Accident Analysis and Prevention 178 (2022) 106850

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Age is more than just a number: The relationship among age, non-chronological age factors, self-perceived driving abilities, and autonomous vehicle acceptance

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ARTICLE INFO

Keywords:
Older adults
Autonomous vehicles
Non-chronological age
Self-perceived driving abilities
Crowdsourcing

ABSTRACT

Globally, adults aged 65 and older are a rapidly-growing population. Aging is associated with declines in perceptual, cognitive, and physical abilities, which often creates challenges in completing daily activities, such as driving. Autonomous vehicles (AVs) promise to provide older adults one way to maintain their mobility and independence. However, recent surveys of AV acceptance suggest that older adults have a lower AV acceptance compared to younger generations. One challenge is that most of these assessments have not accounted for the various non-chronological age factors that contribute to how older adults perceive their own driving skills and the utility of AVs. To fill this research gap, this study investigated the effects of non-chronological age factors and rated self-perceived driving abilities on AV acceptance across three age groups. An online survey was conducted using Amazon Mechanical Turk (MTurk), for which 438 valid responses were received. Respondents were categorized into a younger (18–40 years), middle-aged (41–64 years), and older (65–79 years) adult age group. Results showed that drivers of a younger age, with higher educational attainment, who rated themselves to have higher social support, and who have lower rated self-perceived driving abilities, report being more willing to accept AVs. Findings from this work can help to inform models of AV technology acceptance and guide in the development of marketing strategies to promote knowledge of AVs.

1. Introduction

Adults aged 65 years and older are now the fastest-growing age group in the world (Erber, 2012; Sanderson and Scherbov, 2019). In the United States, between the years 2008–2018, the proportion of older adults increased by 35 % and, by 2060, this population is projected to account for more than a quarter of the general population (US Department of Health and Human Services, 2018; Vespa et al., 2020; Vincent and Velkoff, 2010). This significant shift in demographics presents a number of societal challenges as well as opportunities.

Aging is generally associated with declines in perceptual, cognitive, and physical abilities, which may negatively affect a person's capability to successfully perform instrumental activities of daily living, such as managing transportation, communication, and commerce activities (Anstey et al., 2005; Bushnik, 2018; Hogan, 2005; Murman, 2015). With respect to the daily task of driving, the U.S. Department of Transportation Federal Highway Administration (2020) reports that there were 46 million licensed older drivers in 2019, which represents a 37 % increase from the year 2010. Given this knowledge, much attention has been devoted to understanding and supporting aging drivers. Declines in perception can diminish older adults' ability to identify elements in the driving environment (e.g., Monge and Madden, 2016), cognitive decrements may hinder the speed and accuracy of older individuals' decision-making abilities (e.g., Harada et al., 2013), and physical/psychomotor declines can result in slower and less precise movements and maneuvers (e.g., Stelmach and Hömberg, 1993). Older adults, who are aware of these age-related changes, have been known to adopt self-regulated behavioral strategies to compensate for such declines. Example behaviors include reducing driving frequencies, avoiding particularly difficult driving situations (e.g., high traffic and nighttime driving, limiting in-vehicle distractions), and ceasing driving altogether (Molnar et al., 2015; Molnar et al., 2018). Consequences of

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https://doi.org/10.1016/j.aap.2022.106850
Received 5 July 2022; Received in revised form 30 August 2022; Accepted 20 September 2022
Available online 18 October 2022
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using these strategies could be high dependency on others, limited autonomy, and a diminished overall quality of life (Chihuri et al., 2016; Liddle et al., 2014; Molnar et al., 2007).

One of society's leading and most promising technological developments that can help older adults maintain (and extend) their mobility and independence is autonomous, or self-driving, vehicles (AVs; Maurer et al., 2016). These vehicles are categorized into six levels ranging from Level 0 (no automation) to Level 5 (fully autonomous) (SAE, 2021). Intermediate levels of AVs, i.e., Levels 1–4, require shared control or human intervention under certain conditions. In general, the successful implementation of any level of vehicle automation can only be realized if drivers' perception of these vehicles is positive and if the drivers intend to use them. But, to date, research suggests that older adults may have lower acceptance of technology, including AVs, compared to their younger counterparts (Abraham et al., 2017; Acheampong and Cugurullo, 2019; Bansal and Kockelman, 2018; Czaja et al., 2006; Hudson et al., 2017, 2019; Hulse et al., 2018; Owens et al., 2015; Rovira et al., 2019). For example, Owens et al. (2015) compared the perception of advanced systems in vehicles across four different generations, including Millennials (born between 1983 and 2001), Generation X (born between 1965 and 1982), Baby Boomers (born between 1946 and 1964), and the Silent Generation (born between 1929 and 1945). They found that older generations indicated more hesitation towards using these systems. In another study, Hudson et al. (2019) examined the effects of age and education on people's attitudes towards AVs, and found relatively younger people with more educational attainment to have a higher attitude rating regarding AVs. Rahman et al. (2019) investigated factors that are part of several technology acceptance models, such as perceived usefulness, trust, and attitude towards AVs (e.g., from the Technology Acceptance Model (TAM; Davis, 1989), Theory of Planned Behavior (TPB; Ajzen, 1991), and Automation Acceptance Model (AAM; Ghazizadeh et al., 2012)), for participants aged 60 years and older. This study found these factors to be positively correlated with a person's familiarity with AVs.

Overall, these studies have investigated the influence of various demographic factors such as age, education, and living location, as well as components of technology acceptance models, such as attitude, trust, perceived usefulness, and ease of use, with respect to AVs. However, many prior studies that have sought to understand the effects of age on AV acceptance do not comprehensively account for the fact that aging is a heterogeneous process. This means that the presence, and rate, of decline of cognitive and physical abilities in older adults of the same or similar age may be different due to differences in cognitive, physical, and social factors associated with one's particular lifestyle or life course (Ballesteros et al., 2015; Franklin and Tate, 2009; Hertzog et al., 2008; Kelly et al., 2017; Rowe and Kahn, 1997; Seeman and Chen, 2002; Vaillant and Mukamal, 2001). For example, engagement in activities, such as (cognitive) reading, physical exercise, and/or social interactions and exchanges (with friends and family), has been linked to better perception, processing speed, executive function, memory, attention, and motor control and coordination (e.g., Ballesteros et al., 2015; Carlson et al., 2012; Hughes et al., 2008). Thus, with respect to the complex task of driving, it is possible for an older adult in their 70s to have better driving skills than another individual in their 60s, likely because of differences in life activities and course. These non-chronological age factors may in fact significantly influence how older adults perceive the utility and usability of autonomous vehicles. But currently, no data are available on how differences in cognitive, physical, and social factors relate to older adults' AV acceptance.

Another factor that is likely to impact older adults' acceptance of AVs, but which has also not been studied extensively, is the subjective opinion that older individuals have regarding their own driving skills, also known as self-perceived driving abilities. A review (Huang et al., 2020) synthesized the literature on self-perceived driving abilities in older age and showed that older adults often highly rate their driving skills. Specifically, they rate that they drive 1) better than themselves at a younger age, 2) better than their age cohort, and 3) well relative to all other drivers (Huang et al., 2020). Such perspective of one's own driving could lead to lower acceptance of AVs. For example, older adults may insist on remaining in (manual) control of a vehicle as opposed to relying on automated vehicle systems, given that they typically have had a lifetime of manual driving experience and may not feel comfortable relinquishing control to automated driving systems (Abraham et al., 2017; Azevedo-Sa et al., 2021), especially when a person believes themselves to drive well.

But, this perspective may be inaccurate and the person's driving abilities could be objectively poorer than what he/she perceives them to be. For example, Marottoli and Richardson (1998) found no correlation between 35 older adults' self-ratings of their driving ability and ratings given by a driving therapist of these same older adults' on-road driving performance. Furthermore, nine persons whom the driving therapist deemed as having moderate or major problems on the road test rated their own driving abilities to be at least as good as their peers, with three of the nine rating their abilities as being better than the other older adults. Likewise, Freund et al. (2005) classified the performance of 38 % of 152 older adults, who were referred by a physician, family member, or themselves for evaluation of driving skills using a simulator, as 'unsafe.' However, all of the 'unsafe' drivers self-rated their expected driving performance as the same or better than other drivers of their age. A systematic search we conducted yielded no research effort that has determined whether, and to what extent, age across the lifespan moderates the relationship between self-perceived driving abilities and AV acceptance.

In contrast to the prior assessments of older adults' perceptions of AVs, we investigate the relationships among non-chronological age factors, self-perceived driving abilities, and AV acceptance across different age groups. Based on the literature, we propose a conceptual model (Fig. 1) built on the hypothesis that non-chronological age factors (e.g., higher engagement levels in cognitive, physical, and social activities) and self-perceived driving abilities negatively correlate with AV acceptance. Particularly, cognitive activities include those that require thinking and problem solving (e.g., playing games), physical factors relate mainly to bodily exercise, and social activities are ones that involve interactions with other people. Self-perceived driving abilities are ratings provided by persons regarding their own driving skills. We designed and administrated a nationwide online survey to test this hypothesis.

2. Methods

2.1. Survey Administration

Participants were recruited using the Amazon Mechanical Turk (MTurk) platform (https://www.mturk.com). Eligibility criteria included: (1) U.S. residency, (2) at least 18 years of age, (3) possession of a U.S. driver's license, and (4) a minimum 97 % approval rate (i.e., the percentage of an MTurk worker's submitted tasks that have been approved by the survey requesters). After agreeing to participate on

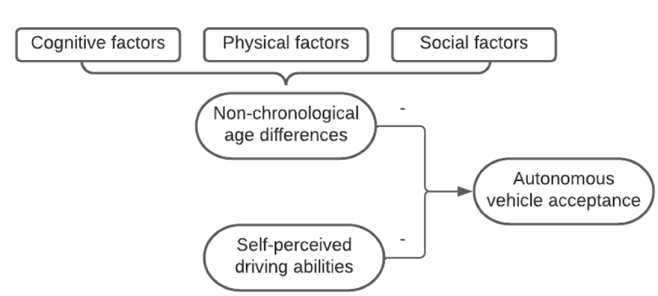

Fig. 1. The conceptual model of older adults' AV acceptance (a supplement of the current AV acceptance model).

MTurk, participants were redirected to Qualtrics™ (https://www.qualtrics.com/), the survey platform, where they were first presented with an electronic consent form. Next, each participant was presented with the survey, which contained 72 questions (see Appendix A for complete list of questions) in six sections on (1) demographics – 8 questions, (2) AV acceptance – 24 questions, (3) self-perceived driving abilities – 15 questions, and three different non-chronological age factors sections: (4) physical – 3 questions, (5) cognitive – 10 questions, and (6) social aspects of one's life – 12 questions. The order of the latter three sections was randomized. Finally, an optional question that asked for feedback on the study was provided at the end of the questionnaire.

To improve the reliability and accuracy of responses, three attention-check questions were presented throughout the survey (Thomas and Clifford, 2017). The first attention-check question was located between the AV acceptance and non-chronological age factors sections and asked, "How old were you when you obtained your first driver's license?" The numeric response to it should have matched the value from the question in the demographic section "At what age did you obtain your first driver's license?" to validate whether the respondent was paying attention. The second attention-check question was a multiple-selection question presented in the social factors section: "Please select 'Somewhat Disagree.' This is to ensure that you are reading questions." Here, the respondent should have chosen "Somewhat Disagree." The final attention-check question, located at the end of the survey (immediately before the optional question), was similar to the first: "In what year were you born?". Responses from participants who failed to answer these three questions correctly were eliminated from data analysis.

Additional filters used to ensure the reliability of the collected responses are based on participants' recorded behaviors on the survey platform. First, the amount of time participants spent on each section was assessed: all sections consisted of at least 10 questions each. Based on our internal pilot testing, it is very unlikely for a respondent to have properly read and answered one section within 5 s. Therefore, a completion time of less than 5 s for an entire section was likely the result of random clicking or a response generated by a bot. Second, the number of mouse clicks made by participants on a webpage was surveyed: the answer to each question required at least one mouse click, and multiple questions were presented on a single webpage. Thus, if the number of mouse clicks was less than the number of questions, the response was likely generated by a bot or an automated form-filling software.

Overall, the survey took an average of 11 min to complete. Each participant was compensated a total of $2.00 (USD) upon the completion. The study was approved by the Purdue University Institutional Review Board (IRB-2020-1050) prior to survey data collection.

2.2. Measures: Sections of survey questions

2.2.1. Demographics

In total, 592 respondents completed the survey. After applying reliability filters, only 438 completed surveys were deemed as valid. These respondents were then categorized into three age groups: 141 younger ($\bar{x}$=32.7 years, age range 22 – 40), 111 middle-aged ($\bar{x}$=53.2 years, age range 41 – 64), and 186 older ($\bar{x}$=68.9 years, age range 65–79) adults. This sample consisted of 215 males (49. 1 %), 222 females (50.7 %), and one person who reported their gender as 'other.' The descriptive statistics of age and gender across three age groups are reported in Table 1.

Respondents' education distribution was: 10 doctoral degrees (2.2 %), 65 master's degrees (14.8 %), 185 bachelor's degrees (42.2 %), 83 associate degrees (18.9 %), and 95 high school diplomas or GED degrees (21.7 %). The descriptive statistics of education level across the three age groups are found in Table 2. Also, overall, 107 respondents lived in urban areas (24.4 %), 240 in suburban areas (54.8 %), and 91 in rural areas (20.8 %) (reported for each age group in Table 2).

For driving-related demographic questions, the mean age at which respondents received their first driver's license was 17.4 years (SD = 3.19, age range 14–56). In terms of how often respondents drove a car in a typical year, 157 respondents reported driving every day (35.8 %), 167 respondents selected 4–6 days per week (38.1 %), 101 respondents chose 1–3 days per week (23.1 %), nine respondents drove once a month to once a week (2.1 %), one respondent noted driving less than once a month (0.2 %), and three indicated "I do not drive anymore" (0.7 %) - two of which were in the younger age group and one was in the older group. Respondents were also asked to report the average number of miles they drive in a typical year. For this question, 139 respondents reported driving 0–5,000 miles per year (31.7 %), 153 respondents drive 5,000–10,000 miles per year (34.9 %), 116 respondents selected 10,000–15,000 miles per year (26.5 %), and 30 drive more than 15,000

Table 1
Age (group) and gender distribution of valid survey respondents.

Gender		Age group			Total
		Younger	Middle-aged	Older	
Male	N	87	44	84	215
	Range	22–40	41–64	65–79	22–79
	Mean	32.8	51.7	69.4	51.0
	SD	4.91	7.83	3.91	17.2
Female	N	53	67	102	222
	Range	2–40	41–64	65–78	23–78
	Mean	32.6	54.2	68.5	55.6
	SD	5.10	6.50	3.14	15.1
Other	N	1	0	0	1
	Range	–	–	–	–
	Mean	35	–	–	35.0
	SD	–	–	–	–
Total	N	141	111	186	438
	Range	22–40	41–64	65–79	22–79
	Mean	32.7	53.2	68.9	53.3
	SD	4.95	7.13	3.52	16.31

Table 2
Education level, living location, driving frequency, and driving miles of valid respondents by age group.

Education	Age group			Total
	Younger	Middle-aged	Older	
Doctoral (e.g., PhD, MD, PsyD)	1	2	7	10
Master's (e.g., MA, MS, MSW)	19	9	37	65
Bachelor's (e.g., BA, BS)	71	43	71	185
Associate (e.g., AA, AS)	19	30	34	83
High school diploma or GED	31	27	37	95
Location				
Urban area	43	22	42	107
Suburban area	77	61	102	240
Rural area	21	28	42	91
Driving frequency				
Everyday	49	43	65	157
4–6 days/week	61	41	65	167
1–3 days/week	26	26	49	101
Once a month to once a week	2	1	6	9
Less than once a month	1	0	0	1
I do not drive anymore	2	0	1	3
Driving miles				
0–5,000 miles	44	27	68	139
5,000–10,000 miles	46	40	67	153
10,000–15,000 miles	38	37	41	116
Above 15,000 miles	13	7	10	30
Total	**141**	**111**	**186**	**438**

miles (6.8 %). The descriptive statistics of driving frequency and miles across the three age groups can be found in Table 2.

Before respondents proceeded to the next section, which was the first set of survey questions related to self-perceived driving abilities, they were asked whether they had heard of the term “automated car” or “self-driving car.” Out of the 438 respondents, 437 answered “yes,” the exception being one person in the younger age group.

2.2.2. AV acceptance

AV acceptance was measured using the 24-item Self-driving Car Acceptance Scale (SCAS) (Nees, 2016). This scale assesses one’s acceptance level based on eight subdimensions (i.e., trust in AVs, cost, compatibility, enjoyment, usefulness, ease of use, experience with automation, and intention to use AVs; with three items in each subdimension, see Section Two of Appendix A). A 7-point Likert scale ranging from “strongly disagree” to “strongly agree” was used as the response option for each item. The average score (range: 1 – 7) of each item was calculated.

2.2.3. Self-perceived driving abilities

Self-perceived driving abilities (SPDA) were assessed using the 15-item Perceived Driving Ability (PDA) scale (MacDonald et al., 2008). This assessment examines people’s ratings of their own driving regarding common situations, such as interpreting road signs at a distance, reversing or backing up a vehicle, or making quick driving decisions (see Appendix A, Section Three). The overall score ranges from 0 to 45 points, which is the sum of each of the 15 items rated from 0 (poor) to 3 (very good).

2.2.4. Non-chronological age factors

Non-chronological age factors were measured using existing validated cognitive, physical, and social assessments. Use of these existing instruments, without modification, enables assessment of whether the scales behaved as expected in the study, but with a possible cost that the questions are not targeted to factors specific to driving. Modifying even some parts of existing scales, such as the wording or terminologies used by the original author, could decrease their accuracy or alter the measured construct of the scale. Hence, given that our goal was to assess general cognitive, physical, and social factors, we determined that the use of established scales was suitable for answering our particular research questions without the need to modify any scales.

Cognitive factors were measured using the Higher Cognitive Abilities Subscale (HC) part of the Florida Cognitive Activities Scale (FCA) (Schinka et al., 2005, 2010). According to Schinka et al. (2005), the score of the 10-item HC scale showed higher correlations with cognitive abilities compared to the other subscales in FCA, which assesses activities that place high demands on cognitive abilities. Example items include playing knowledge games, reading, or cooking, based on a 5-point frequency response option that ranges from “never did this activity” to “every day” (see Appendix A, Section Four). The average value of each item ranges from 1 to 5 and is used to calculate the overall cognitive activity score.

Physical factors were measured using the Godin Leisure-Time Exercise Questionnaire (Godin, 2011), which calculates frequencies and intensities of weekly aerobic exercises (see Appendix A, Section Five). In particular, this questionnaire contains three sections that ask questions regarding one level of exercise (strenuous, moderate, and light). Each strenuous intensity exercise (e.g., running) that is performed for more than 15 min is awarded nine points. Similarly, moderate (e.g., fast walking) and light (e.g., easy walking) intensity exercises that last more than 15 min can earn five and three points, respectively. The total score of this questionnaire is the sum of the three sections of levels of exercises. The physical exercise groups in this study were categorized based on the calculated scores: Sedentary group: < 14; Moderate group: 14–23; Active group: > 23.

Finally, social factors were assessed using the Multidimensional Scale of Perceived Social Support (MSPSS) (Zimet et al., 1988). Based on our conceptual model illustrated in Fig. 1, ideally, the three non-chronological age factors (and associated measures) should be independent from each other, since similar scale questions across factors may result in incorrect and high correlations among the measured scores. The social activity scale consists of six items related to attending social events, such as playing bingo or going to restaurants, going on day/overnight trips, engaging in community/volunteer work, visiting relatives or friends, participating in groups, such as senior centers, and attending church or religious services (e.g., Krueger et al., 2009; see Appendix A, Section Six). There is partial overlap between some of these items and those in the cognitive scale, for example, which inquire about “playing chess, bridge, or knowledge games,” or “attending church/religious activities." Given this overlap, we used an assessment of social support instead of social activity (e.g, Barnes et al., 2004; Kelly et al., 2017; Krueger et al., 2009). The MSPSS was designed to evaluate a person’s perception of adequate social support from friends, family, and significant others. This scale consists of 12 items, each on a 7-point Likert scale ranging from “strongly disagree” to “strongly agree.” The average MSPSS score (range: 1–7) was calculated as the overall social support score in this study.

2.3. Statistical analysis

2.3.1. Reliability and validity of the measurement scales

We only utilized the five aforementioned survey instruments for measuring the constructs of interest. Our goal was not to collect validating evidence (Kane, 2013) for instrument development purposes. Therefore, we performed reliability analysis to confirm whether the selected scales and instruments behaved as expected. Particularly, we assessed the reliability metrics of the numerical responses collected from our survey scales, and then examined any problematic patterns from the distribution of survey scores that could imply issues related to either data collection or results interpretations.

For standardized scales and questionnaires (such as the SPDA and SCAS) that apply Classical Test Theory (Crocker and Algina, 1986) framework with one or more underlying latent traits, we applied the coefficient omega reliability (McDonald, 1970) to check the reliability of total scores (preferred value > 0.7). Here, the reliability is a property of observed test scores from a particular instrument in a specified examinee population. Additionally, two traditional item quality indices were investigated: internal consistency and item discrimination, as a common practice for instrument development and evaluation (McMorris and Kundert, 1994). The inter-item correlations were computed by checking instrument internal consistency, and item-total score correlations were computed by checking item discrimination.

For the questionnaire regarding physical factors (i.e., Godin Leisure-Time Exercise Questionnaire), given that the nature of this instrument is a self-report scoring rubric, we inspected the item score distributions (i.e., frequency table) to assess its response patterns and determine whether they match the expected behavior patterns of our test population.

2.3.2. Correlation analysis

As part of data pre-processing, some demographic information, such as age group, education level, and living location had to be coded as numeric values. Particularly, for age groups, the younger group (age range: 18–40 years) was coded as ‘1,’ the middle-aged group (age range: 41–64 years) was coded as ‘2,’ and the older group (age range: 65–79 years) was coded as ‘3.’ For education level, ‘1’ was assigned to the lowest education level (i.e., a high school diploma), and ‘5’ was assigned to the highest education level (i.e., doctoral degrees). For the living location, rural areas were coded as ‘1,’ suburban areas were coded as ‘2,’ and urban areas were coded as ‘3.’ For entries where respondents answered “other” to any question, those responses could not be converted into numerical values and therefore were excluded from analysis.

This resulted in a total of 438 respondents remaining for final analysis.

2.3.3. Regression analysis

Hierarchical multiple regression was used to determine the predictors of AV acceptance. Here, the dependent variable was the AV acceptance score (range: 1–7, low to high, respectively). In model 1, demographic factors, such as age, education, and location, were first included; in model 2, the non-chronological age factors and SPDA were added. This two-step model approach helps to examine the influence of the addition of factors in the second model on the first model. Therefore, the two regression equations are:

Model 1:

$$AVacceptance = b_o + (b_1{*}age) + (b_2{*}education) + (b_3{*}location) \tag{1}$$

Model 2:

$$\begin{aligned} AVacceptance = b_o &+ (b_1{*}age) + (b_2{*}education) + (b_3{*}location) \\ &+ (b_4{*}cognitiveactivity) + (b_5{*}physicalactivity) \\ &+ (b_6{*}socialsupport) + (b_7{*}SPDA) \end{aligned} \tag{2}$$

The significance level was set at 0.05.

3. Results

3.1. Reliability and validity of the measurement scales

For standardized survey instruments that apply the Classical Test Theory framework, i.e., the HC Subscale/FCA (cognitive activity), MSPSS (social support), SCAS (AV acceptance), and SPDA scale (self-perceived driving ability), we computed the reliability coefficient estimations of total scores and correlation coefficients of inter-item and item-total score variables.

By assuming the number of underlying latent factors is 1, the reliability omega coefficient of each survey instrument was computed using the R packages "psych" and "GPArotation" (Bernaards and Jennrich, 2005; Bunn, 2008; Revelle, 2010). As shown in Table 3, the reliability omega coefficients of the FCA, Social Support, SCAS, and SPDA scores are all larger than the preferred value of 0.7, indicating that the measured scores from the selected instruments in our test population showed an acceptable level of reliability. Also, another reliability coefficient, Cronbach's Alpha, was calculated as an additional reference for assessing reliability.

In addition, to further ensure that responses for each question demonstrated appropriate patterns within an instrument, we computed biserial correlations among each item as well as biserial correlations between item scores and the total scores for the four standardized scales and survey instruments. We expected to observe positive moderate to high correlations among the items, and positive low to moderate correlations between each item and the total score (preferred value > 0.4, or at least ~ 0.2, positively correlated; Piedmont, 2014). The computation results are reported in Appendix B (Tables B1-B5). For each instrument, the inter-item correlation coefficient is in the correlation matrix, and the item-total score correlation coefficient is listed in the last row of the table. We used a heatmap to highlight the values within the correlation matrix, where larger correlation coefficients are represented by a darker shade; positive values are illustrated using a blue hue and negative ones are using a red hue.

Table 3
Reliability coefficient estimates (Omega and Alpha) of the four survey instruments employed.

Survey instrument	Omega total (Preferred value > 0.7)	Cronbach's Alpha (Preferred value > 0.7)
Florida Cognitive Activities (FCA) Scale	0.78	0.72
Multidimensional Scale of Perceived Social Support (MSPSS)	0.98	0.96
Self-driving Car Acceptance Scale (SCAS)	0.93	0.95
Self-Perceived Driving Ability (SPDA) scale	0.93	0.91

For the Florida Cognitive Activities Scale, which measures the cognitive activity level of respondents, we observed positive low to moderate correlations among all items. We also found positive moderate to high correlations between each item and the total score. The results indicate that this particular survey instrument demonstrates our intended response patterns, thus we did not identify questionable patterns from the collected data (see Table B1 in Appendix B).

For the Multidimensional Scale of Perceived Social Support, which measures the social support level of respondents, we also observed positive moderate to high correlations among all items. We found positive moderate to high correlations between each item and the total score. The results (see Table B2 in Appendix B) indicate that this survey instrument generally demonstrates our intended response patterns.

For the Self-driving Car Acceptance Scale, which measures respondents' AV acceptance, there are 24 items grouped into eight subdimensions of AV. Therefore, we computed the correlation coefficients for both item-level and subdimensions levels. We observed positive small to moderate correlations among all items, except for subdimensions 4 vs 6 (Enjoyment vs Perceived Ease of Use) and subdimensions 4 vs 7 (Enjoyment vs Experience). We also found positive moderate to high correlations between each item and the total score except subdimensions 4 (Enjoyment). As for inter-item correlations, we observed item # 6, "The cost of a self-driving car would be the most important thing I would consider before purchasing one," to have systematic negative moderate correlations with all other items. Similar patterns were also found for items #s 12, 20, and 21.

In general, the results of the SCAS in Tables B3 and B4 of Appendix B indicate that most of the items within this survey instrument behaved as expected, except for a few potentially weaker items (e.g., items #s 6 and 12). Given that this scale is from a relatively recent and work-in-progress report (as mentioned by the author; Nees, 2018), minor sensitivity issues regarding the extent to which questions appropriately measure the magnitude of the specified subfactors, such as those described above, are to be expected. Considering that the majority of the items still behaved as intended, the scores collected here were considered to be sufficiently reliable, if interpreted with caution.

For the SPDA scale, which measures one's perception of their own driving abilities, we observed positive small to moderate correlations among all items. In addition, we found positive moderate to high correlations between each item and the total score. The results indicate that this survey instrument behaved as we expected (see Table B5 in Appendix B).

Finally, for the Godin Leisure-Time Exercise Questionnaire, which measures respondents' level of physical activity, a general trend was that more people engaged in up to three 15-minute activities per week compared to the other activity lengths. Also, by comparing the score distributions among the strenuous, moderate, and mild/slight activity items, we observed that people engage more in mild/slight activities than in moderate or strenuous ones. These two trends are both reasonable, and therefore suggest that the patterns of the item responses of this instrument behave as expected.

In summary, the results indicated that the five scales and instruments employed in this study all roughly demonstrated responses patterns as they are intended. Therefore, we proceeded and used the collected data for further statistical analysis.

3.2. Correlation matrix

Data from 438 respondents were analyzed to study the correlations among the selected demographic information, the three non-chronological age factors, and SPDA.

The results indicate that there are small to medium correlations

Table 4
Correlation matrix of 8 selected factors across all age groups (using Spearman's r_s).

Factors	1	2	3	4	5	6	7
1. Age	—						
2. Education	0.054	—					
3. Location	-0.09	0.072	—				
4. Cognitive activity	*** 0.219	*** 0.197	-0.046	—			
5. Physical activity	* -0.114	* 0.117	0.007	*** 0.194	—		
6. Social support	-0.06	-0.029	-0.035	*** 0.174	* 0.116	—	
7. SPDA	** 0.152	0.06	-0.044	** 0.14	* 0.099	*** 0.221	—

(degrees of freedom = 437; *p <.05, **p <.01, ***p <.001.)
Note: Blue hue indicates positive values, where the darker shades represent higher values. Red hue indicates negative values, where the darker shades represent lower values.

across several factors (see Table 4). Statistically significant correlations were between: Age and Cognitive Activity, Age and Physical Activity, Age and SPDA, Education and Cognitive Activity, Education and Physical Activity, Cognitive Activity and Physical Activity, Cognitive Activity and Social Support, Cognitive Activity and SPDA, Physical Activity and Social Support, Physical Activity and SPDA, and Social Support and SPDA. As shown in Table 4, the same heatmap approach is applied.

3.3. Regression model

For the hierarchical multiple regression analysis, the full model (model 2) that consisted of age, education, location, cognitive activity, physical activity, social support, and SPDA was statistically significant, $R^2 = 0.162$, F (7, 430) = 11.87, p <.001; adjusted $R^2 = 0.148$. The addition of the three non-chronological age factors and the SPDA led to a significant increase in R^2 of 0.057, F (4, 430) = 7.28, p <.001. Full details are presented in Table 5.

3.4. Follow-up analysis

A follow-up one-way analysis of variance (ANOVA) was performed to

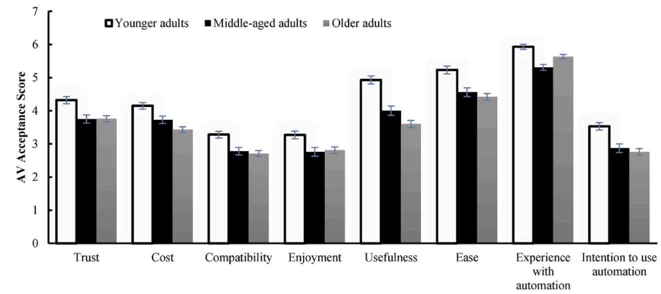

Fig. 2. AV acceptance subdimension scores for younger, middle-aged, and older adults.

compare differences across the three age groups with respect to SPDA, AV acceptance, and each of the eight AV acceptance subdimensions. The average scores for each AV acceptance subdimension for younger, middle-aged, and older adults can be found in Fig. 2. There was a significant main effect of age on SPDA, $F(2,435) = 3.89, p = .021, \eta_p^2 = .018$. Here, older adults ($\bar{x}$=36.75) had the highest SPDA score, followed by middle-aged adults (v = 35.41) and then younger adults ($\bar{x}$=34.851). Based on post-hoc analysis, the difference between older and younger age groups was significant (p = .022), but the differences between the younger and middle-aged (p = 1.00) and the middle-aged and older age groups were not (p = .237).

There was also a significant main effect of age on AV acceptance, $F(2,435) = 24.55, p < .001, \eta_p^2 = .101$. Specifically, younger adults ($\bar{x}$=4.33) had an overall higher AV acceptance score compared to both middle-aged ($\bar{x}$=3.76) and older ($\bar{x}$=3.64) adults. Similar age-related differences were also found in all eight AV acceptance subdimensions (Table 6). Specifically, the p-value for all subdimensions were less than 0.001, except for enjoyment, which was less than 0.01.

Furthermore, given that age, education, social support, and SPDA were main predictors of AV acceptance (Table 5), and that AV acceptance differed only between the younger and older age groups, we conducted follow-up multiple linear regression analysis for younger and older adults separately to examine age-related differences. In this model (i.e., model 3), AV acceptance was the dependent variable, and age (younger or older adult group), education, social support, and SPDA were independent variables. The regression equation is expressed in the following form (b_0 is the intercept/constant and b_1 – b_4 are the slope coefficients):

Table 5
Hierarchical multiple regression predicting AV acceptance.

Variable	AV acceptance			
	Model 1		Model 2	
	B	β	B	β
Constant	5.071***		4.475***	
Age	−0.334***	−0.299	−0.283***	−0.254
Education	0.076	0.083	0.082*	0.091
Location	0.110	0.077	0.119	0.083
Cognitive activity			−0.068	−0.040
Physical activity			0.109	0.090
Social support			0.159***	0.222
SPDA			−0.014*	−0.092
R^2	0.105		0.162	
F	16.995***		11.864***	
Adjusted R^2	0.099		0.148	
F change	16.955***		7.279***	

Note: B = unstandardized regression coefficient; β = standardized coefficient; R^2 = coefficient of determination. *p <.05, **p <.01, ***p <.001.

Table 6
Mean AV acceptance subdimension scores (SD in parentheses) and results of ANOVA tests.

	Younger adults M (SD)	Middle-aged adults M (SD)	Older adults M (SD)	ANOVA tests
Trust	4.32 (1.22)	3.75 (1.30)	3.76 (1.29)	F(2,435) = 9.49***
Cost	4.15 (1.17)	3.73 (1.26)	3.43 (1.21)	F(2,435) = 15.29***
Compatibility	3.28 (1.24)	2.78 (1.25)	2.71 (1.22)	F(2,435) = 10.14***
Enjoyment	3.27 (1.57)	2.76 (1.31)	2.81 (1.25)	F(2,435) = 10.96**
Usefulness	4.93 (1.43)	4.00 (1.51)	3.60 (1.48)	F(2,435) = 33.22***
Ease	5.23 (1.31)	4.56 (1.45)	4.42 (1.44)	F(2,435) = 14.14***
Experience with automation	5.93 (0.83)	5.31 (1.09)	5.63 (0.91)	F(2,435) = 13.40***
Intention to use AVs	3.53 (1.40)	2.87 (1.36)	2.76 (1.32)	F(2,435) = 14.00***

Note: *p <.05, **p <.01, ***p <.001.

Table 7
Multiple linear regression predicting AV acceptance between younger and older adults.

Variable	AV acceptance			
	Younger adults		Older adults	
	B	β	B	β
Constant	3.669 ***		3.833**	
Age	−0.008	−0.048	−0.007	−0.029
Education	0.152	0.166	0.094	0.120
Social support	0.090	0.120	0.152***	0.242
SPDA	0.001	0.004	−0.021*	−0.152

Note: B = unstandardized regression coefficient; β = standardized coefficient; R^2 = coefficient of determination. *p <.05, **p <.01, ***p <.001.

$$AV\ acceptance = b_o + (b_1{*}age) + (b_2{*}education) + (b_3{*}socialsupport) + (b_4{*}SPDA) \quad (3)$$

As shown in Table 7, interaction effects were found for social support and SPDA. Specifically, social support and SPDA significantly predicted AV acceptance for older adults only, but not for the younger adult group.

4. Discussion

This study used responses from a national online survey to quantify the relationship among non-chronological age factors, self-perceived driving abilities, and autonomous vehicle (AV) acceptance. Overall, younger age, higher educational attainment, the perception (presence) of more social support, and lower self-perceived driving abilities were all associated with higher ratings of AV acceptance. In addition, comparisons among younger, middle-aged, and older adults suggest that younger adults have higher AV acceptance than older adults, but also lower self-perceived driving abilities.

4.1. Relationship among demographic factors and AV acceptance

The relation of age and education to AV acceptance found in the current study has also been reported in prior studies (e.g., Abraham et al., 2017; Acheampong and Cugurullo, 2019; Bansal and Kockelman, 2018; Czaja et al., 2006; Haboucha et al., 2017; Hudson et al., 2017, 2019; Hulse et al., 2018; Rahman et al., 2019; Rovira et al., 2019). Haboucha et al. (2017) found that younger people, and those with higher education, were more likely to select autonomous vehicles as their preferred commuting method for various scenarios. According to the authors, individuals with more education could be more knowledgeable about, and have a greater understanding of, AVs and thus may more positively perceive this technology. This hypothesis is further supported by other studies (e.g., Porter and Donthu, 2006; Quazi and Talukder, 2011), which suggest that people with more education tend to have increased knowledge about new innovations and are more apt to learn and understand the benefits of new technology. However, in Haboucha et al. (2017), older adults accounted for only 3.4 % of study respondents. In contrast, in our study, we compared three different age groups, where older adults accounted for 43.3 % of participants (younger adults made up 31.5 % and middle-aged adults made up 25.1 % of respondents).

For each of the eight subdimensions of the AV acceptance questionnaire, older adults gave lower ratings compared to younger respondents. One possible explanation for this finding could be that, currently, information about AVs is not presented to older adults as pervasively as it is to younger populations. This could limit older individuals from developing a more comprehensive knowledge and understanding of AVs and their associated capabilities. Several recent studies have found that older adults' ratings of acceptance of autonomous vehicles increase after being exposed to the technology (Classen et al., 2021; Haghzare et al., 2021; Rahman et al., 2019), further supporting the notion that their lack of understanding of AVs could be a barrier to use. On the other hand, the younger population has grown up with technology integrated into many areas (and tasks) in their lives (e.g., Helsper and Eynon, 2010), has established rapport with various technologies as a result of past experiences, and may more easily embrace emerging technologies into new aspects of daily life. Older adults, in contrast, may not feel inclined to relinquish control over a task (driving) for which they have multiple decades of experience performing (Abraham et al., 2017). A meta-analysis focusing on self-regulated driving in older adults (Ang et al., 2019) found the number of older individuals who ceased driving to decrease from 32 % (between the years 1990–2000) to 15 % (between 2010 and 2018). Data from our study provides additional support for the hypothesis that older adults might be reluctant to give up driving, given that only one out of the 113 older respondents reported having stopped driving (see Table 2).

The reported living location did not show a significant correlation with AV acceptance, which was not in line with previous studies. For example, Rahman et al. (2019) found that people residing in suburban areas showed a stronger desire to trust AV technology compared to those who lived in urban or rural areas. Respondents in their study were asked to assume they were pedestrians and provide their perceptions of interacting with AVs. However, in our study, respondents primarily represented vehicle drivers/passengers. Even though driving patterns (e.g., distance or duration) may be different for people living in urban, suburban, and rural areas, their acceptance levels were still similar. This could imply that our respondents, who likely had some baseline knowledge about technology given their association with the virtual MTurk platform, may have had similar perceptions of AV technology that did not depend on where they lived. They may be more accustomed to answering surveys and questionnaires based on their general perception and knowledge of technology as opposed to from a practical need or utility perspective.

4.2. Relationship between self-perceived driving abilities and AV acceptance

In addition to demographic factors already acknowledged by previous work, our results provide evidence that self-perceived driving abilities is another factor that could reflect differences in AV acceptance levels. That is, drivers with higher self-perceived driving abilities may be less willing to adopt AVs. Based on findings in Section 3.4, older adults showed an even stronger relationship between self-perceived driving abilities and AV acceptance compared to the younger adult group. One possible explanation could be that there is a greater range of driving abilities among older adults compared to younger respondents. Even at the same or similar ages, older adults may have experienced heterogeneous changes in cognitive and physical processes, resulting in very different ratings in perceived driving abilities. Those who rated their driving abilities higher than their similar age cohorts might prefer to trust their own driving abilities and, thus, have a lower AV acceptance rating. In contrast, people with lower self-perceived driving abilities may seek driving assistance, for which AVs may be a good option, leading to a higher AV acceptance score. The younger adults may share more similar comments on their driving abilities because of the greater similarity of their general cognitive and physical abilities, and their years of driving experience, which are key to good driving performance.

Our study also found that older adults had higher overall self-perceived driving scores compared to younger adults, in general. This may be attributed to the perception they have formed based on decades of driving experience (mean years of driving experiences: 15.5 years for younger adults vs 51.5 years for older adults). In other words, driving skills and confidence may be enhanced with more driving experience until there is evidence (via subjective or objective feedback regarding one's driving skills or self-awareness of declines in cognitive and physical functioning) suggesting that their driving has become a concern. Thus, without this knowledge, it may be difficult for them to adapt their perspective. Alternatively, older adults may intentionally highly rate their own driving skills out of fear of being judged and/or losing driving privileges, if they show signs of vulnerabilities or declines in driving abilities (Huang et al., 2020; Joanisse et al., 2012). Given the goal of the survey, it is also possible that some older adults perceive automated (vehicle) systems to be a type of assistive technology designed for people with lower self-perceived driving abilities, who need additional help while driving, and/or who can no longer drive, which could have prompted them to rate their driving abilities as ‘high,’ if they do not believe themselves to identify with these groups (Werner et al., 2022).

4.3. Relationship among non-chronological age factors and AV acceptance

We evaluated three types of non-chronological age factors – cognitive, physical, and social – and expected that all factors would be associated with AV acceptance. Our first expectation was that perceived social support would be negatively correlated with AV acceptance. This hypothesis was formed based on prior work inferring that people with greater support, from social networks, are afforded more opportunities to receive assistance with daily tasks (Berkman et al., 2000). Thus, we expected people with more support to not perceive a need for AV technology. On the contrary, perceived social support was positively associated with AV acceptance, and based on the analysis in Section 3.4, this effect was only observed for older adults. But, the particular social support received (and reported) by respondents did not necessarily relate to transportation, since the survey instrument queried aspects such as “my family really tries to help me” and “I get the emotional help and support I need from my family.” This finding could suggest that respondents who currently receive more social support are those also receiving some form of help with instrumental activities of daily living (Hughes et al., 2008). The extent to which a person can effectively perform these activities reflects their ability to live independently (Bushnik, 2018). Thus, if an individual is already receiving some assistance for certain high-level tasks in this category, such as managing finances, then they may have a greater willingness to accept assistance in other areas of their life (i.e., transportation) and ultimately use AVs. We did not ask respondents’ about support they receive for particular daily living activities. Therefore, the details of the social support factor warrant further investigation to separate transportation-related support from other forms of support, and uncover more in-depth explanations for this positive correlation.

Also, contrary to expectation, cognitive and physical factors were not found to be predictors of AV acceptance for the younger nor older age group. This lack of significant correlation may be explained by findings from previous literature that the benefits of non-chronological age factors (e.g., physical exercise) may be observed in cognitive tests, such as Mini-Mental State Exam (MMSE; Folstein et al., 1975), but these benefits may not affect older adults’ perceptions on AVs. Future studies should investigate more relevant measurement tools related to cognitive and physical factors that may impact AV acceptance. For example, physical factors related to people’s mobility concerns, such as the frequency and the level of desire for seeking mobility assistance (e.g., using wheelchairs), may be more strongly associated with AV acceptance than daily physical exercise frequency or intensity.

4.4. Limitations and future work

There are some limitations of this study. First, participants were only recruited using the MTurk platform. Although the use of MTurk is an acceptable and validated research approach that has been employed in several experiments (Aguinis et al., 2021; Vakharia and Lease, 2013), MTurk workers may not be representative of the general population (Aguinis et al., 2021; Chambers et al., 2016; Thomas and Clifford, 2017), especially older adults. But, the older adults who do actively and frequently use such a platform are likely to be more familiar with technology, in general. Also, despite the practical benefits of using MTurk, such as access to a large and diverse pool of participants, speed of data collection, or reasonable cost, previous studies have found that MTurk workers to be younger and more educated compared to the general U.S. population (e.g., Chambers et al., 2016). Future research may seek to use a mixture of qualitative research methods, including surveys distributed in local communities and by mail, and interviews or focus groups.

Secondly, the Self-driving Car Acceptance Scale (SCAS) was recently developed when we conducted the survey and was still under development. It therefore has not been refined using larger-scale field tests. We proceeded with our statistical analyses with caution. If updated in the future, researchers should utilize the modified version of this instrument.

Finally, the data collected as part of this study were all self-reported measures, which are subjective ratings that could be affected by various implicit and explicit factors, such as self-presentation bias (Horswill et al., 2013). Future research needs to make use of objective metrics that can be verified, such as number of speeding tickets and driving accidents as measures of driving safety, performance of specific driving tasks in simulated or naturalistic environments, and questions that probe knowledge of AVs and other topics of interest.

5. Conclusion

This study examined the effects of non-chronological age factors and self-perceived driving abilities on autonomous vehicle (AV) acceptance. Also, self-perceived driving abilities and AV acceptance were compared across younger, middle, and older age groups. A survey was developed and distributed nationally using an online platform. Overall, drivers of a younger age, with higher educational attainment, with access to social support, and who have lower self-perceived driving abilities were found to be more willing to adopt AVs. Findings from this work can be used to advance theories on technology acceptance related to autonomous vehicle technologies, and to develop marketing strategies and educational material to increase knowledge and awareness of AVs.

CRediT authorship contribution statement

Gaojian Huang: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing – original draft, Visualization. **Ya-Hsin Hung:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing – original draft, Visualization. **Robert W. Proctor:** Conceptualization, Methodology, Validation, Writing – review & editing. **Brandon J. Pitts:** Conceptualization, Methodology, Resources, Writing – original draft, Writing – review & editing, Supervision, Project administration, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

This work was partially supported by the Link Foundation Modeling, Simulation, and Training Fellowships and NSF Awards #1755746 (PI: Brandon J. Pitts) and #2121967 (PI: Robert W. Proctor).

Appendix A List of survey questions

Section one: Demographics (8 questions)

1. What is your age: ______
2. What is your gender:
   o Male
   o Female
   o Other ____
3. Your highest level of education attainment:
   o Doctoral (e.g., PhD, MD, PsyD)
   o Master's (e.g., MA, MS, MSW)
   o Bachelor's (e.g., BA, BS)
   o Associate (e.g., AA, AS)
   o High school diploma or GED
   o Other ___________________
4. Below, which option best describes where you live?
   o Urban area (Areas that are generally highly populated metropolitan areas, such as in a city or town)
   o Suburban area (A residential area on the outskirts of a city or town)
   o Rural area (Areas settled outside of towns and cities. Such areas are distinct from more intensively settled urban and suburban areas)
   o Other _______________
5. At what age did you obtain your first driver's license? ___
6. How often do you drive a car in a typical year (prior to the COVID-19 pandemic)?
   o Every day
   o 4-6 days/week
   o 1-3 days/week
   o Once a month to once a week
   o Less than once a month
   o I do not drive anymore
7. On average, how many miles do you drive in a typical year (prior to the COVID-19 pandemic)?
   o 0-5000 miles
   o 5000-10000 miles
   o 10000-15000 miles
   o Above 15000 miles
8. Before today, had you heard of the term "automated car" or "self-driving car"?
   o Yes
   o No

Section two: AV acceptance (24 questions)

Definition of a self-driving car: A vehicle that has full responsibility of controlling all vehicle movements (dynamics) and monitoring the roadway and the environment. It can drive itself with or without drivers/passengers present. Please select your level of agreement with the following statements related to self-driving vehicles: 1 = Strongly disagree; 2 = Disagree; 3 = Somewhat disagree; 4 = Neither agree or disagree; 5 = Somewhat agree; 6 = Agree; 7 = Strongly agree

9. Self-driving cars will be safe.
10. I would trust a self-driving car to get me to my destination.
11. People will need to watch self-driving cars closely to be sure the computers don't make mistakes.
12. I would be willing to pay more for a self-driving car compared to what I would pay for a traditional car.
13. The benefits of a self-driving car would outweigh the amount of money it would cost.
14. The cost of a self-driving car would be the most important thing I would consider before purchasing one.
15. I do not think that computers should be driving cars.
16. It is important for a human to be able to take back control from a self-driving car.
17. There are some driving scenarios that will be too difficult for a self-driving car to handle.
18. I enjoy driving a car.
19. I prefer to be the driver rather than the passenger in a car.
20. I enjoy cruising or going for joy rides.
21. A self-driving car would allow me to be more productive.
22. A self-driving car would allow me to be more safe while in the car.
23. Self-driving cars will reduce traffic problems.
24. Self-driving cars will be easy to use.
25. It will be a lot of work to figure out how to use a self-driving car.
26. It would take me a long time to figure out how to use a self-driving car.
27. I like to use technology to make tasks easier for me.
28. I have bad experiences when I try to use new technology instead of doing things "the old-fashioned way".
29. There are tasks in my life that have been made easier by computers doing the work for me.

30. I would like to own a self-driving car.
31. Even if I had a self-driving car, I would still want to drive myself most of the time.
32. In a self-driving car, it will be important to me to have the option to turn off the computer and drive myself

Section three: Self-perceived driving abilities (15 questions)

For each item, please rate how well you currently do the following:
(0 = poor, 1 = fair, 2 = good, 3 = very good)

33. See road signs at a distance
34. See road signs at a distance (night)
35. See your speedometer and controls
36. See pavement lines (at night)
37. Avoid hitting curbs and medians
38. See vehicles coming up beside you
39. See objects on the road (at night) with glare from lights or wet roads
40. Quickly spot pedestrians stepping out from between parked cars
41. Move your foot quickly from the gas to the brake pedal
42. Make an over-the-shoulder check
43. Quickly find a street or exit in an unfamiliar area and heavy traffic
44. Get in and out of your car
45. Reverse or back up
46. Make quick driving decisions
47. Drive safely (avoid accidents)

(Attention check question #1) How old were you when you obtained your first driver's license?
____

Section four: Cognitive factors (10 questions)

Please describe how frequently you engage in each of the following activities in a typical year (prior to the COVID-19 pandemic): (0 = never did this activity/used to do, but not in the past year1 = less than once per month2 = 1-4 times per month3 = 5 or more times per month4 = every day)

48. Playing chess, bridge, or knowledge games
49. Solving crossword puzzles, acrostics
50. Reading books/stories
51. Writing letters
52. Doing original art/craft work
53. Doing art or craft kits/patterns
54. Preparing meals from new recipes
55. Cooking familiar recipes
56. Walking/driving in unfamiliar places
57. Attending church/religious activities

Section five: Physical factors (3 questions)

Prior to the COVID-19 pandemic, during a typical 7-day period (one week), on average, how many times do you do the following kinds of exercise for more than 15 minutes in your free time: Please answer using the number of separate occurrences. For example, for 7 times per week, enter "7" in the box. If you do not partake in the activity, please enter "0".

58. Strenuous exercise (heart beats rapidly)
    (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long-distance bicycling)
59. Moderate exercise (not exhausting)
    (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)
60. Mild/light exercise (minimal effort)
    (e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)

Section six: Social factors (12 questions)

Please indicate <u>your level of agreement</u> with each of the following statements: 1 = Strongly disagree; 2 = Disagree; 3 = Somewhat disagree; 4 = Neither agree or disagree; 5 = Somewhat agree; 6 = Agree; 7 = Strongly agree

61. There is a special person who is around when I am in need _____
62. There is a special person with whom I can share joys and sorrows _____
63. My family really tries to help me _____

64. I get the emotional help & support I need from my family _____
65. I have a special person who is a real source of comfort to me _____
66. My friends really try to help me _____

(Attention check #2) Please select “Somewhat Disagree.” This is to ensure that you are reading questions

67. I can count on my friends when things go wrong _____
68. I can talk about my problems with my family _____
69. I have friends with whom I can share my joys and sorrows _____
70. There is a special person in my life who cares about my feelings _____
71. My family is willing to help me make decisions _____
72. I can talk about my problems with my friends _____

(Attention check #3) In what year were you born?

____

(Optional) Please provide any comments or feedback that you would like to share with us.

____

Thank you again for your participation.

You can download the Information Sheet here (Download Link) to obtain information about the objectives of the study. If you have questions, comments, and/or concerns about this research project, please contact us.

Appendix B Correlation coefficients of item scores within measured scales

Table B1
Florida Cognitive Activities Scale (Cognitive Activity).

Item	1	2	3	4	5	6	7	8	9	10
Item 1	-									
Item 2	0.46	-								
Item 3	0.26	0.31	-							
Item 4	0.23	0.18	0.33	-						
Item 5	0.21	0.25	0.2	0.3	-					
Item 6	0.2	0.25	0.17	0.23	0.65	-				
Item 7	0.12	0.19	0.16	0.13	0.22	0.25	-			
Item 8	0.09	0.2	0.14	0.09	0.17	0.21	0.5	-		
Item 9	0.16	0.16	0.12	0.24	0.19	0.19	0.21	0.14	-	
Item 10	0.09	0.14	0.12	0.26	0.14	0.16	0.08	0.02	0.15	-
Cog Total	**0.55**	**0.63**	**0.55**	**0.54**	**0.62**	**0.61**	**0.52**	**0.46**	**0.44**	**0.39**

Note: Blue hue indicates positive values, where the darker shades represent higher values.

Table B2
Multidimensional Scale of Perceived Social Support (Social Support).

Item	1	2	3	4	5	6	7	8	9	10	11	12
Item 1	-											
Item 2	0.94	-										
Item 3	0.6	0.57	-									
Item 4	0.68	0.67	0.88	-								
Item 5	0.93	0.94	0.61	0.68	-							
Item 6	0.51	0.52	0.58	0.56	0.52	-						
Item 7	0.49	0.48	0.59	0.58	0.48	0.83	-					
Item 8	0.63	0.65	0.8	0.86	0.63	0.59	0.64	-				
Item 9	0.5	0.53	0.56	0.55	0.53	0.77	0.84	0.63	-			
Item 10	0.91	0.93	0.59	0.67	0.95	0.53	0.5	0.64	0.53	-		
Item 11	0.54	0.54	0.83	0.78	0.56	0.57	0.62	0.79	0.56	0.55	-	
Item 12	0.48	0.51	0.54	0.53	0.49	0.78	0.86	0.64	0.89	0.51	0.58	-
Social Total	**0.84**	**0.85**	**0.82**	**0.86**	**0.86**	**0.77**	**0.79**	**0.86**	**0.79**	**0.86**	**0.8**	**0.78**

Note: Blue hue indicates positive values, where the darker shades represent higher values.

Table B3
Self-driving Car Acceptance Scale (AV acceptance, subdimensions level).

Item	1	2	3	4	5	6	7	8
Item 1	-							
Item 2	0.54	-						
Item 3	0.77	0.57	-					
Item 4	0.12	0.22	0.21	-				
Item 5	0.75	0.6	0.67	0.15	-			
Item 6	0.61	0.43	0.53	0.07	0.59	-		
Item 7	0.39	0.26	0.3	-0.03	0.38	0.48	-	
Item 8	0.76	0.62	0.8	0.37	0.78	0.56	0.31	-
AV_all	**0.85**	**0.73**	**0.84**	**0.38**	**0.86**	**0.74**	**0.49**	**0.91**

Note: Blue hue indicates positive values, where the darker shades represent higher values.

Table B4
Self-driving Car Acceptance Scale (AV acceptance, item level)

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Item 1	-																							
Item 2	0.88	-																						
Item 3	0.46	0.43	-																					
Item 4	0.67	0.68	0.39	-																				
Item 5	0.67	0.69	0.4	0.85	-																			
Item 6	-0.38	-0.38	-0.17	-0.29	-0.32	-																		
Item 7	0.78	0.76	0.48	0.68	0.68	-0.31	-																	
Item 8	0.36	0.36	0.39	0.39	0.37	-0.12	0.41	-																
Item 9	0.53	0.5	0.48	0.5	0.5	-0.19	0.56	0.51	-															
Item 10	0.09	0.1	0.13	0.19	0.21	0	0.15	0.28	0.19	-														
Item 11	0.13	0.14	0.11	0.22	0.23	-0.04	0.14	0.21	0.14	0.64	-													
Item 12	0.02	0	0.09	0.04	0.06	0.11	0.08	0.12	0.08	0.61	0.41	-												
Item 13	0.57	0.59	0.27	0.62	0.66	-0.35	0.54	0.28	0.35	0.18	0.19	-0.03	-											
Item 14	0.72	0.73	0.36	0.72	0.74	-0.41	0.71	0.38	0.47	0.2	0.23	0.05	0.74	-										
Item 15	0.71	0.69	0.44	0.67	0.7	-0.33	0.69	0.32	0.5	0.12	0.14	-0.02	0.63	0.74	-									
Item 16	0.65	0.63	0.38	0.57	0.55	-0.23	0.61	0.26	0.42	0.09	0.11	-0.03	0.53	0.61	0.67	-								
Item 17	0.49	0.47	0.42	0.42	0.41	-0.1	0.52	0.2	0.4	0.08	0.11	-0.01	0.38	0.43	0.54	0.72	-							
Item 18	0.44	0.44	0.38	0.33	0.35	-0.08	0.47	0.15	0.34	0.05	0.06	0.01	0.33	0.37	0.49	0.66	0.85	-						
Item 19	0.41	0.39	0.18	0.38	0.39	-0.22	0.4	0.09	0.22	-0.02	0.07	-0.14	0.4	0.38	0.4	0.4	0.39	0.36	-					
Item 20	0.21	0.26	0.15	0.17	0.16	-0.07	0.26	-0.05	0.18	-0.04	0.02	-0.03	0.16	0.14	0.2	0.26	0.35	0.36	0.51	-				
Item 21	0.29	0.34	0.16	0.24	0.24	-0.1	0.34	-0.01	0.13	-0.03	0.03	-0.03	0.23	0.23	0.34	0.37	0.35	0.3	0.5	0.35	-			
Item 22	0.77	0.78	0.44	0.81	0.8	-0.41	0.8	0.4	0.54	0.16	0.2	0.02	0.69	0.81	0.74	0.67	0.54	0.46	0.5	0.25	0.31	-		
Item 23	0.58	0.59	0.46	0.58	0.59	-0.21	0.63	0.47	0.49	0.49	0.45	0.33	0.5	0.66	0.56	0.46	0.45	0.38	0.23	0.19	0.16	0.67	-	
Item 24	0.32	0.32	0.37	0.35	0.37	-0.15	0.36	0.64	0.44	0.33	0.26	0.18	0.28	0.38	0.33	0.24	0.21	0.17	0	0.01	-0.1	0.34	0.56	-
Total	0.8	0.81	0.57	0.81	0.81	-0.26	0.83	0.51	0.65	0.37	0.37	0.21	0.7	0.81	0.8	0.75	0.67	0.6	0.49	0.33	0.37	0.88	0.8	0.5

Note: Blue hue indicates positive values, where the darker shades represent higher values. Red hue indicates negative values, where the darker shades represent lower values.

Table B5
Self-Perceived Driving Ability (SPDA) Scale.

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Item 1	-														
Item 2	0.69	-													
Item 3	0.36	0.29	-												
Item 4	0.43	0.6	0.37	-											
Item 5	0.31	0.24	0.4	0.32	-										
Item 6	0.43	0.36	0.41	0.37	0.45	-									
Item 7	0.51	0.7	0.24	0.57	0.3	0.45	-								
Item 8	0.43	0.4	0.34	0.42	0.4	0.55	0.53	-							
Item 9	0.36	0.31	0.43	0.36	0.46	0.52	0.38	0.54	-						
Item 10	0.35	0.32	0.35	0.3	0.37	0.55	0.3	0.42	0.51	-					
Item 11	0.42	0.48	0.2	0.38	0.27	0.44	0.53	0.46	0.34	0.42	-				
Item 12	0.17	0.11	0.31	0.16	0.26	0.31	0.16	0.22	0.35	0.36	0.12	-			
Item 13	0.33	0.34	0.31	0.35	0.36	0.5	0.35	0.44	0.46	0.44	0.42	0.4	-		
Item 14	0.4	0.41	0.27	0.39	0.43	0.5	0.43	0.51	0.54	0.55	0.53	0.28	0.57	-	
Item 15	0.29	0.25	0.4	0.29	0.41	0.42	0.31	0.44	0.46	0.41	0.3	0.31	0.46	0.5	-
PDA Total	**0.67**	**0.7**	**0.54**	**0.67**	**0.58**	**0.72**	**0.73**	**0.72**	**0.69**	**0.66**	**0.67**	**0.43**	**0.68**	**0.74**	**0.6**

Note: Blue hue indicates positive values, where the darker shades represent higher values.

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