

# Am I Too Old to Drive?: Opinions of Older Adults on Self-Driving Vehicles

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## ABSTRACT

Fully autonomous or “self-driving” vehicles are an emerging technology that may hold significant mobility potential for both disabled persons and for older adults unable to operate a conventional motor vehicle. It can be argued, however, that the needs, preferences and concerns of older adults and disabled persons regarding this technology have been insufficiently explored. Using focus group methodology, this study explores the sentiments of 39 older adults (55+) regarding self-driving vehicle technology. Discussions from the focus groups revealed that although participants believed that self-driving vehicles can enhance their mobility and independence, they were concerned about their reliability and safety. Participants expressed additional concerns regarding their ability to purchase such a vehicle and the training required to operate it. Opinions were mixed regarding the consideration of older adults in the design of the technology.

## Author Keywords

older adults; autonomous vehicles; self-driving vehicles

## CCS Concepts

•**Social and professional topics** → **People with disabilities; Seniors; •Applied computing** → **Transportation; Consumer products;**

## INTRODUCTION

Older adults, persons aged 55 and older, often face increasing obstacles to personal mobility as they age. Age related declines in cognitive and/or visual capacities or physical impediments from a stroke, fall or other health crisis may make the safe operation of a conventional motor vehicle

difficult or impractical. The deleterious effects of this driving cessation on older adults’ physical, mental, cognitive and social functioning have been broadly studied [2, 3, 15]. Emerging autonomous vehicle technologies have been described as potentially emiloreating this issue for many seniors given that the most advanced of these technologies are projected to operate without a human driver and with minimal direct human control. By removing the need for direct management of safety critical steering, acceleration and braking, older adults and persons with a range of disabilities may potentially travel safely, independently and conveniently. Despite the promise of this technology, however, there are significant knowledge gaps as it relates to the experiential needs, user preferences and concerns of seniors relative to self-driving vehicles. How, for instance, should a self-driving vehicle accomodate a senior with speech difficulty, a motor disability or hearing loss, for instance? What are the preferences of seniors regarding vehicle interaction and operation and do these preferences differ from those of younger adults? These and other knowledge gaps are problematic given that good design is often driven by user research and an understanding of user needs. This knowledge gap may therefore serve as an impediment to the accessibility of this emerging technology for seniors and de facto barrier to consumer adoption.

While issues with mobility exist for other populations, persons with disabilities for instance, mobility for seniors will grow increasingly important given the size, overall wealth and increasing life expectancy of the senior population. According to the US Census Bureau, there were approximately 35 million people in the U.S. age 65 and older in 2003 [14]. This number increased by nearly 27% from 2003 to 2013 to approximately 43 million people [14]. It is projected that by 2030 there will be roughly 74 million seniors living in the United States; representing more than a quarter of the total U.S. population [13, 34]. Failure to adequately consider the needs and concerns of this group could prove disastrous for consumer adoption of self-driving vehicles given the financial wherewithal of many older adults [19, 37].

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Despite the scientific and market research need, there have been few studies that have directly addressed the needs, preference and concerns of seniors regarding self-driving vehicles. The present study was designed to contribute to the literature an exploration of the opinions and concerns of older adults regarding self-driving vehicle technology through the focus on a sub group that has received even less attention in this context; African Americans. Using participatory design and focus group methodology, 39 people aged 55 or older participated in seven focus group sessions over a five-day period. Within each one-hour session, participants were asked to provide their general opinions regarding self-driving vehicles, comment on their hopes for the technology, reflect on their concerns, and express their preferences regarding interaction mechanisms among other topics. We believe that this work furthers our goal of contributing to the literature research that furthers the understanding of the needs and preferences of users with a range of needs as it relates to emerging self-driving vehicle technology. Research of this type will become increasingly critical if universal access to this technology is to be realized and broad consumer adoption is to be supported.

### RELATED WORK

The rise in adaptive/advanced driver assistance systems (ADAS) and, coincidentally, autonomous vehicles (AVs) has created new opportunities for expanding the transportation and mobility of senior citizens. With advances in vehicle safety and improvement in overall health, there are more older drivers on the road. According to a report from the Insurance Institute of Highway Safety, comparing drivers from 1995-98 to 2005-08, older adults between the ages of 75-79 have driven 60% more miles than drivers ages 35-54 and 51% more for drivers 81 years and older [24]. By 2030, it is estimated that 1 in 5 Americans will be 65 years and older [18]. Such a continued growth in this population, especially with those who are licensed and on the road, does bring consideration to future risk of crashes. The physical and cognitive abilities which are essential when operating a vehicle have been shown to degrade with age [30]. Even with advances in ADAS, when a critical situation calls for human takeover of control, this decrease in physical or cognitive abilities has the potential to place other drivers, pedestrians and the senior driver themselves in harms ways.

Autonomous or self-driving vehicles can serve as the “middle ground” to aid in reducing such risk to the driver and others by allowing older adults to maintain their independence and mobility while removing the need for direct human control. However, while the promise of automated transportation is an appealing and convenient prospect, there is the challenge of wide acceptance of such technology and the change it brings. There are concerns about the concept of a vehicle driving itself and transporting people to their destination. Choi and Ji adopted the Technology Acceptance Model to examine people’s perception of the use of autonomous vehicles and investigate the factors that drive people to accept them [15]. Results from the study revealed that perceived usefulness and trust had the most significant effect on behavioral intention and would best motivate adoption of autonomous vehicle

use. Additionally, it was revealed that trust has a negative effect on perceived risk. For older adults, trust is an even greater factor in determining their acceptance of ADAS and autonomous vehicles given their lack of prior knowledge of the technology [36]. In addition to trust, other studies have revealed that usefulness, behavioral intention, reliability and legality are also significant influencers on acceptance of autonomous vehicles [26,31].

The opinions of consumers generally regarding self-driving vehicle technology have been broadly explored. Studies by Brugemen et al. and Piao et al. have shown that older adults were less accepting of owning or riding in an autonomous vehicle than their younger counterparts (ages 18-49) [12,33]. In terms of levels of automation, older adults prefer little to no automation in their vehicles in comparison to younger adults [1,35]. This could be attributed to older adults’ familiarity and comfort with the way they have driven and greater resistance to change in the latter stages of their lives. However, some studies suggest that older adults are as willing to own or try an autonomous vehicle as younger adults [22,40].

In most cases, opinions from participants were gathered through online surveys with structured questions. In the case of Molnar et al. [29], interviews were used to obtain participants’ attitudes of automated vehicles. Few studies looked to obtain a more in-depth understanding of the participant’s background, prior knowledge of automated vehicles, or beliefs regarding who would be able to buy such a vehicle. The study conducted by Molnar et al. [29] focused on participants who were subjected to level 3 automated vehicles, not level 5, on which this study will focus. Level 3 automation allows for conditional automated driving by the vehicle except in conditions where the driver is requested to take control. Level 5 automation is unconditional automated driving with little human input. In the present study, we use focus groups to obtain more in-depth information about the perspectives and attitudes of older adults regarding self-driving vehicles as well as to investigate possible stereotypes and perceptions about the kinds of persons who would own such a vehicle. The latter data may shed additional light as to why older adults may be less willing to own one.

In addition, we look to obtain opinions from the African American population. The rise in automated vehicles, can prove to be especially beneficial to minority older adults given their relatively high rates of driving cessation. Studies have shown that racial/ethnic minorities in the United States cease driving at higher rates than their White counterparts as they age [16,17,28]. Self-driving vehicles may provide an alternative transportation option for those who may be physically or cognitively unable to operate a motor vehicle but still desire to have some measure of personal mobility. Minority groups like African Americans may therefore disproportionately benefit from advances in vehicle automation, though the opinions and preferences of older African American adults have been insufficiently explored.

## METHOD

Each one-hour session of the study was split between a brief participatory design session and a post-session focus group. Participatory design was chosen to help support an in-depth understanding of participants' expectations of self-driving vehicles. Participatory design was combined with the use of focus group methodology because it provided the research team with an opportunity to elicit subjective perspectives regarding the research topics. This approach also allowed for a significant amount of flexibility to pursue themes that emerged during the course of discussion.

### Participant Recruitment

Interested individuals were invited to participate if they were aged 55 or older. Advertisements indicated that interested individuals should also have transportation to one of two locations in central South Carolina. Participants were recruited by email and flyers at centers serving older adults. Those interested in participating were asked to call or email for additional information and scheduling. The Institutional Review Board of the authors' university approved this study and each participant provided informed consent the day of his or her session. Participants were compensated with a \$10 prepaid gift card for their participation.

### Description of Participants

Seven sessions were conducted over a five-day period in two separate locations in South Carolina. In total, 39 participants were involved in the study in groups of between 4 and 6 people. Study participants had a mean age of 74 years old (range = 57 to 91 years old) and a household annual income that ranged from under \$11,500 to \$35,000. All study participants were African American. Krueger and Casey have argued that focus group participants should share similar characteristics (e.g. gender group, age-range, social class background) in order to encourage open dialogue within the group but with enough variation to allow for contrasting opinions [25]. An attempt was made to group participants near their preferred location in accordance with this principle with a primary factor of similarity being a participant's age. No other factors were considered for the purpose of constructing the focus groups (e.g. race, gender, education). As a result of this approach, when feasible, participants were placed in a group with other individuals +/- 10 years of the mean age. Where placement in such a group was not possible, typically due to logistical or scheduling constraints, an attempt was made to place the participant in a group with at least one individual of similar age.

### Procedure

Each session lasted approximately one hour with a procedure that was identical for each session. After each participant was seated in the meeting space, the informed consent document was read aloud by the study moderator. After being provided light refreshments, a brief ice breaking exercise was led by the session facilitator / moderator to introduce participants to one another and encourage interaction between participants.

Identical mediating tools were used in each session. Each participant was presented with an identical ideation 'kit' and participants were asked to select from this kit: 1) one image that best reflected the type of person who they felt would be more likely to use a self-driving vehicle, 2) one image that best reflected what this vehicle would look like, and 3) one image that best reflected where this person might live. After this exercise a semi structured interview followed, lasting approximately 45 minutes. This paper reports on the results of the semi structured interview as well as relevant demographic data.

### Focus Group Guide

We created a semi-structured script to elicit information from participants regarding self-driving vehicles. Questions focused on participant understanding and awareness of current developments regarding self-driving vehicles, hopes and aspirations for future self-driving vehicle technologies, concerns related to the accessibility of self-driving vehicles and opinions regarding the legal environment for the use of this technology by older adults. The focus group guide was pilot tested with three participants in a group setting prior to beginning data collection to ensure that it was comprehensible and comprehensive.

### Data Capture and Transcription

Each session was video recorded and transcribed verbatim by a professional transcriptionist prior to analysis. The completed transcript was then verified by a member of the research team against the original recordings.

### Analysis

In preparation for analysis all transcripts were entered into MAXQDA [27], a computer program for qualitative data analysis. After initially familiarizing ourselves with the data two investigators independently coded all quotations from participants (EH, ND). For each researcher this hybrid process began with a set of 33 a priori codes agreed upon by the research team in advance then continued with codes inductively identified within the data. Each coding was then categorized and refined by each researcher independently. Both independent analyses were then merged into a single definitive version by a third researcher (JB) with any disagreements in coding and categorization settled by this third researcher and agreed upon by the research team collectively.

## RESULTS

Results of the analyses of focus group data are organized around 7 major thematic findings: 1) self-driving vehicle concerns, 2) purchase considerations, 3) risk and trust, 4) legal and ethical concerns, 5) self-driving vehicle interactions, 6) self-driving vehicle design, and 7) potential benefits of self-driving vehicles. Across the seven sessions self-driving vehicle concerns were raised 325 times followed by 214 comments related to vehicle purchase considerations. Comments associated with risk and trust occurred 164 times and were followed by comments related to legal and ethical concerns (150), self-driving vehicle interactions (98), and self-driving vehicle design (56). Issues related to the potential benefits of self-driving vehicles

were the least discussed, occurring 36 times. In many instances more than one theme was addressed in a single conversational turn.

### Self-Driving Vehicle Concerns

#### *Understanding of self-driving vehicles*

When asked about their understanding of what a self-driving is, most replied that it is a vehicle that does the driving and you (the passenger) just sit there

You're not really participating of the driving of the car in any way. It's to me. You / You're in the car but the car is so designed that it pretty much drives itself, with the various computers or whatever...

#### *Ability to operate self-driving vehicle*

When asked about their confidence in operating a self-driving vehicle, nearly all participants expressed their confidence in operating such a vehicle given their familiarity with operating a conventional vehicle:

I don't think it should be any different than operating a hand-driven one.

#### *Ability to take control of self-driving vehicle*

Participants were questioned about their ability to take control of a self-driving vehicle in exigent circumstances. Not only did participants express their confidence in taking control but they also indicated that such a feature should be required in a self-driving vehicle:

One would be that unless it has some way that I could manually take over this car. You know?... But in case there's some emergency, there must be something built in that you then can take control if you're physically, mentally and visually able to do so.

One participant did not agree with the idea of taking control of the self-driving vehicle:

I don't want to be in control. If it's self-driving, I want it to drive me.

#### *Age-related concerns*

During the seven sessions, a common topic being mentioned was age and how self-driving vehicles can be a benefit for older adults. Participants felt that as they grow older, they may not have the physical or cognitive ability to operate a conventional motor vehicle:

I think it would be safer. I mean if / if the self-driven car is a safe vehicle, it might be best for a ninety-five-year-old person then getting one and let them do the drive / I mean, let it do the driving

It would be better for some, because if they can't drive, and all they'd have to do was to get in the car and that car takes them.

As a senior eventually one day I probably won't be able to drive. The self-driving car might be a good thing for me. I don't know.

Of particular note, there were mentions of how older adults were still capable of operating conventional motor vehicles

and driving on the road, some at the same level of competence as young people:

Such consideration will tie in with a discussion about the legal and ethical concerns of self-driving vehicles.

### Purchase Considerations

#### *Cost*

The biggest factor when considering the purchase of a self-driving vehicle was cost. Participants provided a guess on how much a self-driving vehicle would cost. Price estimates varied among the participants, with some estimating between \$30,000 to \$65,000. Others considered self-driving vehicles to be on the same price level as high performance or ultra luxury vehicles with estimates of \$150,000, \$200,000 and \$300,000. Comments from the participants indicated that they did not believe such vehicles would be affordable for the average person:

Affordability. You know, you know, people, average people wouldn't be able to afford one of those cars.

I don't / I don't think I would be able to afford one in this present because I feel like uh with the / with them / with this new invention just coming out I feel like it might be a little bit more than I can afford.

... the majority of us can't afford. I don't think we could afford it in the first place.

#### *Maintenance, repairs, and insurance*

There were concerns about the maintenance and repair options for self-driving vehicles. Mainly, there were questions asked about the availability of mechanics trained to repair such vehicles and whether they would be able to provide on-site assistance in the event of breaking down on the road:

Just be able to go out the actual road. And that's what I would be thinking of. I mean, how many mechanics would be already trained to come and assist you. You would have to have a special type of mechanic that would even be able to come to assist you.

Insurance was also a notable mention. All agreed that like any conventional vehicle, there would have to be some sort of insurance option for self-driving vehicles.

#### *Features of self-driving vehicles*

Most of the responses for desired features included roadside assistance (which ties in more with insurance than being a standalone feature):

I want some roadside assistance.

In addition, participants requested a telematics system for vehicle monitoring or sensors that can detect when someone falls ill in vehicle and needs medical attention:

Yesterday on the news they got these bracelets where uh they can find these people that was alzheimer's and people getting lost. They can find them just that quick, find out where they're going. And that's a good thing, with the self-driving car. For me. 'Cause you could be hurt.

Well, they may need to put OnStar in that.

And if you got sick.. You wouldn't have to drive, you know. I've seen a lot of people, they've been driving, and they passed out. They have wrecks. And I say, it might not, you know, if / I don't know whether you could talk to the car or not, but I know that if you didn't feel good. . .

### Risk and Trust

Most of the participants expressed concerns in trusting a self-driving vehicle. A common refrain was uncertainty regarding its capabilities. Participants felt that because it is a new technology and they do not possess adequate knowledge of what it can do, they are hesitant to immediately trust it with their lives:

I would have to see like some kind of training source to see how this car is gonna act. I mean I wanna know if this car is gonna know exactly what it's doing or how it's gonna drive. Is it gonna drive too fast? Or. . . You know? What kind of mechanism that's gonna let you know I mean if it's congested. Like 85 sometimes you get all those backups and we're sitting in that big traffic jam, how / how do I know what that car is gonna do?

Others also expressed that they would prefer to maintain control of their vehicle and the process of transitioning control to the self-driving vehicle is not something they feel they can get used to:

No, I wouldn't want one of these cars. Because I don't have no kind of control over it. I couldn't sit in a car and it's just going, doing everything by itself. Because even in the car now, when somebody else is driving, I'm driving too, only on the other side. And so, you know, that's why I couldn't handle it. My nerves just wouldn't let me.

I mean, I know they sound great, but I don't know if I can trust this vehicle. I'm used to handling and braking everything myself. I'd really have to think twice about getting in a car like that

### Reliability

All of the participants expressed concerns about the reliability of self-driving vehicles, in particular, that the vehicle they purchase is not a 'lemon'; in the U.S., a lemon is an idiom to reference a vehicle, often brand new, that has a number of substantial defects that severely affect its safety, utility, or value:

Hoping you don't get a lemon. You know, some of them cars, when they come out / a lot, they are lemons. And I'd say, you know, you gotta look at all of it. you know. That's a new car. And there's new cars coming out as lemons, too.

### Vehicle safety

The biggest concern about the safety of self-driving vehicles is in its ability to reliably monitor certain aspects of the road. For example, questions were raised regarding how the vehicle monitors and controls its speed as the speed limit changes:

What about the speed limit? Will they automatically go the speed limit in that particular area?

Well, it depends on how fast the car go. A lot of people just go up and down the road now, flying and just don't care. go like zoom. And they, you know, they just don't care. So, like I said, I don't know whether that will do that or not. . .

### Legal and Ethical Concerns

#### Training and licensure

Participants were in support of having additional training in learning how to operate a self-driving vehicle. Most agreed that drivers should have a unique license in order to own or operate such a vehicle:

It's just like learning to drive. If , like I said, learning how to drive the vehicle, and then if I had to, and know the ins and out of it, I think I would be safe / feel safe driving it. But just getting in there and letting it do the driving and I don't know nothing about the car, I wouldn't feel safe. So, that's like to me that would come under training. For this particular person. After they purchased the car, they'd really be trained on the stuff

Beyond licensing the discussion of self-driving vehicle legislation pertaining to older adults and persons with disabilities, discussed in the recent literature [9, 11], was limited. When asked about their concerns regarding laws being put in place to prevent older adults from operating self-driving vehicles, participants were overtly resistant with one stating:

I hope not. As it is now, you can drive until you're 100 years and older. If you're in your right mind and you know, know where you're going, know what you're doing.

#### Privacy

When participants were asked about privacy concerns in a self-driving vehicle, some voiced concerns about the prospect of possibly being monitored or having certain information recorded:

I would be concerned if this uh car is reporting like route, what I'm doing, and all that kind of stuff. If it would do that I mean, I would be concerned if it's doing that, sending out this type of personal stuff. Like somebody saying, "You know she did this and she did that now." Would it be that smart?

Some participants did mention that, in certain situations, it may be beneficial if the self-driving vehicle would send information pertaining to the driver's health in the event of an emergency:

. . . You don't have any privacy. I mean, it can work in both ways. I mean, if it DID work. If the person within the car were getting sick or something and you might have programmed it if this person is getting sick, then you need to go to the hospital or something. That would come in handy. But if you're on the phone talking to someone personally. . .

*AV morality*

Participants were presented with a scenario where they are in a self-driving vehicle and due to some unforeseen critical situation, the vehicle must make a choice between hitting a tree or hitting a pedestrian. Participants were asked what the vehicle should do. Many felt uncomfortable with answering this question. For those willing to answer, all agreed that the vehicle should hit the tree even though it may bring harm to the vehicle occupants, as they did not want the vehicle to hit the pedestrian, causing great harm or even death.

**Self-Driving Vehicle Interaction**

*User interactions with self-driving vehicle*

When asked about their preferred mode of interaction with the self-driving vehicle, most participants indicated a preference for voice. In addition, participants did make mention of seating preference within the vehicle, with some preferring to remain in the driver seat and others preferring to sit in the back; much like how people would sit in a taxi or other ridesharing service:

I want to ride in the back seat of the car itself. You know.

Those preferring to sit in the driver's seat expressed their concern about the event that the self-driving vehicle may need to relinquish control back to the human driver

*Interactions with non-self-driving vehicles*

An important area of concern for participants was the vehicle's ability to drive effectively among non-self-driving vehicles. A key question that arose during the sessions was how will the self-driving vehicle handle the unpredictable behavior of drivers on the road, especially in situations of determining right-of-way and sudden braking:

Yeah, because you know, like say for instance you go, even though you had the right of way, you have to get out for somebody else to avoid an accident. But with the car, would the car be able to do that? You know. If someone starts in your direction, would the car be able to just accelerate itself or do whatever needs to be done to keep you safe?

Yeah, they want you if you're not moving fast enough, you know, they wanna, "Hey, move over! Get out of my way!" They'd be putting on the brakes, you know, and they'd come up right up behind you, you know, and, "Hey, this little vehicle..." you know if it doesn't know, "I need to speed a little bit." I'd be still tugging along, you know. It's something to think about.

*Interactions with pedestrians*

There were concerns about the ability of a self-driving vehicle to detect a pedestrian on the road and stop in an adequate amount of time. This particular issue was influenced by an incident in Tempe, AZ where a self-driving ride-sharing vehicle struck and killed a pedestrian as they were crossing the road [39].

**Self-Driving vehicle Design**

*Accessibility*

For design considerations, participants brought up concerns about the design of self-driving vehicle for people with dis-

abilities. Of particular note, people who are blind or have low vision were the most talked about population:

It would be something good for the blind. They cannot see.

... but like the uh and not being disrespectful, for the blind person – can you tell me how or when they get in the car. I mean, you know they're blind, so when they get in the car they're just telling the car to do this and that and it'll take them where they want to go...

Also discussed were people with motor disabilities such as those confined to a wheelchair.

*Design of self-driving vehicle*

There was a very brief discussion regarding the powertrain of the self-driving vehicle. Many were curious as to whether the vehicle would be all-electric, gasoline based, or a mixture of both.

*Older adult needs being considered*

When asked if they believed that auto manufacturers were designing self-driving vehicles while considering the needs of older adults, there was an even divide in opinions. Some felt that their needs were being considered while others felt they were not. For those who were skeptical about their needs being considered, the main concern was the older adult's ability to properly operate a self-driving vehicle as they get older:

'Cause they're not uhm used to doing something that they / they don't know anything about. And it would be hard to explain that thing to a ninety-year-old or an eighty-year-old. You know?

*Minorities being considered*

When asked about minorities being considered during self-driving vehicle development, most participants did not believe they were, most notably because of the perceived price of such vehicles when launched:

I don't think there would be many minorities on the average getting one of those self-driving cars. Number one, I feel like it'll probably be overpriced, out of our range. We can't afford it, you know, it'd be on the same level pricewise as the regular cars. But I don't think so.

**Potential Benefits of Self-Driving Vehicles**

When discussing potential benefits of self-driving vehicles, two factors came up frequently: independence and mobility. Participants believed that self-driving vehicles will allow them to travel without the aid of family, friends, or other people that they rely on typically:

it offers more independence to a person who might not be able to drive in the future.

Participants also expressed a belief that self-driving vehicles will enable them to travel more often without the concern of having to manually operate a vehicle:

As a senior eventually one day I probably won't be able to drive. The self-driving car might be a good thing for me.

## DISCUSSION

### Self-Driving Vehicle Concerns

The vast majority of participants demonstrated a fair understanding of what a self-driving vehicle is conceptually and what it can do for consumers. Participants felt confident in their ability to operate a self-driving vehicle and to take control in the event a situation deemed it necessary. This is consistent with the studies of Molnar et al. and Schoettle and Sivak [29, 35] who found that the vast majority of older adults would prefer to keep a steering wheel and gas and brake pedals in a self-driving vehicle and have more control over the vehicle in comparison to young adults. Although participants envisioned how self-driving vehicles can improve their independence and mobility, many of them did not feel completely comfortable with not having any degree of control of the vehicle.

### Purchase Considerations

Cost was a major factor when considering the purchase of a self-driving vehicle. A majority of participants expressed a belief that self-driving vehicles would be very expensive given that the technology is a new innovation from automakers. Participants contended that automakers, at this stage, may not take into consideration the needs or financial wherewithal of the ‘average’ person, thus rendering the costs of such a vehicle relatively high. Participants estimated costs of such vehicles at \$50,000+, some even projecting costs to be more than \$100,000. The views expressed in relation to cost are consistent with [11]; participants in the study were blind or had low vision, but expressed nearly the same views in regards to buying a self-driving vehicle. Although recent studies have shown that people are willing to pay extra to own a self-driving vehicle [4, 20], in the current study, very few participants were willing to do so.

Preliminary analysis from the ideation kits revealed that Asian faces were the most common images selected as people who would own an autonomous vehicle. Within the focus group discussion participants who made this selection commented that Asians/Asian Americans were more commonly associated with technical savvy, wealth and sports or luxury vehicles. These results are perhaps not surprising given the documented disparity between median household incomes between African Americans, White or Caucasian Americans and Asian/Asian Americans; African Americans have historically had a lower median household income than these other racial or ethnic groups [21, 32, 38]. Our findings suggest that African Americans, though they may disproportionately benefit from autonomous vehicles due to the relatively high rates of driving cessation, may not view themselves as capable of purchasing such a vehicle or being a target market for manufacturers.

### Risk and Trust

The overall attitude about self-driving vehicle technology was particularly negative in terms of trust. The views expressed centered around the reliability of the electronic equipment in the vehicle and vehicle safety. Most participants when presented with a scenario where the vehicle must make a critical

decision in the event of a potential crash, chose not to respond when asked if the vehicle should prioritize their safety. Those who did answer expressed a desire for the vehicle to avoid the pedestrian and risk harm to themselves. Other participants expressed that the vehicle should be equipped to handle the situation in a manner that would avoid harm to all parties. A study conducted by Bonnefon, Shariff, Rahwan [5] investigated the same ethical dilemma with self-driving vehicles. Results from the study revealed that participants were willing to sacrifice passengers of self-driving vehicles to avoid striking and killing pedestrians; however, they also indicated that they would not purchase or own such vehicles that would make self-sacrificing decisions.

### Self-Driving Vehicle Interactions

Discussions related to preferences for in-vehicle interactions were brief and all participants indicate that voice would be their preferred method for entering a destination or address for a self-driving vehicle. Additionally, some participants brought up the idea of sitting in the back of the vehicle rather than the front, as if they were riding in a taxi or other ridesharing service. In a study by Brinkley [11], participants described their interaction with an autonomous vehicle human-machine interface (HMI) and their preferred method of interaction. Similar to the current study, most participants desired voice input as the default method; unlike the current study, they also indicated a preference for smartphone integration and interaction. The addition of smartphone integration in the Brinkley study, was influenced by the participants’ concerns about the accuracy of the speech recognition component of the HMI and their comfort in using their own smartphones, in which they indicated that were very accessible.

Further discussions surrounding self-driving vehicle interactions revolved around vehicle interaction with pedestrians and non self-driving vehicles. Much of the talk concerning vehicle safety, trust, and risk focused on the importance of the self-driving vehicle being able to anticipate how human drivers will behave on the road. Many responses centered around traffic signals and how often drivers tend to “beat” the red light signal. Another scenario involved speeding drivers and their tendency to pass over or cut off slower drivers, especially in near tailgating distance; participants wanted to know how would the self-driving vehicle handle such a situation? Results from Hulse et al. [23] revealed that although self-driving vehicles were generally viewed as a ‘somewhat low risk’ form of transportation, participants viewed them as more risky than human-operated vehicles from the perspective of passenger safety. Responses from the current study can be viewed as a reflection of Hulse’s study as participants expressed a lack of trust in letting a self-driving vehicle operate with little human input.

### Self-Driving Vehicle Design Considerations

Regarding the design and development of self-driving vehicles, the sessions brought up the question of whether self-driving vehicle manufacturers are considering the needs of people with disabilities. The needs of visually impaired persons were

frequently discussed during the focus groups. Research exploring the use of and opinions regarding assistive technology in a self-driving vehicle by visually impaired persons is limited beyond the work of Brinkley et al. [7, 8, 10, 11] and Brewer [6]. In the study by Brinkley et al. [11], opinions were decidedly negative; participants felt that their needs were being largely ignored. Opinions from the current study were mixed, many believed that their needs are being considered and many others believed that was not the case. When asked whether the needs of minorities were being considered, most participants expressed doubt, citing that brand new self-driving vehicles would be too expensive for the average African American family household to afford. None of the opinions expressed came from personal experiences with self-driving vehicles. Opinions were largely based on what participants had observed through the media, with luxury vehicles showcasing advanced driver assistance technology. The prices of those luxury vehicles are in the range of prices that most participants estimated that self-driving vehicles would cost.

### Benefits of Self-Driving Vehicles

Similar to the literature, the greatest benefits discussed during the focus groups were increase independence and mobility. A few of the participants expressed that they either did not drive anymore or had limited driving experience. Many mentioned that having a self-driving vehicle would provide greater mobility. Another common benefit discussed was how a self-driving vehicle can help drivers who become sick and are unable to drive themselves to the nearest medical facility; a self-driving vehicle can be a crucial help in such scenarios, especially if the driver is by themselves. Many of the participants believed that it would be important for self-driving vehicles be outfitted with a telematics system such as OnStar in case of such emergencies. One topic of interest that came up in many of the sessions was the consideration of older adults who may be too old to reliably operate a self-driving vehicle. Many felt that these persons should be accompanied by another adult, regardless of whether the vehicle can accurately and reliably transport them to their destination.

### Limitations

While focus groups can be a useful method for collecting large rich data from multiple perspectives at once, there are potential drawbacks that can affect the accuracy of the data. Unpredictable group dynamics can affect the quality of the data. Given that our sample consisted of adults over the age of 55, there was potential to have participants who may not be as communicative or provide unintelligible communication.. Additionally, given the risk that our participants have little to no knowledge about self-driving vehicles, there was potential for confusion from our questioning that may lead to actual responses not consistent with our expectations.

### CONCLUSION

The present study was initiated with the intent to contribute to the literature and exploration of the opinions, preferences and concerns of older adults regarding self driving vehicles. Using focus group methodology we asked participants to articulate their understanding of self-driving vehicle technology, reflect

on the potential benefits and comment on the perceived negatives of the technology. Our findings suggest that although participants believed that self-driving vehicles are beneficial to their mobility, older adults expressed many concerns that made trusting a self-driving vehicle difficult. In particular, reliability and safety were the biggest concerns common across all focus groups. There was concern regarding the potential for automated system malfunctions leading to an accident, although participants expressed confidence in their ability to take control of the vehicle if necessary. Another obstacle is the cost of purchasing a self-driving vehicle. Many felt that such an advanced vehicle would have a cost outside of their price range and that of the average person. Preliminary results of the ideation kit suggest that participants do not believe that African Americans possess the wealth necessary to initially purchase an autonomous vehicle and that manufacturers may not directly consider African Americans in the design and development of the technology. Participants also expressed significant concerns regarding the consideration of the needs of persons with disabilities and older adults. These findings are significant given that older adults, older African Americans and persons with disabilities may disproportionately benefit from autonomous vehicles given their documented personal mobility limitations. We argue that this work furthers the understanding of an arguably under-explored group, African American seniors, while contributing to the literature a general exploration of the opinions of seniors regarding self-driving vehicle technology.

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