AUTONOMOUS VEHICLES AND ALTERNATIVES TO DRIVING: TRUST, PREFERENCES, AND EFFECTS OF AGE

Hillary Abraham
MIT AgeLab
77 Massachusetts Avenue E40-290, Cambridge, MA 02139
Tel: 617-715-2009; Email: habraham@mit.edu

Chaiwoo Lee
MIT AgeLab
77 Massachusetts Avenue E40-287, Cambridge, MA 02139
Tel: 617-452-2176; Email: chaiwoo@mit.edu

Samantha Brady
MIT AgeLab
77 Massachusetts Avenue E40-287, Cambridge, MA 02139
Tel: 617-452-2176; Email: sambrady@mit.edu

Craig Fitzgerald
New England Motor Press Association
43 Bonney Drive, Holliston, MA 01746
Tel: 802-342-3999; Email: vespafitz@gmail.com

Bruce Mehler
MIT AgeLab
77 Massachusetts Avenue E40-215a, Cambridge, MA 02139
Tel: 617-253-3534; Email: bmelhler@mit.edu

Bryan Reimer
MIT AgeLab
77 Massachusetts Avenue E40-209a, Cambridge, MA 02139
Tel: 617-617-452-2177; Email: reimer@mit.edu

Joseph F. Coughlin
MIT AgeLab
77 Massachusetts Avenue E40-279, Cambridge, MA 02139
Tel: 617-253-4978; Email: coughlin@mit.edu

Word count: 4563 words text + 8 tables/figures x 250 words (each) = 6,563 words

Date: November 15th, 2016

ABSTRACT

New vehicle technologies and transportation alternatives offer the potential of expanded mobility solutions for users of all generations. While many industries are focused on creating these options, only limited research has explored their use, adoption, and appeal as they apply to older generations. An online survey was fielded in order to gather information on satisfaction with current in-vehicle technology, inclination to use differing levels of automation, transportation alternatives to driving your own car, and methods of learning to use in-vehicle technology across users of all ages. The survey found that respondents reported generally being satisfied with technology in their vehicles, but are not learning to use the systems with their preferred methods of learning. A majority of respondents indicated a willingness to consider transportation alternatives, but far fewer had taken advantage of the alternatives in the past year. Older adult respondents, in particular, are not taking advantage of new mobility solutions at the levels that they might. Finally, while many older adults generally expressed a willingness to use some level of automation, they expressed less interested in full autonomy than younger drivers.

Keywords: Mobility, Transportation, Vehicle Automation, Technology, Driving Alternatives

INTRODUCTION

Automated vehicle systems (adaptive cruise control, automated emergency braking, Autopilot™, Pilot Assist™, etc.), fully autonomous (self-driving) vehicles, and alternative transportation services (ride sharing, car sharing, etc.) are now constantly in the news. A range of technology companies, automotive manufacturers and suppliers, startups, and academic organizations are leading various technological efforts to develop the systems necessary to make transportation more responsive, accessible, and ultimately safer for all consumers across generations. While considerable effort has been placed on assessing consumers' understanding of and preferences for these technologies, limited attention appears on these issues as they relate to drivers across the lifespan. It is expected that differences between younger drivers (on average more technologically oriented) and older drivers (on average more likely to benefit from increases in mobility options) would impact preferences for various technological innovations provided by automation. Tailoring technologies to these cohorts' acceptance of changes in transportation and the driving experience may advance the speed in which systems can be effectively deployed. Towards this end, this paper aims to dive deeper into age-related preferences for automated vehicle technologies, technology education, and mobility alternatives in order to provide better insight into the current market.

With technological advancements in external sensing, path planning, vehicle control and more, innovations in highly automated and autonomous vehicle development are increasingly finding their way into consumer vehicles in the form of active safety, driver assistance systems, and limited automated driving features. Forecasts from a few years to 30 or more captivate discussions around the timeframe for the availability of self-driving vehicles (*1*). One of the primary obstacles confronting the adoption of automated driving is the very definition of what constitutes "an automated system." For example, one can conceivably point to automated transmission as a core technology that automated a major component of vehicle operations by freeing the driver's hands to do other things (e.g. holding a phone, eating or drinking, etc.) and relieving the cognitive process from the demands of monitoring the need to shift gears. The National Highway Transportation Safety Administration (NHTSA) has proposed a set of operational definitions for vehicle automation (*2*), and the Society of Automotive Engineers (SAE) put forth an expanded set (*3*). While these definitions detail different levels of automation, they largely speak to an engineering audience charged with developing and regulating such systems.

The bulk of today's conversations on current production of automated vehicle technologies refer to lower level systems that support vehicle control (e.g. longitudinal and lateral moment-to-moment inputs), but not operational decisions. These technologies leave the strategic management of the operational task, and oversight of the automation, to the driver. Consumer adoption, understanding, and proper use of these lower-levels of automation will be crucial for the safe transition toward more highly automated vehicles (*4*). It is not clear that consumers fully understand the range of capabilities that systems currently being introduced into the fleet and under deployment provide, and how these systems may fit into their lifestyles, driving preferences, and overall willingness to use different levels of automated vehicle technology.

In addition, while alternatives to driving and car ownership are increasingly being introduced to consumers, whether such services are readily accessible given vast regional differences in availability, or considered and used by consumers as effective ways to replace driving and car ownership, is still a very open question. A number of efforts have surveyed consumer perceptions about vehicle safety systems, vehicle automation, and alternative transportation *(5 - 7*). These efforts, however, have only just begun to provide a basis for cohesively considering the potential interrelationships of factors as they impact older adults, who are one of the groups who might experience the greatest potential benefit from such systems.

A number of different types of vehicle automation can reduce accident severity and increase mobility, two core needs of an aging global population (*4*). However, it is not clear if consumers have a clear grasp of the complexity involved with various types of automation, and how the wide array of developments based upon these systems may be used to support their mobility needs. To effectively develop and deploy systems that enhance driver safety and mobility through greater degrees of automation, consumers' understanding, trust and desire for these systems will need to be developed to support the marketplace. For consumers to optimally leverage the advances of many technologies, adequate technology training may be required. Little is established about how consumers are currently acquiring this training for new vehicle technologies. Additionally, it is not yet fully understood how drivers across the lifespan acquire information about technological and service alternatives, view today's automotive technologies, see future automation systems supporting them, look to learn about these systems, and consider options for alternative transportation. To explore these topics, a survey instrument was developed to gain deeper insight into key questions including:

1. Are consumers satisfied with technology that is already in their vehicle?
2. How are consumers learning about in-vehicle technologies? How would they prefer to learn?
3. Are consumers willing to use various alternatives to driving? Do they currently use them?
4. Are consumers willing to use automation in vehicles?
5. Are older adults willing to use autonomous vehicles and / or alternatives to driving that may increase mobility?

Literature Review

Recent studies on vehicle safety systems and vehicle automation point out the importance of understanding consumer perceptions, attitudes and experiences regarding related systems. A number of studies on acceptance of autonomous vehicles identified factors that could influence and shape consumer perceptions and attitudes. In a study on defining the scope of acceptance of autonomous driving, Fraedrich and Lenz surveyed consumer comments posted online to describe object-related constructs (e.g. reliability, safety, flexibility, sustainability, liability, etc.) and subject- or affect-related constructs (e.g. trust, desirability, etc.) (*8*). Woisetschläger discussed effects of brands and branding strategies, and found significant effects of functional trust, perceived convenience, symbolic value and innovation affinity on acceptance (*9*). Rödel et al. reported on the effects of perceived usefulness, perceived ease of use, perceived behavioral control, trust and fun on acceptance of various levels of autonomy (*10*). Several studies also found driver characteristics and driving history, such as types of cars people currently drive and previous experiences with or exposure to in-vehicle technologies, as determinants of acceptance (*10 - 15*).

Studies have also discussed a number of different individual and socio-demographic traits that could influence acceptance. While age diversity has previously received limited consideration, age has recently gained considerable interest as a key characteristic that is associated with physical and cognitive functions, experience with new technology, and ability to learn, which can together contribute to possible age differences in how people interact with autonomous vehicles (*16*). Many cross-generational studies found that younger drivers are more likely to accept autonomous vehicles and related technologies, while older drivers feel less comfortable or interested in the idea (*11, 13, 15, 17*). However, a few studies observed limited or nonsignificant age effects (*12, 18*), and Rödel et al. reported age effects to differ between various levels of automation, suggesting age as a topic to be further investigated in depth (*10*).

Findings and discussions from existing efforts call for a comprehensive investigation on the relationships between age, relevant experiences, attitudes, and willingness to use or purchase to better understand consumer acceptance and preferences of autonomous vehicles and other mobility solutions. As Nordhoff et al. proposed in their conceptual model, multiple factors and components - socio-demographics, mobility characteristics, vehicle characteristics, trust, social influence, usefulness, efficiency and more –contribute to acceptance of autonomous vehicles, but the complex interrelationships describing preferences towards the driving alternatives are yet to be empirically validated (*19*).

METHODS

Participants

Participants were recruited using online advertisements and web posts to the BestRide, MIT AgeLab, and New England University Transportation Center websites. Recruitment was targeted broadly in order to attract respondents nationwide. In total, 3034 individuals completed the survey. Responses were excluded from analysis if the individual was under the legal driving age of 16, did not own a vehicle, or reported owning a vehicle with a production year earlier than 1980. Of the 3034 completed surveys, 80 were removed, leaving a convenience sample of 2954 responses for analysis.

The sample was 59% male and 40% female; the remaining 1% of individuals selected an "other or choose not to answer" option. The sample was slightly weighted toward older adults. Participants aged 65 or older constituted 32.1% of the sample, and participants aged 55 to 64 made up 19.5%. Younger generations made up smaller percentages (13.3% aged 45 to 54, 11.2% aged 35 to 44, 17.0% aged 25 to 34, and 6.8% aged 16 to 24). Half of participants owned a car with a production year later than 2010, and 93% of participants owned a car with a production year after 2000. Slightly less than half (44.7%) of respondents were from Massachusetts, indicating the sample was weighted toward residents of the east coast. The remainder of responses were widely distributed across the country (Figure 1).

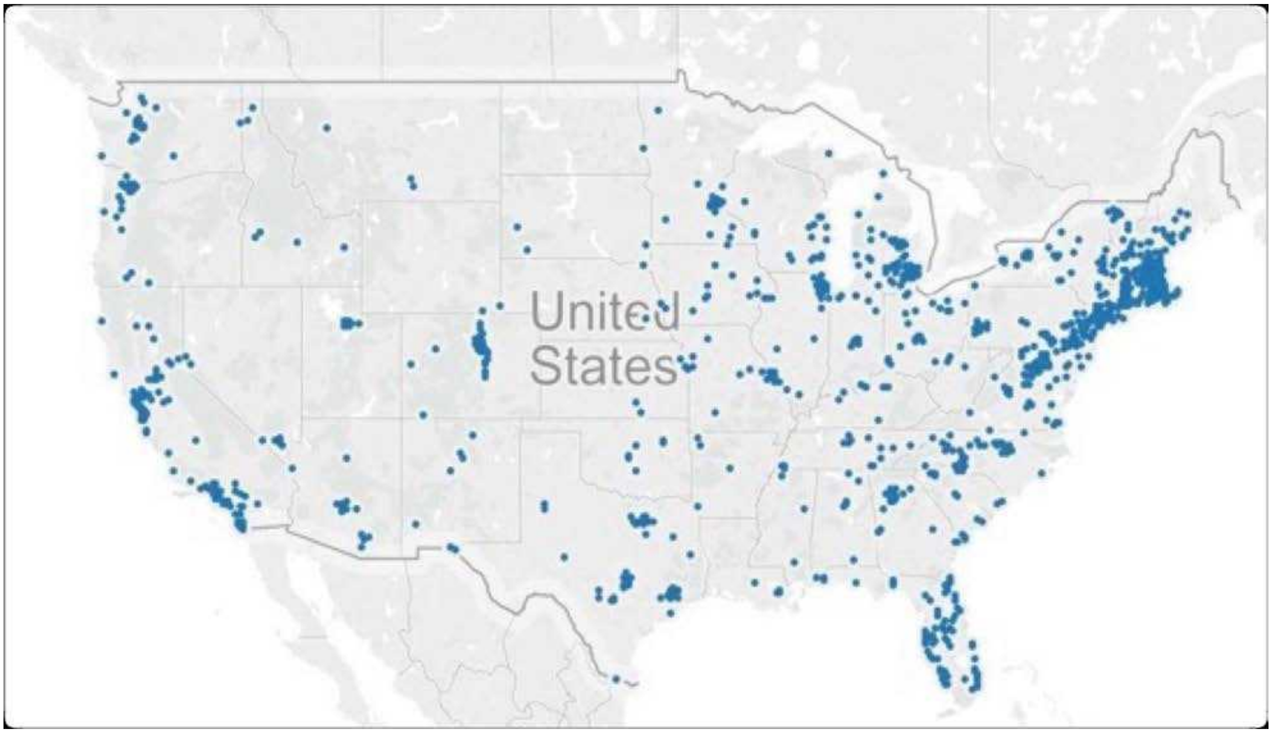

FIGURE 1 Location of Survey Respondents.

Survey Procedure and Instrument

Participants were told the survey would take less than 10 minutes and would involve answering questions related to their preferences and opinions regarding automated driving technologies. Participants were not offered compensation for responding, but were told their involvement would help researchers understand the impact of emerging safety technologies on driver performance, attention, distraction, and safety.

The survey consisted of 15 fixed-response forced-choice questions focusing on automation preferences, technology in the respondent's current vehicle, and alternatives to driving. Participants were first asked the year, make, and model of their vehicle; if they did not currently own a vehicle, they were unable to proceed to the remainder of the survey. The survey continued with 6 questions on varying levels of autonomy, 3 questions on perceptions of alternatives to driving, and 5 questions on the technology that exists in their current vehicle. Three additional questions were posed to collect the following demographic information: age, gender identity, and zip code. The full survey instrument is available upon request by emailing the authors. The survey was constructed in Qualtrics, allowing participants to take it online via computer or mobile device. The survey was open for data collection from April 25th – May 13th 2016.

RESULTS

Satisfaction

Participants were asked two questions about their feelings regarding the technology in their current vehicles. The first provided five options ranging from "very happy" to "no opinion" to "very unhappy". The second asked whether they were happy with how the technology was integrated into the design of their car on an 11-point scale. Most individuals reported being pleased with the technology already in their vehicle (Table 1). Over half reported positive associations with the technology: 28% of participants rated themselves as "very happy" with the technology, and an additional 42% liked "most of the features". Some individuals (15%) liked some of the technology in their vehicle but do not use most features. A smaller number of respondents were very unhappy with the technology, or had no opinion on it either way (6% and 8%, respectively). Mean response for satisfaction with technology integration in their current vehicles was 8.08 on the 11-point scale, suggesting that most individuals are fairly happy with the integration.

TABLE 1 Satisfaction with current in-vehicle technologies

Question	Response Options	Percent Responded
How do you feel about the technology in the car you drive today?	Very unhappy	6%
	Like some, but don't use most	15%
	No opinion	9%
	Like most of the features	42%
	Very happy	28%
Are you happy with how that technology is integrated with the design of your car today?	1 (Very Unhappy)	2%
	2	1%
	3	3%
	4	3%
	5	3%
	6	13%
	7	10%
	8	14%
	9	22%
	10	16%
	11 (Very Happy)	14%

Learning to Use Technology

Participants were also asked how they learned to use the technology in their vehicles and how they would prefer to learn to use the technology (Figure 2). The vehicle manual (63%) and trial-and-error (59%) were the two most commonly used methods of learning how to use the technologies. However, far fewer individuals (25%) selected trial-and-error as a preferred method of learning, expressing a greater preference for the ability to use websites, dealer interactions, other supplied manufacturer material, or having the car teach them. The differential between experienced dealer support and preference for more support is particularly noteworthy, as is the substantial endorsement of interest in direct instruction from the vehicle.

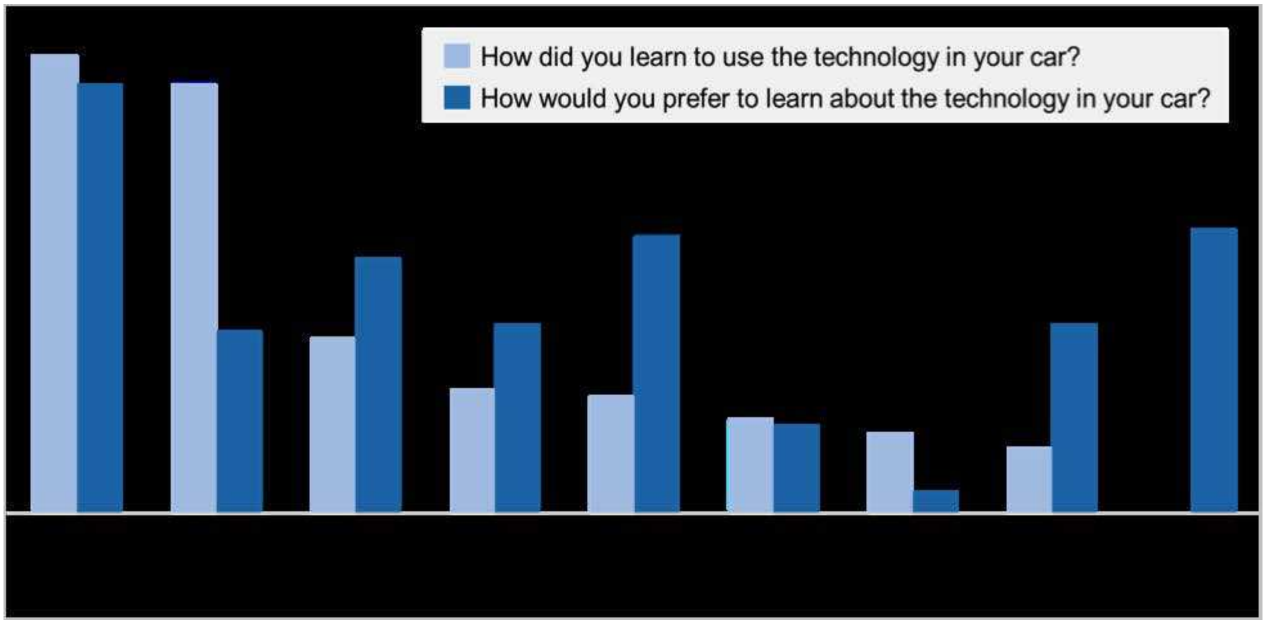

FIGURE 2 Current and preferred methods for learning to use in-vehicle technologies (the "car teaches me" option only presented for "how would you prefer to learn" question).

Based on a frequency analysis with chi-square goodness-of-fit tests, significant differences were apparent in the age breakdown of preferred learning methods (Table 2). Younger adults were more likely to prefer to use trial-and-error or have a friend or family member explain the technology, while older adults preferred using the manual or having the dealership explain the system. Both younger and middle-aged adults endorsed the option of having the car teach them how to use the technology, but older adults were less interested in the idea. Significant gender differences were also found. More men preferred to learn using websites or on-line videos, vehicle manuals and other manufacturer materials, and by trial and error or by luck compared to women. Women preferred to learn from family or friend, dealers, or have the car teach them compared to men.

TABLE 2 Age & gender differences in preferred methods for learning to use in-vehicle technologies

How would you prefer to learn about the technology in your car?	Age								Gender		
	16-24	25-34	35-44	45-54	55-64	65-74	75+	Sig.	Male	Female	Sig.
A friend or family member*	23.8%	12.9%	11.5%	8.4%	11.4%	13.5%	9.7%	*	7.7%	19.4%	*
Websites or on-line videos*	30.2%	42.4%	43.8%	42.8%	36.6%	36.3%	29.8%	*	40.7%	34.4%	*
Dealer while interacting with sales staff*	21.3%	22.1%	18.4%	25.7%	25.5%	32.6%	35.1%	*	23.1%	31.4%	*
Dealer during delivery*	18.8%	28.4%	27.2%	29.5%	39.5%	46.5%	39.9%	*	33.5%	37.9%	*
Vehicle manual*	53.5%	54.7%	54.7%	55.2%	60.1%	65.6%	67.5%	*	62.7%	54.2%	*
Other material provided by manufacturer	20.3%	23.7%	24.8%	26.2%	27.7%	28.5%	29.4%		28.7%	22.6%	*
Trial and error*	38.1%	39.4%	32.9%	23.9%	17.3%	15.6%	14.9%	*	28.1%	19.2%	*
By luck*	5.9%	5.4%	5.4%	2.3%	2.3%	1.9%	1.8%	*	3.9%	2.2%	*
The car teaches me	34.2%	42.9%	36.6%	39.2%	41.3%	37.6%	31.6%		36.6%	41.6%	*

*: Differences significant at $\alpha=0.05$

Alternatives to Driving

Perceptions and use of driving alternatives were asked in relation to those that would occasionally be used in lieu of driving, those that were permanent alternatives to car ownership, and those that had been used in the past year. While many participants considered the given choices as appropriate for occasional alternatives to driving, far fewer respondents had used any of the alternatives aside from subway or bus systems (Figure 3).

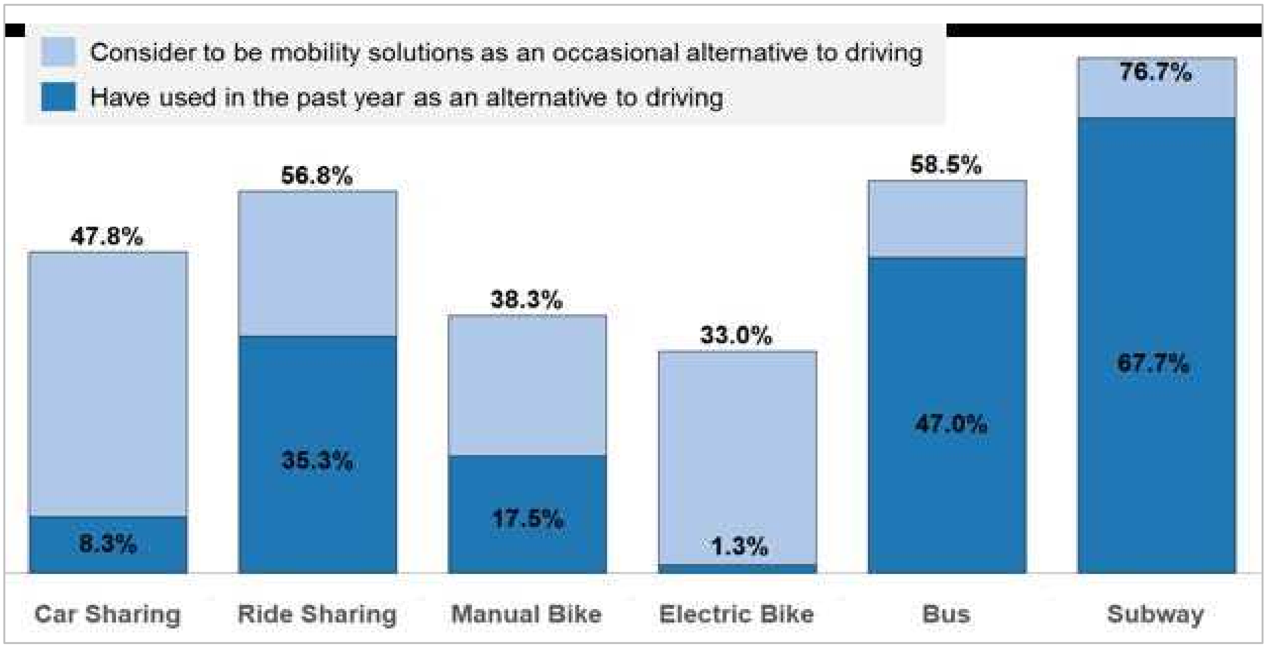

FIGURE 3 Alternatives to driving: considered vs. used.

Older adults (75+) in the sample were far less likely to use most alternatives to driving than younger and middle-aged adults (Table 3). Older adults were most likely to select "none of the above" as having been used in the past year (29.4%). While older adults reported having used public transportations systems in the past year, only a few reported having used newer mobility solutions such as car sharing (3.9%) or ride sharing (16.2%). Though middle-aged and younger adults were more likely to report considering car sharing or ridesharing as occasional alternatives to driving, many older adults (75 years of age or older) also reported considering these two methods; 39.9% considered car sharing and 48.7% considered ridesharing as occasional alternatives to driving. Older adults were equally likely as younger adults to consider the public bus an occasional alternative to driving. While older adults were less likely to consider the subway or train as an occasional alternative to driving, overall consideration of this method was still high (68.4%). Gender differences were also observed. Men were more likely to have used and to consider using manual or electric bicycles offered from a parking hub, while women were more likely to have used and to consider using car sharing, ridesharing, and various means of public transportation. Statistical significance of these differences were found with a chi-square goodness-of-fit test as shown in Table 3.

TABLE 3 Age & gender differences in use & considerations of alternatives to driving

		Age								Gender		
		16-24	25-34	35-44	45-54	55-64	65-74	75+	Sig.	Male	Female	Sig.
Which of the following have you used in the past year as an alternative to driving?	Car Sharing (Zipcar, etc.)	12.9%	13.1%	11.2%	9.7%	6.8%	4.3%	3.9%	*	7.8%	8.8%	
	Ridesharing (Uber, Lyft, etc.)	53.0%	56.3%	41.7%	34.6%	31.2%	22.4%	16.2%	*	34.4%	37.0%	
	Manual bike from parking hub close to the city	30.2%	30.4%	23.6%	17.8%	13.7%	9.3%	3.5%	*	21.1%	11.8%	*
	Electric bike from parking hub close to the city	2.0%	2.6%	2.4%	1.3%	0.7%	0.4%	0.0%	*	1.4%	0.9%	*
	Public bus	60.4%	56.1%	47.1%	42.2%	44.0%	44.6%	37.7%	*	44.0%	51.9%	*
	Subway or train	66.3%	72.0%	64.4%	69.2%	67.6%	69.4%	57.0%	*	62.7%	75.3%	*
	None of the above	12.4%	12.3%	14.5%	19.6%	20.5%	20.6%	29.4%	*	21.0%	14.9%	*
Which of the following would you consider to be mobility solutions as an occasional alternative to driving?	Car Sharing (Zipcar, etc.)	39.6%	44.9%	45.0%	48.6%	55.1%	49.4%	39.9%	*	43.9%	54.1%	*
	Ridesharing (Uber, Lyft, etc.)	69.3%	65.0%	58.0%	56.2%	56.0%	50.6%	48.7%	*	54.2%	61.2%	*
	Manual bike from a parking hub close to the city	54.5%	51.1%	48.6%	42.7%	41.1%	23.8%	11.8%	*	41.1%	34.1%	*
	Electric bike from a parking hub close to the city	34.2%	40.4%	39.9%	37.4%	37.3%	24.4%	14.0%	*	35.2%	29.6%	*
	Public bus	58.4%	62.8%	56.5%	57.3%	56.5%	58.2%	59.6%		54.1%	65.0%	*
	Subway or train	72.8%	79.3%	76.7%	77.1%	79.5%	76.1%	68.4%	*	73.5%	81.5%	*
	None of the above	5.9%	5.0%	6.9%	6.1%	5.4%	6.9%	9.2%		7.3%	4.9%	*

*: Differences significant at α=0.05

Willingness to Use Automation

Consumers' willingness to use automation in vehicles was assessed with two questions corresponding with different dimensions of automation. Younger adults were generally more comfortable with the idea of cars driving themselves compared to older adults (Table 4). For instance, among participants aged 25 to 34, 40% said the maximum level of automation they would be comfortable with is full autonomy, and 61.0% of them said that they would be comfortable using automotive features that take control of driving. The proportion of participants who indicated that they would be comfortable with full autonomy and automation features that take control of driving were significantly lower for older segments.

TABLE 4 Willingness to use automation in vehicles: age & gender differences

		Age								Gender		
		16-24	25-34	35-44	45-54	55-64	65-74	75+	Sig.	Male	Female	Sig.
What is the maximum level of automation you would be comfortable with?	No automation	12.4%	8.0%	9.7%	6.1%	5.0%	3.8%	3.1%	*	8.0%	3.7%	*
	Emergency only	18.3%	11.3%	15.7%	16.0%	14.7%	12.2%	16.7%		13.3%	15.1%	*
	Help driver	26.7%	25.4%	21.1%	41.2%	44.4%	56.0%	52.2%	*	32.0%	53.0%	*
	Partial autonomy	16.3%	15.3%	19.0%	13.2%	17.0%	13.9%	15.4%		16.8%	13.9%	
	Full autonomy	26.2%	40.0%	34.4%	23.4%	18.9%	14.2%	12.7%	*	30.0%	14.3%	*
Which of the following automotive features would you be comfortable using? (Features that…)**	…reduce potential / severity of collision	72.8%	78.9%	79.5%	82.4%	85.4%	90.3%	89.0%	*	80.1%	89.4%	*
	…help with speed control	56.4%	69.2%	66.5%	60.1%	64.8%	62.8%	61.8%	*	66.7%	59.4%	*
	…help with steering	48.0%	58.3%	56.8%	57.0%	61.0%	62.9%	60.1%	*	58.5%	60.1%	
	…periodically take control of driving	55.0%	61.0%	55.9%	44.8%	47.3%	38.1%	38.6%	*	53.3%	40.2%	*

*: Differences significant at α=0.05
**Response options were taken from SAE definitions for levels of automation

Older adults, on the other hand, were comfortable with some of the automation features presented in the questions, but were more likely to draw the line at some point. Adults 45 and older were comfortable with active assistance technologies that help the driver while the driver remains in control, but less comfortable with partial or full autonomy. Older adults were more comfortable than younger segments with collision avoidance/mitigation features and slightly more comfortable with features that help with steering, but far less comfortable with giving-up control of driving compared to younger participants. A comparison of responses from male and female participants showed that men were more likely to be comfortable with higher levels of automation in general, and with features that help with speed control and that take control of driving compared to women. Female participants, however, indicated that they are more comfortable with features that reduce the potential and/or severity of collision than men. Table 4 shows a summary of these findings from a frequency analysis with z-tests for column proportions (for maximum level of automation) and chi-square goodness-of-fit tests (for features that people are comfortable using) for statistical comparison.

A path analysis was done to describe relationships between variables in a more holistic way. Multiple regression was used to describe associations between variables that represent age, current experiences, attitudes toward related organizations, and willingness to use and pay (Figure 4). In Figure 4, numbers attached to arrows are standardized coefficients describing the degree and direction of association between variables.

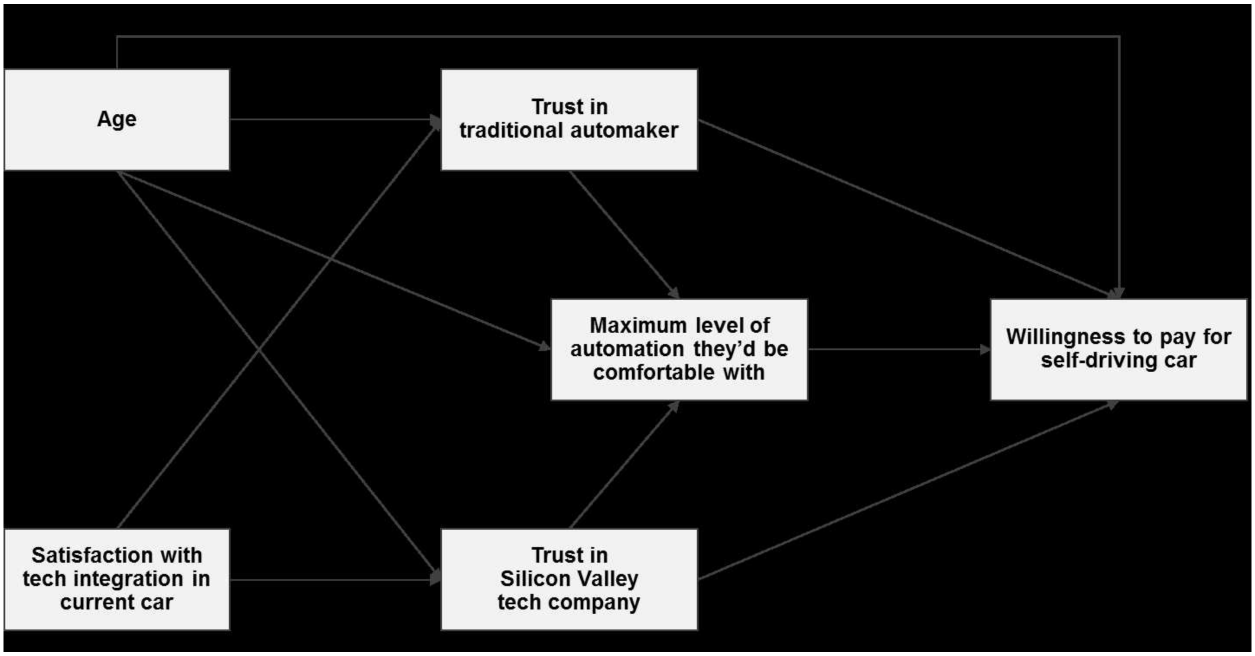

FIGURE 4 Path analysis: age, current experiences, trust and willingness to use (: Correlations significant at α=0.01).**

The path analysis showed that younger adults in the sample reported a willingness to pay more for a self-driving car, are more comfortable with higher levels of automation, and have higher trust in the different entities that are working to build a self-driving car (i.e. traditional automakers and Silicon Valley technology companies) compared to older adults. Also, consumers who are more satisfied with the technology in their current car indicated higher trust toward entities working to build a self-driving car compared to those who are less happy with what they currently have in their car. Furthermore, higher trust in the different entities to build a self-driving car and more comfort with higher levels of automation were associated with willingness to pay more for a self-driving car, indicating a significant association between attitudes toward autonomous vehicles and behavioral intentions to use them.

CONCLUSIONS

Transportation continues to be a challenge for adults as they age and become less able to drive safely (*20*). There are a number of existing and emerging transportation alternatives to supplement or replace driving. While most older respondents would consider using any of the proposed alternatives, few are actively taking advantage of newer programs such as car or ride sharing. It is important to note that car ownership was a requirement for participation in the survey; use of car or ride sharing services may be more popular amongst older adults who do not own a car. However, high reported interest in these alternatives amongst current vehicle owners combined with their low reported use may also reflect the spotty availability of these services in suburban and rural areas where a higher concentration of older adults live *(21),* as well as the still nascent comfort with using on-demand alternatives. Additionally, car or ride sharing are somewhat dependent on the use of technology to access the service. For example, Zipcar, a popular car-sharing service, necessitates visiting their website or using their app to find an available vehicle and reserve it for a set period of time. It is unclear if the dependence on technology for specific services in each transportation category impacts the likelihood of use in older adult populations.

Fully autonomous vehicles have enormous potential to enhance mobility. However, the trust to adopt these technologies is not yet here for many potential users and may need to be built-up over time. It is important to consider that the time frame involved in building trust in autonomous vehicles may vary considerably across individuals. Driver expectations for vehicle control are governed by a lifetime of learning that will likely differ in some ways from the control strategies governed by computational algorithm. As our experiences with these technologies increase over the coming years, it is critical that we begin to better understand drivers' willingness to tolerate divergence from expectations, comfort in the loss of control, and a range of other critical elements associated with automated vehicles to support an optimal transition to enhanced safe mobility. What is clear, however, is that trust can be quickly eroded by negative experiences, societal events, etc. These data were gathered in the weeks before the first fatal automation accident (*22*) was reported; as such it is unclear what if any impact this highly publicized tragedy may have on the generalizability of these results. Further, the range of experiences with automated driving technologies are rapidly becoming a topic of daily international news, making longitudinal studies of this nature an area of need.

The survey results suggest that while individuals are generally comfortable with technology integrated into their current vehicles, there may be some hesitation around one's comfort with full automation among the older adult population who could benefit from it the most. The encouraging finding, however, is that greater than 50% of the older adult market responding to the survey appears comfortable with the concept of technological innovations that help the driver; the reduction of interest in automation appears when the driver needs to relinquish control (i.e. in semi- or fully-autonomous driving). Since older drivers have a lifetime of driving experience behind them, they may find it discomforting to relinquish control to a system they believe to be inferior to their driving experience or that they do not fully understand. Training and perceived ease-of-use of a technology directly correlate with eventual adoption of the technology. Improved training methods that more closely align with preferred learning strategies may help by allowing drivers of all ages to become more comfortable with progressing levels of automation, eventually leading to adoption of fully autonomous vehicles. Improved training methods may also reduce the chance of receiving inaccurate information on system capabilities. Trial and error has been shown to lead to gaps in functional understanding of vehicle technology (*23),* and many drivers of vehicles with semi-automated safety systems show only partial or inaccurate understanding of the operating characteristics of these technologies (*24*). Improved educational opportunities provided by those who are ideally knowledgeable about vehicle safety systems, e.g. dealership staff or online tools, may reduce the high number of individuals who report using trial and error to learn the technology in their cars, in turn improving owner understanding and operation of vehicle technology.

While this work is inherently limited by the convenience sample of car owners, future efforts may consider drawing on a nationally representative or an international sample without a bias to car owners to examine how attitudes may differ by region, cultural background, car ownership status, or the availability of transportation alternatives in suburban and rural areas. In addition, future exploration may assess possible differences in attitudes related to education, income and gender.

ACKNOWLEDGMENT

Support for this work was provided by the US DOT's Region I New England University Transportation Center at MIT and the Toyota Class Action Settlement Safety Research and Education Program. The views and conclusions being expressed are those of the authors, and have not been sponsored, approved, or endorsed by Toyota or plaintiffs' class counsel.

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