

Older Adults’ Attitudes and Opinions about Automated Vehicles: A Literature Review

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Abstract

The maintenance of mobility and independence among older adults are frequently cited benefits of developing automated driving technologies. This paper reviews the empirical literature on older adults' attitudes and opinions regarding partial to fully automated vehicles. The findings of 10 studies are reviewed. Overall, the attitudes and opinions of today's older adults reflect a cautious approach to vehicle automation. The majority of studies find that older adults report that they are reluctant to travel in a fully-automated vehicle, have little interest in owning or leasing a vehicle that is highly automated, and have neutral to negative opinions about this technology. Older adults are concerned about how well the technology works and with having to give up all control of the vehicle. Older adults also have very little direct experience with automated vehicle technology and opinions are undoubtedly influenced by this lack of experience. Further research is needed to better understand what older adults think about partial and highly automated driving technology, based on actual real world experience.

Introduction

One of the most interesting technological advances in automotive technology has been the continuing development of automated or self-driving vehicles. The potential of automated vehicles as a way for maintaining independence among older adults is often mentioned in the media. For example, in a 2015 article in the *New York Times*, Chris Urmson, then director of self-driving cars at Google, stated that older adults and blind people were the two groups who would receive the greatest benefits from automated vehicles (Kessler, 2015). Other

recent articles have had headlines suggesting similar impacts for older adults including: "Senior citizens will lead the self-driving revolution" (Hawkins, 2018); "Driverless cars promise far greater mobility for the elderly and people with disabilities" (Halsey, 2017); "Self-driving cars will transform the lives of the elderly: Transport secretary says new vehicles will allow old people to retain their freedom" (Salmon, 2017); "Autonomous vehicles will improve transportation options for older Americans and people with disabilities" (St. Amant, 2017); and "Self-driving cars: Transforming mobility for the elderly and people with disabilities" (Polonetsky & Claypool, 2017).

Given the media attention devoted to the topic of how automated vehicles will benefit older adults, it is not surprising that a recent survey of adults in the United States (US) found that 62% of respondents who said they would not ride in an automated vehicle and 91% of respondents who said they would, reported that automated vehicles would help the elderly and disabled be more independent (Pew Research Center, 2017). The purpose of this paper is to review the empirical literature on what older adults themselves think about automated vehicles.

Levels of Automation

It is easy to imagine a future where automated vehicles will play an important role in alleviating many of society's problems, and promoting independent mobility for older adults. Indeed, once a vehicle is developed that can give rides to people at any time or in any weather condition without needing input from a driver (i.e., fully automated), older adults will benefit greatly. Vehicles with full automation, however, are not yet available.

Many currently available in-vehicle technologies are designed to take over partial operation of a vehicle such as some forward collision mitigation, adaptive cruise control, and active lane keeping systems (see Eby et al., 2015, 2018). Some vehicles have technologies with a higher level of automation that will take over full operation of the vehicle under certain circumstances, such as the Tesla Autopilot, but these technologies still require the driver to maintain awareness and take back control of the vehicle periodically. It is important to make a distinction between the various levels of automation. The National Highway Traffic Safety Administration (NHTSA, 2018) and the Society of Automotive Engineers, International (SAE, 2016) have provided descriptions for 6 levels of vehicle automation as shown in Table 1.

Level	Name	Description
0	No automation	The driver controls all vehicle functions.
1	Driver assistance	The driver controls all vehicle functions, but is given some assistance from an in-vehicle technology. The vehicle can control only one vehicle function, such as steering or braking, but not both.
2	Partial automation	The driver still needs to be engaged in the driving task at all times, but the vehicle can control more than one function of the vehicle under certain circumstances.
3	Conditional automation	The vehicle can perform all driving functions under certain circumstances, but the driver needs to be able

		to quickly take back control of the vehicle when circumstances change
4	High automation	The vehicle can perform all driving functions under certain circumstances and there is no need for the driver to monitor anything under these circumstances. Can also be a driverless shuttle that operates under limited circumstances.
5	Full automation	The vehicle is self-driving in all circumstances. There is no need for a driver and all occupants in the vehicle are passengers.

Vehicles equipped with automation technology at levels 1-3 require that the driver maintain attention to the driving task, and be engaged enough that they can take back control of whatever vehicle operation(s) were under the control of the technology if need be. With level 4 automation, a driver may or may not be needed depending on the circumstances under which the technology is designed to drive in the fully automated mode. For example, an automated shuttle used on a fixed route at a University may not need a driver. Under level 5 automation, a driver is never needed and most of the societal benefits discussed in recent news headlines will be realized. There are no level 4 or 5 technologies for vehicles currently available to the public and once these technologies are available, researchers predict that it will likely take decades for these technologies to significantly infiltrate the vehicle fleet (see e.g., Bansal & Kockelman, 2017). This

review focuses on studies that include older adults who report on their attitudes and opinions toward level 3-5 vehicles when they are in automated driving mode. We do not review opinions of other in-vehicle technologies that may comprise components of an automated driving system, such as forward collision mitigation systems. The interested reader is referred to a recent synthesis of the literature on this topic (Eby et al., 2015).

Methods

The search for literature consisted of three steps. First, we defined a set of search terms that included the various names for automated vehicles (e.g., self driving cars, automated vehicles, level 3-5 automation) and older adults (e.g., senior, elderly, mature). Second, articles were searched in TRID, PsycINFO, Google Scholar, and ScienceDirect. From these databases, relevant journal articles, technical reports, and conference papers were gathered. An Internet search was also conducted to find news articles and web pages pertaining to this review's topic. Finally, manual searches of the reference lists of relevant articles were conducted to collect additional articles that appeared to be appropriate.

The articles from the search were reviewed by the research team. To be eligible for further review, articles needed to: 1) provide findings specifically for older adults, 2) focus on opinions, attitudes, and thoughts; and 3) focus on automated vehicle technology at level 3 or higher. Appropriate articles are included in the review.

Results

Researchers in France presented survey data from 524 people (which included older adults) in La Rochelle (Piao et al., 2016). The study found that older

adults reported less interest in using and owning automated vehicles than respondents age 18-34. Fifty-six percent of older adults reported that they would consider using an automated vehicle as compared to 62% for people age 35-64, and 43% of older adults reported that they would like to own an automated vehicle as compared to 52% of respondents age 18-34. Similar results were found in a national US survey of 4135 adults (Pew Research Center, 2017), with 35% of respondent age 50 or older reporting that they were interested in riding in a fully automated vehicle as compared to 51% of respondents age 18-49.

Schoettle and Sivak (2015) surveyed 505 drivers using an on-line survey tool. About 27% of respondents were age 60 or older. They asked respondents about their preferred level of automation among three levels of automation corresponding roughly to level 0 (no automation), levels 3 (partial automation), and level 5 (full automation). About 50% of older drivers-chose no automation, 39% chose partial, and 11% chose full automation. Results also indicated that 77% of older drivers reported that they were moderately or very concerned about riding in fully automated vehicles and there was less concern for partially automated vehicles (54% were moderately or very concerned). Nearly all older drivers wanted automated vehicles to have controls that would allow them to take over control of the vehicle if they so desired.

Another Internet-based survey in the US assessed perceptions of automated vehicle technology in a sample of 114 respondents with 46% age 60 and older (Brugeman, Dennis, & Spulber, 2016). Older adults were the most likely age group to report that they were not at all interested in owning or leasing an automated vehicle with 23% of older adult respondents

reporting this as compared to 23%, 15%, 7%, and 1% for the younger age groups.

A study involving structured interviews of 12 older drivers in Germany found that 75% of participants were not willing to ride in a fully automated vehicle because of concerns about technical failure (Diepold et al., 2017).

A study of 2954 drivers in the US (52% were age 55 or older) that investigated preferences toward automated vehicles found somewhat different results (Abraham et al., 2016). Respondents were asked about the maximum level of automation that they were comfortable with. Among drivers age 65-74, 4% reported "no automation," 12% "only in emergency," 56% only to "help driver," 14% "partial automation," and 14% "full autonomy". Results were similar for respondents age 75 or older.

A study of 1000 drivers in the UK (age range 18-85) explored opinions of automated vehicles using an on-line survey (Hulse, Xie, & Galea, 2018). The study reported that attitudes toward automated vehicles were generally positive but less so with increasing age. About one-quarter of respondents reported that they needed to learn more about the safety aspects of automated vehicles.

Researchers asked 556 respondents in Austin, Texas (18% of whom were age 66 or older) about their intent to use fully automated vehicles. Their results indicated that older adults were about equally likely to report that they would use self-driving cars as other age groups (Zmud, Sener, & Wagner, 2016). One-half of older adults reported that they were extremely or somewhat likely to use automated vehicles, as compared to 50%, 52%, and 46% for the three other younger age groups.

A study in Germany (Hartwich, Beggiato, & Krems, 2018), used a driving simulator to investigate differences in

comfort, enjoyment, and acceptance between a younger (25-35 years) and older group (65-85 years) of drivers. The study used two "driving styles" for the automated vehicle: familiar (speed profiles were within the boundaries for a specific participant based on his or her manual driving patterns in the simulator) and unfamiliar (a style that was outside the speed profile bounds from manual driving). After driving/riding in the simulator under these various conditions, respondents completed a series of questionnaires. The study found that as compared to manual driving: full automation increased driving comfort for both age groups but decreased enjoyment for younger drivers; and younger drivers were more likely to prefer their familiar driving style while older drivers preferred the unfamiliar style.

Finally, researchers in Michigan conducted structured interviews with 72 respondents divided equally into three age-groups: 16-19, 25-45, and 65-75 (Molnar et al., 2017). Interviews were conducted after respondents participated in several simulated drives in a high-fidelity simulator that included several situations in which the automated driving (level 3) gave back vehicle control to the respondent. With regard to the older adult respondents: they held generally neutral views of automated vehicles prior to the study; older adults reported greater challenges in resuming operation of the vehicle; and most reported that they trusted the automated driving but this was possibly related to the driving being simulated rather than in a real automated vehicle.

Conclusions

Despite the general impression expressed not only in the media but also in far reaching surveys that automated vehicle technology will help older adults maintain mobility and independence, the attitudes

and opinions of today's older adults toward vehicle automation were more cautious. In the majority of studies reviewed for this paper, older adults report that they were reluctant to travel in a fully-automated vehicle, had little interest in owning or leasing a vehicle that is highly automated, and had neutral to negative opinions about this technology. In those studies that explored the reasons behind these general impressions, results suggested that older adults were concerned about how well the technology worked and with having to give up all control of the vehicle.

In general, older adults were not that familiar with the technology. This is not surprising, given the relatively recent development of partial and highly automated driving. Most of the older adults in these studies have never experienced using these technologies in the real world and instead have to rely on verbal descriptions and their own imagination for forming their opinions. As described by Molnar et al. (2017), basing opinions of automated vehicles on the use of driving simulators to "simulate" automated driving is confounded by the study participants' knowledge that the traffic is not real and opinions are often based more on the driving simulator itself.

Further research is needed to better understand what older adults think about partial and highly automated driving technology, based on their using it in the real world. Research into fully automated driving and older adults, however, should begin to have a different focus. Under the assumption that level 5 automation operates as designed, the use of this technology for helping older adults stay mobile and independent may still be hampered by the following issues:

- Difficulty entering and exiting the vehicle, particularly when mobility devices are being used;
- Difficulty moving from home to the vehicle and the vehicle to a destination, particularly when the person has significant functional decline;
- Comfort and safety of the vehicle seating;
- Handling of emergency situations; and
- Communication between the vehicle and occupant, particularly when the older adult has cognitive or auditory declines.

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