FOUNDATION FOR TRAFFIC SAFETY

RESEARCH BRIEF

Perceptions and Attitudes Towards Automated Vehicles, United States, 2021: Examining the Alignment Between Preferences for Adoption and Perceived Safety

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As emerging transportation technologies continue to evolve and society acknowledges the potential benefits, various automated technologies are becoming more prevalent and affordable on new vehicles. In conjunction with this trend, there have been increasing calls for some vehicle technologies to be equipped on all new vehicles to improve traffic safety (National Transportation Safety Board, n.d.). Efforts to help expedite this movement are critical to leverage the reported potential benefits through large-scale deployment of automated vehicles (AVs). To this end, additional studies to better understand public perceptions and attitudes towards AVs are necessary to continue to promote the adoption of AVs.

Past research by the AAA Foundation for Traffic Safety has examined public trust in, adoption of, and concerns about different levels of automated vehicles and how these measures have changed over time (Kim & Horrey, 2022). As a follow-up, this study focused on examining how well people's attitudes regarding AV adoption were aligned with their perceptions of the safety of driving or riding in AVs. Results showed that about three in four respondents were aligned in terms of the AV level they preferred to own and the level they felt was safest. Among those who were mismatched in their responses, the majority (78%) felt that lower levels of AV technology were safer than the level they preferred. Additionally, those who reported mismatched responses were more concerned about most potential AV issues examined in this study (e.g., technology malfunction, lack of driving control) compared to their counterparts.

Method

This study used data collected from the Traffic Safety Culture Index, which is a national online survey carried out by the AAA Foundation for Traffic Safety annually (AAA Foundation for Traffic Safety, 2022). Since 2018, this survey has included an additional set of questions about respondents' understanding, expectations, and concerns across different levels of AVs (following SAE J3016; Society of Automotive Engineers, 2021). Further details about the development of survey instrument are available in Kim et al. (2019). The survey was administered in English and Spanish to an online research panel whose participants were recruited based on standard probability-based random digit dial and address-based sampling methods. Data were collected from U.S. residents ages 16 or older. Weights applied to the data accounted for the probabilities of being selected as online panelists and as survey respondents, as well as of non-response at both recruitment stages. Further, weights were adjusted to align respondents' characteristics to those of the U.S. population.

More than 3,000 respondents completed the survey. Table 1 summarizes the total number of survey respondents (unweighted) in 2021 and their composition by age group

Table 1. Demographic distribution of the sample used for this study

	n (unweighted)	% (weighted)
Age		
16–18	922	4.7
19–24	133	7.9
25–39	511	25.5
40–64	1,114	41.9
≥ 65	702	20.1
Gender		
Male	1,687	48.4
Female	1,695	51.6
Total	**3,382**	**100**

and gender. A quarter of respondents to 2021 survey were between 25 years and 39 years old, and 52% were female (based on weighted results).

This study conducted descriptive analyses using cross-tabulations to examine people's attitudes towards AV adoption and perceived safety of AVs in relation to demographic factors. Additionally, this study explored how well respondents' attitudes towards AV adoption align with their perceived safety of AVs. It is noteworthy that while researchers used various instruments to characterize people's AV adoption and perceived safety in their studies (Zmud et al., 2016; Xu et al., 2018; Jing et al., 2019), this study used the following survey items to measure them, respectively:

- If cost was no barrier and you could own a vehicle with any level of automated technology within the next couple of years, with what level would you be most comfortable?
- What level of automated vehicle technology would you personally feel safest having in a car that you use regularly?

Both items allowed respondents to select one SAE AV Level from Level 0 to Level 5, which they think would be most applicable to them. All analyses were conducted based on weighted data, and the corrected Pearson F test (Rao and Scott, 1984) was used to test for significance. This brief reports results on the following topics:

- People's attitudes towards AV adoption in relation to age and gender
- People's perceptions of the safety of AVs in relation to age and gender
- Comparison between people's attitudes towards AV adoption and their perceived safety of AVs to examine the degree of alignment
- Comparison between people's attitudes towards AV adoption and their perceived safety of AVs, in relation to various factors (i.e., age, gender, vehicle model year owned, self-reported understanding of AVs)
- Comparison between people's attitudes towards AV adoption and their perceived safety of AVs, in relation to their concerns across AV levels

Results

Attitudes towards AV adoption

With respect to adoption, 26% of respondents reported preferring Levels 0 or 1 to own as their vehicles within the next couple of years, even if cost were no barrier, while 16% indicated interests in owning Level 5 AVs (Table 2).

The greatest proportion of respondents indicated Level 3 as their preference; however, this varied by age group. In general, teens and adults under 40 years tended to be more comfortable with higher AV levels (Levels 4 & 5), compared to those aged 40 years or older. Among those

Table 2. People's preferred vehicle automation level to own as their vehicles within the next couple of years overall and in relation to age and gender (weighted row %)

AV Level	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
Total	**13**	**13**	**19**	**23**	**15**	**16**
Age*						
16–18	12	10	17	24	17	21
19–24	9	11	16	25	19	20
25–39	11	10	15	21	22	20
40–64	14	14	20	24	13	15
≥ 65	17	17	25	24	9	9
Gender*						
Male	13	12	17	22	17	19
Female	13	14	22	24	14	13

* Statistically significant at $\alpha = 0.05$

Table 3. Vehicle automation level that people feel safest having in overall and in relation to age and gender (weighted row %)

AV Level	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
Total	**14**	**16**	**22**	**24**	**13**	**11**
Age*						
16–18	13	11	22	23	18	14
19–24	11	12	20	26	16	15
25–39	12	13	17	24	18	17
40–64	15	16	23	25	13	9
≥ 65	19	21	26	22	6	6
Gender*						
Male	15	14	18	23	15	14
Female	14	17	25	24	11	8

* Statistically significant at $\alpha = 0.05$

between 25 and 39 years of age, the greatest proportion indicated Level 4 as their preference (22%), whereas among those aged 65 or older, the most preferred AV level was Level 2, endorsed by a quarter of them.

For both males and females, the most preferred AV Level to own as their vehicles was Level 3, but males were more likely to prefer higher AV levels than females.

Perceptions of the safety of AVs

Overall, about a quarter of respondents reported that they would feel safest having a Level 3 AV that they use regularly. The proportions who would feel safest in lower-level AVs (Levels 0, 1, or 2) were greater than those who would feel safest in higher-level AVs (Levels 4 or 5). The propensity, however, varied by age group. More than half of teens and adults under 40 years reported they would feel safest in Level 3 or higher AVs. On the other hand, about two-third of respondents aged 65 years or older reported they would feel safest in Levels 0 to 2 AVs. With respect to gender, males were more likely to feel safe having in a higher-level AV than females.

Comparison between attitudes towards AV adoption and perceived safety of AVs

For approximately three quarters of respondents, the preferred AV level for ownership (AV adoption) corresponded to the same level they perceived as safest. Of these, 17% of respondents reported that they would prefer to own a Level 3 AV and would also feel safest at this level of automation—the AV level with the greatest proportion of matched responses. Meanwhile, 15% would prefer to own Level 2 and would also feel safest with this level of automation.

Among those whose responses regarding adoption and perceived safety were mismatched, the majority (78%) felt that a lower level of automation would be safer than the level they would prefer to own. Among those who reported they would prefer Level 3 AVs, 22% felt that a lower level of automation (Levels 0 to 2) would be safer, while 5% felt that higher levels (Levels 4 and 5) would be safer.

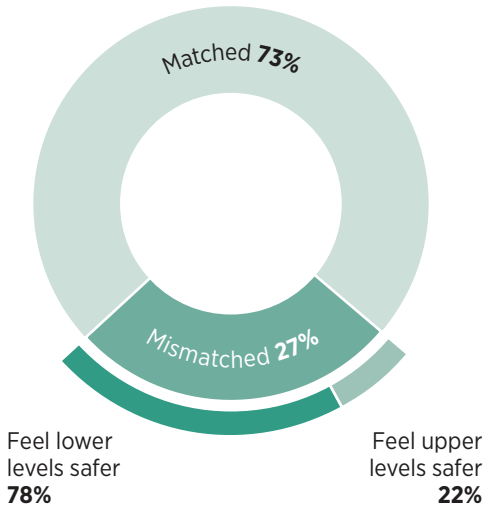

Figure 1. Comparison between AV level that people prefer to own and AV level that they feel safest having in

Further analyses investigated potential factors associated with these mismatches. However, no significant differences were found in relation to examined variables including age, gender, self-reported understanding levels of vehicle automations, and respondents' primary vehicle model year.

Concerns about AV levels

Respondents were asked to rate their degree of concern regarding several potential issues or shortcomings of AV technology. People whose responses were mismatched regarding adoption and perceived safety expressed

Table 4. Concerns about Level 2 AVs among those who would prefer to own a Level 2 AV in relation to responses to questions about AV adoption and perceived safety (% of respondents who were extremely or very concerned about each potential issue)

Concerns about Level 2 AVs	Ratings of Adoption and Perceived Safety	
	Matched	Mismatched
Technology Malfunction	46	58
Over-Reliance	39	55*
No Manual Driving Option†	NA	NA
No/Lack of Driving Control	27	47*
Purchase Price	42	54*
Vehicle Hacking	41	59*
Data Privacy	34	54*
Distraction/Annoying	21	42*
Confusion on How/When to Use	18	32*

* Statistically significant at $\alpha = 0.05$
† Not surveyed due to inapplicability

Table 5. Concerns about Level 3 AVs among those who would prefer to own a Level 3 AV in relation to responses to questions about AV adoption and perceived safety (% of respondents who were extremely or very concerned about each potential issue)

Concerns about Level 3 AVs	Ratings of Adoption and Perceived Safety	
	Matched	Mismatched
Technology Malfunction	50	62
Over-Reliance	43	50
No Manual Driving Option†	NA	NA
No/Lack of Driving Control	25	38
Purchase Price	66	62
Vehicle Hacking	44	52
Data Privacy	38	38
Distraction/Annoying	19	31
Confusion on How/When to Use	21	35*

* Statistically significant at $\alpha = 0.05$
† Not surveyed due to inapplicability

Table 6. Concerns about Level 4 AVs among those who would prefer to own a Level 4 AV in relation to responses to questions about AV adoption and perceived safety (% of respondents who were extremely or very concerned about each potential issue)

Concerns about Level 4 AVs	Ratings of Adoption and Perceived Safety	
	Matched	Mismatched
Technology Malfunction	42	61*
Over-Reliance	34	55*
No Manual Driving Option†	NA	NA
No/Lack of Driving Control	27	37
Purchase Price	65	79
Vehicle Hacking	36	47
Data Privacy	31	36
Distraction/Annoying	15	28*
Confusion on How/When to Use	18	24

* Statistically significant at $\alpha = 0.05$
† Not surveyed due to inapplicability

Table 7. Concerns about Level 5 AVs among those who would prefer to own a Level 5 AV in relation to responses to questions about AV adoption and perceived safety (% of respondents who were extremely or very concerned about each potential issue)

Concerns about Level 5 AVs	Ratings of Adoption and Perceived Safety	
	Matched	Mismatched
Technology Malfunction	39	58*
Over-Reliance†	NA	NA
No Manual Driving Option	14	49*
No/Lack of Driving Control	13	42*
Purchase Price	63	73
Vehicle Hacking	42	52
Data Privacy	30	47*
Distraction/Annoying†	NA	NA
Confusion on How/When to Use†	NA	NA

* Statistically significant at $\alpha = 0.05$
† Not surveyed due to inapplicability

greater concerns regarding most potential AV issues examined in this study compared to their counterparts who were aligned in their adoption and safety responses (Tables 4 to 7). For example, among those who would prefer to own a Level 2 AV but did not think this would be the safest AV level to drive or ride in, 55% were extremely or very concerned about people's over-reliance on Level 2 AV technology (Table 4), compared to 39% of respondents who would prefer to own a Level 5 AV and would feel safest with them.

Among those who would prefer to own a Level 5 AV but did not think it would be the safest to drive or ride in, nearly half were extremely or very concerned about the absence of a manual driving option in these vehicles. Those who would prefer to own a Level 5 AV and would feel safest in them were much less likely to be concerned about this issue (Table 7).

Discussion

Overall, the most preferred AV level for ownership was Level 3 (23%); however, the propensity varied by age group and gender. Respondents under 40 years old and males tended to prefer higher AV levels (Levels 4 and 5). Similarly, the AV level with the greatest proportion of respondents (24%) indicating they would feel safest in was Level 3, and respondents under 40 years old and males were more likely to feel safest in higher-level AVs. In general, people's propensities about AV adoption and perceived safety remained consistent (or similar) compared to past years' survey responses.

For about three in four respondents, the AV level they would prefer to own and that in which they would feel safest were aligned. Among those whose responses were mismatched, the majority (78%) felt a lower level of AV would be safer than the level they would prefer to own. Additionally, they tended to be more concerned about the majority of potential AV issues examined in this study (e.g., technology malfunction, lack of driving control) compared to their counterparts.

The divergence in ratings related to concerns over potential AV issues is one potential reason for the misalignment between perceptions of AV adoption and safety for some respondents. Nazari et al. (2019) also reported a significant negative association between people's safety concerns and AV adoption using a survey administered in California. However, it begs the question as to why this group would prefer to adopt a level of technology that was deemed less safe. Further analyses were unable to reveal factors associated with the alignment of adoption and perceived safety ratings. It could be that the factors examined in this study were not comprehensive enough to characterize this group. That is, this group might be characterized by more complex dynamics between personal attributes and opinions, and additional survey items may be needed. For example, consumer decisions are often driven by factors unrelated to safety. Xu et al. (2018) indicated that in addition to perceived safety, perceived usefulness and perceived ease of use affect people's AV acceptance. Similarly, Hassan et al. (2021) reported that older adults' openness to AVs were related to their perceived benefits from AVs (e.g., whether AVs assist driving-related tasks). Rahimi et al. (2020) also found that people's adoption and willingness to pay for AVs were associated with their modality style (e.g., auto-dependent users, all-mode users, and non-drivers). Meanwhile, some respondents might be more likely to attribute safety concerns to the general population, but not themselves personally (Horrey et al., 2015).

In the past decades, research has improved our knowledge about the characteristics of potential early AV adopters and how to promote public AV acceptance and adoption (Gandia et al., 2019; Lavieri et al., 2017; Krueger et al., 2016). However, a large proportion of the public might still be uneasy about the safety of AVs due to various reasons such as recent media coverage of crashes involving vehicles equipped with some level of vehicle automation. Therefore, continued efforts should be made to research whether and to what extent people's concerns as well as other factors will delay AV adoption and how to address these issues. Further, periodic studies should be conducted to monitor changes in public perceptions and attitudes towards AVs and inform development of public awareness and education strategies.

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The AAA Foundation for Traffic Safety is a 501(c)(3) nonprofit, publicly supported charitable research and education organization. It was founded in 1947 by the American Automobile Association to conduct research to address growing highway safety issues. The organization's mission is to identify traffic safety problems, foster research that seeks solutions, and disseminate information and educational materials. AAA Foundation funding comes from voluntary, tax-deductible contributions from motor clubs associated with the American Automobile Association and the Canadian Automobile Association, individual AAA club members, insurance companies and other individuals or groups.

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