but could also suggest an inequality among low income and low education older drivers in their access to technologies that can potentially improve traffic safety and mobility. It should also be noted that ADAS prevalence is self-reported and some participants may have ADAS of which they are unaware while others may think they have ADAS that their vehicle does not have.

The study also examined changes in how older drivers learned to use ADAS from baseline to Year 3. The study found that over the 3-year period, there were few differences in how people learned to use ADAS with a slight increase in people figuring out the technologies by themselves. This result was surprising. On the one hand, several researchers have pointed out the need to develop better materials and systems for training older drivers on the use of ADAS (Coughlin, 2009; Eby & Molnar, 2014; Reimer, 2014). On the other hand, in the past several years, new programs and materials for helping older drivers learn about automotive technology have been developed and made available including: *Smart Features for Older Drivers* (AAA, 2021); *My Car Does What?* (National Safety Council, 2020), *CarTech VR360* app (National Safety Council and The University of Iowa, 2020), and numerous YouTube videos. It is possible that resources like these are not being used by AAA LongROAD participants. Each of these resources require access to and familiarity with the Internet and computer-based technology. This study found that in both baseline and Year 3, less than 1% reported using the Internet as their primary learning method. These results suggest: (a) further efforts need to be made in developing training videos and materials that do not require knowledge of and access to the Internet; (b) existing Internet-based training programs and materials would provide greater benefit to older drivers if they also had a non-Internet method for accessing them; and (c) society needs to continue to address the "digital divide" among older members of our community (e.g., Antonio & Tuffley, 2015). This latter recommendation refers to the gap in access to and knowledge of digital technologies between older adults and younger adults.

The study found evidence that ADAS frequency of use among participants had not increased significantly since baseline, with about 60% using ADAS at least some of the time. Given that the safety and mobility benefits of ADAS require that these systems be used while driving, efforts should be made to better understand why ADAS are not used more frequently by older drivers. As previously discussed, a lack of training may partially account for the lack of frequent use.

As was found at baseline, large proportions of participants reported that ADAS made them safer drivers. The technologies with the lowest safety perceptions were semi-autonomous parking assist and voice control. While safety perceptions increased from 25% at baseline to 42% at Year 3, semi-autonomous parking assist may be considered more of a convenience technology than a safety technology. Although voice control systems can have important safety benefits as compared to manual controls because of manual distraction while driving, slightly more than one-half of participants did not perceive this technology as improving safety.

Collectively, these results show that the prevalence of ADAS had increased dramatically in this sample of older drivers over a 3-year period. It is expected that prevalence will continue to increase in the coming years as participants continue to replace their vehicles with newer models. Inasmuch as ADAS increase safety among older drivers, the expectation is to see positive changes in traffic-safety-related outcomes, such as decreased crashes. However, some of these safety benefits may be reduced if older drivers do not use the technologies in their vehicles or they do not learn how these technologies function and, more importantly, the operational limitations of these technologies. Results presented in this document also show that as training programs and materials are developed for older drivers, it is important to understand that many older adults, particularly those with lower incomes and education, may not have access to or knowledge of the digital platforms that new programs tend to utilize. New ways of training older drivers about ADAS are needed as well as a better understanding of the factors that impede ADAS adoption and use among older drivers.

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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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APPENDIX

Changes in Prevalence of ADAS in AAA LongROAD participant's vehicles from Baseline to Year 3 by technology and demographic.

Note that an asterisk (*) indicates that within the demographic category for that time period, the prevalence of that technology varied significantly among the levels of the demographic, as determined by Fisher Exact tests. McNemar's statistics shown in bold indicate a significant difference on that demographic between Baseline and Year 3.

Table A1. Adaptive Cruise Control

Demographic	% (n)		McNemar's Statistic
	Baseline	Year 3	
Sex			
Male	7.6 (83)	18.8 (203)	**106.79; p<.0001**
Female	5.8 (69)	16.6 (187)	**110.30; p<.0001**
Age			
65–69	6.7 (65)	14.5 (49)	**29.00; p<.0001**
70–74	6.4 (51)	19.4 (185)	**109.14; p<.0001**
75 and older	7.1 (36)	17.1 (156)	**79.41; p<.0001**
Marital Status			
Married	7.7 (112)*	19.0 (258)*	**133.92; p<.0001**
All other statuses	4.8 (39)*	15.8 (132)*	**83.18; p<.0001**
Education			
HS or less	4.7 (11)*	13.2 (30)*	**18.00; p<.0001**
Some college	4.1 (16)*	14.3 (53)*	**37.00; p<.0001**
Associate or Bachelor Deg	5.2 (36)*	15.3 (102)*	**55.90; p<.0001**
Master, professional, or Doc	9.2 (88)*	21.7 (203)*	**105.53; p<.0001**
Race			
White	6.8 (134)	17.6 (334)	**183.93; p<.0001**
Non-white	5.7 (18)	18.3 (56)	**33.11; p<.0001**
Income			
Less than $20,000	2.3 (2)*	6.9 (2)*	—
$20,000–$49,999	1.0 (5)*	8.9 (16)*	**15.00; p<.001**
$50,000–79,999	4.6 (25)*	15.4 (31)*	**21.00; p<.0001**
$80,000–$99,999	8.4 (27)*	16.2 (19)*	**8.33; p<.01**
$100,000 or more	11.6 (89)*	27.9 (76)*	**39.71; p<.0001**

* Significant at the p < .05 level.
Bold indicates significant at the probability level shown.
— Indicates that cell sizes were too small for analysis.

Table A2. Adaptive Headlights

Demographic	% (n)		McNemar's Statistic
	Baseline	Year 3	
Sex			
Male	4.9 (53)*	8.0 (86)	**21.33; p<.0001**
Female	3.2 (37)*	7.7 (85)	**41.00; p<.0001**
Age			
65–69	4.5 (44)	8.8 (30)	**15.00; p<.001**
70–74	3.2 (25)	8.0 (74)	**22.73; p<.0001**
75 and older	4.2 (21)	7.4 (67)	**22.73; p<.0001**
Marital Status			
Married	4.6 (66)*	8.9 (118)*	**35.27; p<.0001**
All other statuses	2.8 (23)*	6.3 (53)*	**25.14; p<.0001**
Education			
HS or less	2.6 (6)	5.3 (12)	3.5; p=.06
Some college	2.8 (11)	6.6 (25)	**8.89; p<.01**
Associate or Bachelor Deg	3.8 (26)	7.0 (47)	**112.46; p<.001**
Master, professional, or Doc	4.9 (47)	9.7 (87)	**37.00; P<.0001**
Race			
White	3.9 (75)	7.6 (142)	**51.95; p<.0001**
Non-white	4.8 (15)	9.6 (29)	**8.07; p<.01**
Income			
Less than $20,000	0.0 (0)*	0.0 (0)*	—
$20,000–$49,999	0.4 (2)*	0.6 (1)*	—
$50,000–79,999	3.4 (19)*	8.7 (18)*	**7.36; p<.01**
$80,000–$99,999	5.6 (18)*	4.5 (5)*	0.33; p=.56
$100,000 or more	6.5 (49)*	12.6 (32)*	**20.00; p<.0001**

* Significant at the p < .05 level.
Bold indicates significant at the probability level shown.
— Indicates that cell sizes were too small for analysis.

Table A3. Backup/Parking Assist

Demographic	% (n)		McNemar's Statistic
	Baseline	Year 3	
Sex			
Male	42.2 (471)	58.4 (651)	**161.01; p<.0001**
Female	41.0 (514)	59.8 (748)	**228.15; p<.0001**
Age			
65–69	41.1 (415)	61.2 (222)	**61.06; p<.0001**
70–74	43.3 (357)	58.4 (592)	**162.77; p<.0001**
75 and older	39.9 (213)	59.1 (585)	**164.77; p<.0001**
Marital Status			
Married	46.1 (688)*	63.2 (907)*	**219.17; p<.0001**
All other statuses	33.8 (288)*	52.9 (488)*	**169.02; p<.0001**
Education			
HS or less	35.4 (87)*	50.6 (124)	**35.10; p<.0001**
Some college	37.2 (150)*	56.1 (226)	**74.05; p<.0001**
Associate or Bachelor Deg	40.0 (287)*	56.5 (405)	**114.13; p<.0001**
Master, professional, or Doc	45.9 (458)*	64.3 (641)	**165.62; p<.001**
Race			
White	42.2 (858)	60.2 (1220)*	**337.74; p<.0001**
Non-white	37.6 (126)	53.0 (178)*	**51.00; p<.0001**
Income			
Less than $20,000	11.2 (10)*	32.3 (10)*	**4.00; p<.05**
$20,000–$49,999	29.1 (146)*	52.3 (101)*	**33.11; p<.0001**
$50,000–79,999	38.7 (222)*	58.3 (126)*	**30.42; p<.0001**
$80,000–$99,999	45.4 (152)*	68.3 (84)*	**22.15; p<.0001**
$100,000 or more	53.4 (426)*	71.5 (203)*	**55.25; p<.0001**

* Significant at the p < .05 level.
Bold indicates significant at the probability level shown.

Table A4. Blind Spot Warning

Demographic	% (n)		McNemar's Statistic
	Baseline	Year 3	
Sex			
Male	10.4 (116)	25.3 (279)	**154.38; p<.0001**
Female	9.9 (123)	24.9 (305)	**167.01; p<.0001**
Age			
65–69	9.1 (91)	23.4 (84)	**38.21; p<.0001**
70–74	11.1 (91)	24.9 (249)	**146.23; p<.0001**
75 and older	10.8 (57)	25.9 (186)	**137.42; p<.0001**
Marital Status			
Married	11.4 (170)*	26.5 (375)	**198.87; p<.0001**
All other statuses	8.1 (68)*	23.2 (209)	**122.46; p<.0001**
Education			
HS or less	5.8 (14)*	17.1(41)*	**24.14; p<.0001**
Some college	8.0 (32)*	21.9 (86)*	**47.03; p<.0001**
Associate or Bachelor Deg	9.4 (67)*	23.2 (165)*	**89.61; p<.0001**
Master, professional, or Doc	12.6 (125)*	29.6 (290)*	**60.10; p<.0001**
Race			
White	10.1 (204)	25.9 (518)*	**297.60; p<.0001**
Non-white	10.6 (35)	20.3 (66)*	**24.64; p<.0001**
Income			
Less than $20,000	1.1 (1)*	6.7 (2)*	1.00; p=.32
$20,000–$49,999	4.4 (22)*	18.4 (35)*	**22.53; p<.0001**
$50,000–79,999	7.9 (45)*	24.1 (51)*	**34.00; p<.0001**
$80,000–$99,999	13.2 (44)*	30.9 (38)*	**21.00; p<.0001**
$100,000 or more	15.3 (120)*	34.9 (97)*	**48.60; p<.0001**

* Significant at the p < .05 level.
Bold indicates significant at the probability level shown.

Table A5. Cross Traffic Detection

Demographic	% (n)		McNemar's Statistic
	Baseline	Year 3	
Sex			
Male	6.6 (73)	17.7 (193)	**110.77; p<.0001**
Female	5.3 (66)	16.9 (204)	**129.26; p<.0001**
Age			
65–69	5.7 (57)	16.4 (58)	**29.88; p<.0001**
70–74	6.3 (51)	17.8 (175)	**110.30; p<.0001**
75 and older	5.9 (31)	17.1 (164)	**100.15; p<.0001**
Marital Status			
Married	6.6 (98)	18.8 (261)*	**155.57; p-<.0001**
All other statuses	4.9 (41)	15.1 (135)*	**83.38; p<.0001**
Education			
HS or less	4.5 (11)	12.0 (28)*	**15.21; p<.0001**
Some college	4.5 (18)	14.1 (55)*	**31.84; p<.0001**
Associate or Bachelor Deg	5.2 (37)	15.6 (110)*	**66.46; p<.0001**
Master, professional, or Doc	7.3 (72)	21.1 (203)*	**127.03; p<.0001**
Race			
White	5.7 (115)	17.6 (347)	**218.42; p<.0001**
Non-white	7.3 (24)	15.3 (50)	**22.09; p<.0001**
Income			
Less than $20,000	2.3 (2)*	3.3 (1)	—
$20,000–$49,999	2.0 (10)*	11.2 (21)	**11.84; p<.001**
$50,000–79,999	5.1 (29)*	15.6 (33)	**19.17; p<.0001**
$80,000–$99,999	7.3 (24)*	19.5 (24)	**15.00; p<.001**
$100,000 or more	8.9 (70)*	24.0 (65)	**40.09; p<.0001**

* Significant at the p < .05 level.
Bold indicates significant at the probability level shown.
— Indicates that cell sizes were too small for analysis.

Table A6. Emergency Response

Demographic	% (n)		McNemar's Statistic
	Baseline	Year 3	
Sex			
Male	13.7 (146)*	20.1 (208)*	**41.80; p<.0001**
Female	8.1 (97)*	15.0 (171)*	**56.98; p<.0001**
Age			
65–69	10.0 (97)	18.1 (62)	**15.21; p<.0001**
70–74	11.9 (94)	17.8 (165)	**49.95; p<.0001**
75 and older	10.2 (52)	16.8 (152)	**32.89; p<.0001**
Marital Status			
Married	12.0 (170)*	19.5 (259)*	**72.20; p<.0001**
All other statuses	8.8 (72)*	14.3 (120)*	**25.78; p<.0001**
Education			
HS or less	6.8 (16)	12.0 (27)*	**6.55; p<.05**
Some college	11.1 (43)	18.7 (69)*	**16.89; p<.0001**
Associate or Bachelor Deg	10.4 (72)	15.0 (100)*	**20.51; p<.0001**
Master, professional, or Doc	11.7 (111)	20.0 (181)*	**54.08; p<.0001**
Race			
White	10.6 (206)	17.3 (324)	**85.95; p<.0001**
Non-white	11.6 (37)	18.1 (55)	**11.64; p<.001**
Income			
Less than $20,000	2.2 (2)*	7.1 (2)*	0.00; p=1.0
$20,000–$49,999	6.0 (29)*	8.1 (14)*	0.11; p=.11
$50,000–79,999	8.3 (46)*	15.4 (31)*	**12.00; p<.001**
$80,000–$99,999	11.0 (36)*	21.0 (25)*	**6.23; p<.05**
$100,000 or more	16.5 (123)*	26.7 (69)*	**16.00; p<.0001**

* Significant at the p < .05 level.
Bold indicates significant at the probability level shown.

Table A7. Fatigue/Drowsy Driver Alert

Demographic	% (n)		McNemar's Statistic
	Baseline	Year 3	
Sex			
Male	1.6 (18)	5.8 (62)	**42.09; p<.0001**
Female	1.1 (13)	5.3 (63)	**49.00; p<.0001**
Age			
65–69	1.1 (11)	3.1 (11)*	**9.00; p<.01**
70–74	1.6 (13)	6.7 (65)*	**48.08; p<.0001**
75 and older	1.3 (7)	5.2 (49)*	**34.00; p<.0001**
Marital Status			
Married	1.8 (26)*	6.2 (85)	**59.06; p<.0001**
All other statuses	0.5 (4)*	4.5 (40)	**32.00; p<.0001**
Education			
HS or less	0.8 (2)*	3.8 (9)*	**7.00; p<.01**
Some college	0.3 (1)*	2.6 (10)*	**9.00; p<.01**
Associate or Bachelor Deg	1.0 (7)*	5.4 (37)*	**29.00; p<.0001**
Master, professional, or Doc	2.1 (21)*	7.3 (69)*	**46.08; p<.0001**
Race			
White	1.4 (28)	6.0 (117)*	**86.04; p<.0001**
Non-white	0.9 (3)	2.6 (8)*	**5.00; p<.05**
Income			
Less than $20,000	1.1 (1)*	3.5 (1)	—
$20,000–$49,999	0.2 (1)*	2.7 (5)	**4.00; p<.05**
$50,000–79,999	0.5 (3)*	4.9 (10)	**9.00; p<.01**
$80,000–$99,999	1.2 (4)*	4.3 (5)	3.00; p=.08
$100,000 or more	2.4 (19)*	6.0 (16)	**12.00; p<.001**

* Significant at the p < .05 level.
Bold indicates significant at the probability level shown.
— Indicates that cell sizes were too small for analysis.

Table A8. Forward Collision Warning

Demographic	% (n)		McNemar's Statistic
	Baseline	Year 3	
Sex			
Male	8.3 (92)	19.7 (216)	**121.27; p<.0001**
Female	7.2 (89)	19.0 (229)	**123.66; p<.0001**
Age			
65–69	7.7 (77)	17.2 (61)	**27.22; p<.0001**
70–74	8.2 (67)	20.1 (198)	**111.50; p<.0001**
75 and older	7.0 (37)	19.4 (186)	**107.14; p<.0001**
Marital Status			
Married	8.7 (129)*	20.2 (283)	**144.46; p<.0001**
All other statuses	6.2 (52)*	18.1 (162)	**100.32; p<.0001**
Education			
HS or less	3.3 (8)*	10.0 (24)*	**16.00; p<.0001**
Some college	5.8 (23)*	16.1 (63)*	**33.33; p<.0001**
Associate or Bachelor Deg	6.7 (48)*	16.8 (117)*	**60.27; p<.0001**
Master, professional, or Doc	10.2 (101)*	24.7 (240)*	**136.11; p<.0001**
Race			
White	7.7 (156)	19.5 (385)	**208.93; p<.0001**
Non-white	7.6 (25)	18.6 (60)	**36.00; p<.0001**
Income			
Less than $20,000	1.1 (1)*	3.5 (1)*	—
$20,000–$49,999	2.4 (12)*	9.5 (18)*	**12.25; p<.001**
$50,000–79,999	5.3 (30)*	16.6 (35)*	**23.15; p<.0001**
$80,000–$99,999	9.1 (30)*	24.6 (30)*	**14.22; p<.001**
$100,000 or more	12.9 (102)*	29.4 (81)*	**46.08; p<.0001**

* Significant at the $p < .05$ level.
Bold indicates significant at the probability level shown.
— Indicates that cell sizes were too small for analysis.

Table A9. In-Vehicle Concierge

Demographic	% (n)		McNemar's Statistic
	Baseline	Year 3	
Sex			
Male	14.5 (154)*	17.4 (188)*	**14.76; p<.0001**
Female	8.3 (102)*	10.8 (129)*	**12.25; p<.001**
Age			
65–69	9.9 (99)	12.9 (46)	**5.00; p<.05**
70–74	12.1 (98)	14.3 (140)	**14.34; p<.001**
75 and older	11.3 (59)	13.9 (131)	**8.07; p<.01**
Marital Status			
Married	12.3 (181)*	15.2 (211)*	**20.88; p<.0001**
All other statuses	8.9 (74)*	21.1 (106)*	**6.48; p<.05**
Education			
HS or less	10.7 (26)	9.9 (23)	0.29; p=.59
Some college	11.8 (47)	14.2 (55)	2.46; p=.12
Associate or Bachelor Deg	11.6 (82)	13.7 (96)	**3.93; p<.05**
Master, professional, or Doc	10.2 (99)	14.7 (140)	**29.35; p<.0001**
Race			
White	10.4 (208)*	13.3 (261)*	**23.14; p<.0001**
Non-white	14.6 (48)*	17.8 (56)*	**3.86; p<.05**
Income			
Less than $20,000	3.4 (3)*	3.2 (1)*	1.00; p=.31
$20,000–$49,999	8.1 (40)*	12.4 (23)*	1.00; p=.32
$50,000–79,999	10.2 (58)*	9.9 (21)*	0.00; p=1
$80,000–$99,999	12.3 (41)*	21.0 (25)*	**4.50; p<.05**
$100,000 or more	13.8 (107)*	19.0 (52)*	3.00; p=.08

* Significant at the p < .05 level.
Bold indicates significant at the probability level shown.

Table A10. Integrated Bluetooth Cell Phonet

Demographic	% (n)		McNemar's Statistic
	Baseline	Year 3	
Sex			
Male	50.5 (552)*	63.9 (697)	**121.97 ; p<.0001**
Female	50.3 (617)*	64.6 (784)	**145.03; p<.0001**
Age			
65–69	53.6 (534)*	68.6 (243)*	**29.83; p<.0001**
70–74	51.6 (414)*	65.9 (652)*	**118.72; p<.0001**
75 and older	42.3 (221)*	61.0 (586)*	**119.12; p<.0001**
Marital Status			
Married	54.1 (791)*	67.1 (940)*	**147.08; p<.0001**
All other statuses	44.3 (370)*	60.1 (538)*	**119.72; p<.0001**
Education			
HS or less	37.0 (89)*	51.7 (121)*	**27.92; p<.0001**
Some college	48.2 (190)*	63.4 (248)*	**46.72; p<.0001**
Associate or Bachelor Deg	49.4 (348)*	62.8 (438)*	**77.88; p<.0001**
Master, professional, or Doc	55.3 (540)*	68.6 (672)*	**115.04; p<.0001**
Race			
White	50.8 (1011)	65.0 (1284)	**233.19; p<.0001**
Non-white	47.9 (157)	60.0 (196)	**33.80; p<.0001**
Income			
Less than $20,000	16.9 (156)*	34.5 (10)*	**4.00; p<.05**
$20,000–$49,999	36.0 (178)*	54.8 (102)*	**22.53; p<.0001**
$50,000–79,999	50.5 (280)*	66.0 (103)*	**22.53; p<.0001**
$80,000–$99,999	51.8 (171)*	75.2 (91)*	**23.00; p<.0001**
$100,000 or more	63.1 (496)*	73.9 (207)*	**29.45; p<.0001**

* Significant at the p < .05 level.
Bold indicates significant at the probability level shown.

Table A11. Lane Departure Warning

Demographic	% (n)		McNemar's Statistic
	Baseline	Year 3	
Sex			
Male	6.6 (73)	18.0 (198)	**121.12; p<.0001**
Female	5.4 (66)	18.6 (226)	**148.23; p<.0001**
Age			
65–69	5.7 (56)	14.9 (52)	**27.93; p<.0001**
70–74	6.5 (53)	19.3 (193)	**126.03; p<.0001**
75 and older	5.7 (30)	18.5 (179)	**116.03; p<.0001**
Marital Status			
Married	7.0 (103)*	20.0 (282)*	**168.53; p<.0001**
All other statuses	4.2 (35)*	15.8 (142)*	**101.00; p<.0001**
Education			
HS or less	3.7 (9)*	12.9 (31)*	**22.00; p<.0001**
Some college	4.3 (17)*	14.5 (57)*	**36.36; p<.0001**
Associate or Bachelor Deg	5.0 (35)*	16.2 (114)*	**72.20; p<.0001**
Master, professional, or Doc	7.8 (77)*	22.5 (220)*	**138.03; p<.0001**
Race			
White	6.1 (123)	18.9 (376)	**237.39; p<.0001**
Non-white	4.9 (16)	14.9 (48)	**32.00; p<.0001**
Income			
Less than $20,000	2.3 (2)*	6.9 (2)*	—
$20,000–$49,999	1.0 (5)*	9.6 (18)*	**16.00; p<.0001**
$50,000–79,999	4.2 (24)*	16.3 (34)*	**21.16; p<.0001**
$80,000–$99,999	6.7 (22)*	23.1 (28)*	**18.00; p<.0001**
$100,000 or more	10.5 (82)*	27.3 (75)*	**46.08; p<.0001**

* Significant at the $p < .05$ level.
Bold indicates significant at the probability level shown.
— Indicates that cell sizes were too small for analysis.

Table A12. Navigation Assistance

Demographic	% (n)		McNemar's Statistic
	Baseline	Year 3	
Sex			
Male	30.2 (336)	40.0 (442)	**73.92; p<.0001**
Female	27.9 (347)	38.2 (470)	**94.91; p<.0001**
Age			
65–69	29.9 (300)	37.8 (136)	**20.45; p<.0001**
70–74	28.4 (232)	40.6 (406)	**72.35; p<.0001**
75 and older	28.4 (151)	38.0 (370)	**75.98; <.0001**
Marital Status			
Married	32.3 (479)*	42.2 (600)*	**100.00; p<.0001**
All other statuses	23.6 (200)*	34.3 (311)*	**67.70; p<.0001**
Education			
HS or less	23.0 (56)	31.7 (75)	**18.18; p<.0001**
Some college	20.8 (83)	30.5 (122)	**23.29; p<.0001**
Associate or Bachelor Deg	27.6 (197)	37.4 (265)	**49.09; p<.0001**
Master, professional, or Doc	34.8 (346)	45.5 (449)	**80.98; p<.0001**
Race			
White	28.7 (580)	38.6 (773)	**139.29; p<.0001**
Non-white	30.8 (102)	41.8 (138)	**29.88; p<.0001**
Income			
Less than $20,000	2.3 (2)*	12.9 (4)*	2.00; p=.16
$20,000–$49,999	16.6 (83)*	25.5 (48)*	**15.70; p<.0001**
$50,000–79,999	24.1 (136)*	30.8 (66)*	**9.32; p<.01**
$80,000–$99,999	30.3 (101)*	43.9 (54)*	**16.20; p<.0001**
$100,000 or more	43.3 (345)*	47.6 (135)*	**17.78;p<.0001**

* Significant at the p < .05 level.
Bold indicates significant at the probability level shown.

Table A13. Night Vision Enhancement

Demographic	% (n)		McNemar's Statistic
	Baseline	Year 3	
Sex			
Male	0.5 (5)	1.4 (15)	**8.33; p<.01**
Female	0.8 (10)	1.4 (17)	2.57; p=.11
Age			
65–69	0.6 (6)	1.1 (4)	0.33; p=.56
70–74	0.5 (4)	0.7 (17)	**12.00; p<.001**
75 and older	1.0 (5)	1.2 (11)	0.82; p=.37
Marital Status			
Married	0.8 (12)	1.5 (21)	**6.37; p<.05**
All other statuses	0.4 (3)	1.2 (11)	3.57; p=.06
Education			
HS or less	0.4 (1)	1.7 (4)	1.00; p=.32
Some college	0.8 (3)	1.8 (7)	2.00; p=.16
Associate or Bachelor Deg	0.6 (4)	0.9 (6)	0.67; p=.41
Master, professional, or Doc	0.7 (7)	1.6 (32)	**8.00; p<.01**
Race			
White	0.5 (10)*	3.1 (22)*	**7.20; p<.01**
Non-white	1.5 (5)*	1.1 (10)*	2.67; p=.10
Income			
Less than $20,000	0.0 (0)	0.0 (0)	—
$20,000–$49,999	0.2 (1)	0.0 (0)	—
$50,000–79,999	0.9 (5)	1.4 (3)	—
$80,000–$99,999	0.6 (2)	3.3 (4)	3.00; p=.08
$100,000 or more	0.9 (7)	2.2 (6)	0.67; p=.41

* Significant at the p < .05 level.
Bold indicates significant at the probability level shown.
— Indicates that cell sizes were too small for analysis.

Table A14. Semi-Autonomous Parking Assist

Demographic	% (n)		McNemar's Statistic
	Baseline	Year 3	
Sex			
Male	1.4 (15)	3.5 (39)*	**15.11; p<.001**
Female	1.1 (13)	1.7 (21)*	**6.40; p<.05**
Age			
65–69	1.2 (12)	1.9 (7)	3.00; p=.08
70–74	1.5 (12)	3.1 (31)	**15.70; P<.0001**
75 and older	0.8 (4)	2.3 (22)	**4.26; p<.05**
Marital Status			
Married	1.3 (19)	3.1 (44)*	**18.78; p<.0001**
All other statuses	1.1 (9)	1.8 (16)*	2.78; p=.09
Education			
HS or less	0.4 (1)	0.4 (1)*	—
Some college	0.5 (2)	1.5 (6)*	**4.00; p<.05**
Associate or Bachelor Deg	1.0 (7)	2.4 (17)*	**6.23; p<.05**
Master, professional, or Doc	1.8 (18)	3.7 (36)*	**12.5; p<.001**
Race			
White	1.1 (23)	2.8 (56)	**25.60; p<.0001**
Non-white	1.5 (5)	1.2 (4)	0.20; p=.65
Income			
Less than $20,000	0.0 (0)	0.0 (0)	—
$20,000–$49,999	0.6 (3)	1.0 (2)	1.00; p=.31
$50,000–79,999	1.2 (7)	1.9 (4)	3.00; p=.08
$80,000–$99,999	1.5 (5)	1.7 (2)	0.00; p=1.00
$100,000 or more	1.5 (12)	4.7 (13)	3.00; p=.08

* Significant at the p < .05 level.
Bold indicates significant at the probability level shown.
— Indicates that cell sizes were too small for analysis.

Table A15. Voice Control

Demographic	% (n)		McNemar's Statistic
	Baseline	Year 3	
Sex			
Male	23.8 (258)*	33.8(360)*	**81.67; p<.0001**
Female	18.2 (220)*	29.4 (340)*	**98.88; p<.0001**
Age			
65–69	24.3 (238)*	34.2 (119)*	**16.20; p<.0001**
70–74	20.2 (161)*	33.5 (319)*	**88.75; p<.0001**
75 and older	15.4 (79)*	28.4 (262)*	**77.51; p<.0001**
Marital Status			
Married	23.8 (344)*	34.9 (469)*	**114.89; p<.0001**
All other statuses	16.2 (133)*	26.6 (231)*	**65.61; p<.0001**
Education			
HS or less	12.1 (29)	24.6 (56)	**25.48;p<.0001**
Some college	16.7 (65)	25.7 (98)	**18.75; p<.0001**
Associate or Bachelor Deg	20.5 (143)	30.7 (208)	**59.76; p<.0001**
Master, professional, or Doc	25.0 (240)	36.2 (337)	**78.41; p<.0001**
Race			
White	20.6 (405)	31.8 (604)	**164.48; p<.0001**
Non-white	22.4 (72)	29.9 (95)	**16.13; p<.0001**
Income			
Less than $20,000	4.6 (4)*	17.2 (5)*	3.00; p=.08
$20,000–$49,999	10.8 (53)*	19.1 (35)*	**14.73; p<.0001**
$50,000–79,999	19.2 (107)*	31.9 (66)*	**12.57; p<.0005**
$80,000–$99,999	24.5 (78)*	35.0 (41)*	**9.94; p<.002**
$100,000 or more	29.0 (223)*	41.0 (110)*	**31.04; p<.0001**

* Significant at the p < .05 level.
Bold indicates significant at the probability level shown.