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Public concerns and connected and automated vehicles: safety, privacy, and data security

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One dimension of the emerging politics of connected and automated vehicles (CAVs) is the development of public concerns over their societal implications and associated policy issues. This study uses original survey data from the United States to contribute to the anticipation of future policy and political issues for CAVs. Several studies have surveyed the public regarding CAVs; however, there are few studies that highlight the multidimensional public concerns that CAVs will most likely bring. The study breaks down the concept of "public" by showing that the demographic variables of gender, age, race, ethnicity, income, location (rural, suburban, urban), and political ideology (conservative, moderate, liberal) are significantly associated with three of the most salient public concerns to date (safety, privacy, and data security). Furthermore, the effects of demographic variables also vary across the type of policy issue. For example, women tend to be more concerned about safety than their male counterparts, and Hispanics (Latinx) tend to be more concerned about privacy than non-Hispanics. The research shows how the social scientific analysis of the "politics" of CAVs will require attention to the variegated connections between different types of public concern and different demographic variables.

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Introduction

Connected and automated vehicles (CAVs) are equipped with automated driving systems (ADSs) and use communication network systems that monitor other road users and can connect with distant sources. CAV technology is still under development, and in most cases only on-road testing is currently available. In the U.S., where there is already on-road testing of CAVs, some significant accidents have happened for CAVs and for vehicles with advanced driver assistance technologies. Consequently, consumer organizations have mobilized to include CAV safety in their purview, and they have drawn on public opinion polls to gain support for better regulation. For example, an annual survey in 2019 by the American Automobile Association (AAA), a nonprofit advocacy organization for vehicle owners and drivers, indicated that 71% of Americans were "afraid" of the technology (Edmonds, 2020). The AAA stated that this negative perception was partially due to the fact that Americans had been exposed to negative images of CAVs such as the accident in Arizona in 2018 that resulted in the death of a pedestrian (National Transportation Safety Board, 2018).

Thus, one of the areas where the politics of CAVs is already evident involves different views from public interest advocacy organizations and from industry about the need for regulation (Hess, 2020). Both groups can argue that their views represent the public interest on a range of issues, including safety. For example, a future of fully automated vehicles could promise to bring about a significant reduction of traffic-related accidents and fatalities, but in the short term the mix of human drivers and increasingly automated systems has also produced some dramatic safety lapses.

A crucial factor in the construction of the pace and parameters of automation is public opinion, and we argue that it is important to understand public opinion as part of social science research on the emergent politics of CAVs. Public opinion involves the expression of concern about or acceptance of CAVs in general and of more granular public policy issues such as safety and privacy. This study contributes to the broad social science problem of understanding the politics of CAVs by breaking down the concepts of public opinion and public policy and by exploring how different demographic categories relate to different policy issues. In the process, we contribute to an approach to the politics of CAVs that develops a more variegated and granular analysis of publics and policies.

To accomplish the goal, this study builds on and contributes to the emerging peer-reviewed literature on public opinion on CAVs (e.g., Cunningham et al., 2019; Liu, 2020; Tennant et al., 2019; Zhang et al., 2019). In the studies that have focused on public opinion and CAVs, the primary area analyzed for public concern has been safety, partly because of the media attention to accidents and partly because consumer safety organizations have a long track record of attention to automotive safety (Lee and Hess, 2020; Nunes et al., 2018). However, consumer and other advocacy organizations have also begun to point to other societal concerns and policy issues (Hess, 2020). Although there are many possible areas of public concern (including equity, sustainability, and democratic governance processes), this study focuses on the three issues of safety, privacy, and data security, with a rationale for the choice given below. We show how different positions in the social space (by gender, race, ethnicity, etc.) have varying relationships across the three issues. Thus, we show how the social scientific analysis of the "politics" of CAVs can benefit from attention to the variegated connections between different demographic variables and different areas of public concern and associated policies.

Background

Conceptual background. When approaching a broad and nebulous topic such as the "politics" of an emerging technology for which the societal implications are not well understood, it is helpful to begin with some basic definitions. We understand the term "politics" to involve the exercise of power in a wide range of social fields, including in political fields. Power is the capacity to influence the world, including the goals or preferences of other actors, and it is based on the ability to marshal resources or capital in specific circumstances, institutional settings, or social fields. One of the most important ways that power is exercised is via what Bourdieu (2014) calls "symbolic power," a multifaceted concept that we will understand here as the development of cognitive categories, rules, or dispositions that become widely embedded in taken-for-granted practices.

We focus on formal rules that are expressed as law, such as traffic or privacy rules, and that can become embedded in practices and accepted with little questioning. For example, under most circumstances, one stops habitually at a red light. Although rules can become embedded in practices and left unquestioned, they can also become subject to episodes of contention, and we suggest that with the emergence of CAVs, there have been some conflicts. For example, as indicated above, during the 2015–2020 period, consumer organizations in the U.S. began to identify a range of concerns with the rush to put CAVs on the road, and they called for a slower pace and the need for greater policy guidance of the new technology (Hess, 2020). These organizations identified broader citizen or public interest perspectives in the policy debates and conflicts, and in this sense, they helped to articulate and develop the politics of CAVs. Rather than understand the public as "consumers" who need to be educated in order to accept the new technology, the organizations developed a view of the public as citizens who are (or should be) engaged in the steering of technological directions and futures (see also Milakis and Müller, 2021).

Safety, privacy, and data security defined. As indicated above, three of the most prominent areas of public concern to date are safety, privacy, and data security. Although there are other issues related to CAVs such as equity and sustainability, we limit the current analysis to these three dimensions for two reasons. First, there is already a history of politics and policy for regulatory frameworks on transportation safety and on privacy principles (such as the Fair Information Practice Principles) for digital technologies. Second, because these three issues are widely discussed in the media and are the central challenges addressed by civil society organizations (Hess, 2020; Pattinson et al., 2020), survey respondents are more likely to be familiar with societal concerns associated with them.

With respect to safety, consumer organizations in the U.S. have argued that vehicle automation should focus first on driver assistance technologies (such as lane control and parking assistance) rather than immediately moving toward advanced technologies. The resulting incremental approach would also allow time to develop a better understanding of how fundamental definitions of safety and related regulations will need to change. On this point, Stilgoe (2018) stated that we should not compare the safety of CAVs with that of conventional vehicles, but instead we should focus on developing social institutions that can address safety in the new context of CAVs on the road. Likewise, Lee and Hess (2020) noted that regulatory approaches to safety and definitions of safety vary across countries, whereas the CAV technologies are being used internationally. Thus, one of the

contributions of a social science perspective to the politics of CAVs is to point to the social construction or shaping of policy issues such as safety.

Two other and related emerging policy issues are privacy (such as information collected about personal trips and pedestrians) and data security (related to hacking). CAVs need to be data driven and will constantly collect data and make connections with each other, other road users, and infrastructural settings. As Cohen et al. (2020) argued, data-related questions such as ownership, use, and sharing will become more politically important as CAVs integrate and continue to collect data. They claimed that data collection and data systems will require subnational or federal level formal regulations instead of relying on industry-led voluntary self-regulation. In other policy domains with highly automated systems, such as the smart grid, privacy and security concerns have already become salient, and trade-offs between consumer protections and system functionality have emerged (Lee and Hess, 2021). Thus, privacy and security are likely to emerge as increasingly contentious areas in the politics of CAVs.

There are several possible approaches to the social science analysis of the politics of issues such as safety, privacy, and data security. As indicated above, some studies focus on what public interest advocacy organizations are saying, others focus on how concepts such as safety are constructed, and others focus on sociotechnical analyses of how technological developments create new policy problems (which in turn lead to feedback loops from policy). We argue that it is also important to understand current public concerns on these issues for several reasons. First, as indicated above, public concerns can be a point of reference in debates in the public sphere and in policy arenas; in other words, policymakers, industry groups, and public interest advocacy organizations all tend to frame their particular political views as serving the public interest. Empirically, opinion polls that support or undermine these legitimation frames can become a point of reference in the rule-making processes. Second, a better understanding of the demographics of public opinion on these issues can point to new challenges and opportunities for policy change, and it can draw attention to how issues such as safety may have different meanings or levels of salience across demographic categories. In other words, there is no single public opinion, but the opinions break down by various demographic categories or positions in the social space. The variegated nature of public opinion will then affect and inform which types of concerns become salient and, potentially, what the composition of coalitions will be if and when they emerge on specific issues.

Levels of automation. The politics of CAVs emerge along several dimensions, including definitions of automation. A standard, international approach is the set of categories developed by SAE International (2018), which defines six levels of vehicle automation. The SAE standard is widely used, although some countries such as Germany have developed their own levels of automation. At level 0, only limited warnings and emergency interventions are provided to an active human driver. At the other end of the spectrum, level 5 indicates a fully autonomous mode that requires no driver presence and no remote monitoring. Although many companies are striving to achieve level-5 automation, it is unlikely that consumers will regularly interact with level-5 CAVs in everyday settings in the near future. Currently, most vehicles remain at level 3, which requires human driver monitoring and may even prompt drivers or monitoring systems to take over at times. Although some analysts have argued that a human driver will always be necessary (e.g., Nunes et al., 2018), many engineers believe, and the SAE categories assume, that it will be possible to have vehicles without a human driver. Indeed, use categories for high levels of automation already exist for some operational design domains, such as small food delivery vehicles and buses or trains with a clearly demarcated route.

The idea of levels of automation connects with the politics of CAVs in several ways. As indicated above, some consumer safety organizations have argued that regulatory push should steer automation toward the lower levels of driver-assisted technology (Hess, 2020). Hopkins and Schwanen (2021) also argued that the concept of levels of automation implies that the development and innovation of CAVs would be linear and orderly. They suggested that the concept can lead to technocentric attitudes towards CAVs, without much comprehension of the intricate communication and interaction that happen on roads.

As the category of "CAV" can include a variety of levels of automation, it is important to specify what types of automation are under discussion. Thus, methodologically, researchers need to be aware of the differences of understanding both among engineers and policymakers and among the broader public, and we provide clear definitions in the research that follows.

Demographic factors and public opinion. With the argument now developed that public concerns and specific policy issues should be included as part of the social science research portfolio on the politics of CAVs, this section discusses the background social science literature on the topic. Most studies of public perceptions of CAVs have focused on demographic variables such as gender, age, and income for their independent variables. These studies provide an important foundation for public opinion research on CAVs and the basis for control variables for multivariate analyses. In this section, we discuss several of the most important and discussed independent variables.

Regarding gender and the public attitudes towards CAVs, studies consistently show that male drivers are more likely to be interested in and willing to accept CAVs (Bansal et al., 2016; Hohenberger et al., 2016; Zmud et al., 2016). In particular, Bansal et al. (2016) showed that in the U.S., technology-savvy males are more likely to show a greater interest in new technologies with less dependence on others' adoption rates. The relationship between gender and technological savviness is also shown in the information technology domain with computer science and engineering, which is largely dominated by males (Cukier et al., 2002).

Age is also one of the central predictors for driving-related studies (Abraham et al., 2017), but results are not consistent. Researchers have found that younger individuals in the U.K. and New York City are more likely to want to adopt shared automated vehicles (Hulse et al., 2018; Krueger et al., 2016). One reason is that the older generation in Europe, the U.S., Australia, and China is more dependent on private cars and less likely to adopt novel technologies such as ride-sourcing services (Alsnih and Hensher, 2003; Krueger et al., 2016; Zhang et al., 2020). Abraham et al. (2017) also found that younger and middle-aged adults in the U.S. are more likely to be open to fully automated vehicles, and Hohenberger et al. (2016) showed that younger drivers in Germany are more likely to find automated cars pleasurable rather than anxiety-inducing. However, some studies claimed that age is not a significant variable when other contextual aspects are taken into account. For example, Payre et al. (2014) conducted an online survey of French drivers and found that age had no effect on having an interest in CAVs when "contextual acceptability" was introduced, which consisted of questions that had conditions (e.g., if driving was boring to me, if I had passengers in my automated car, if I were over the drink driving limit, if I were tired, etc.).

With respect to gender and age together, Hohenberger et al. (2016) found that in Germany, male drivers are more likely to find CAVs attractive than female drivers, but men are more likely than women to be enthusiastic about CAVs at a younger age, and their interests gradually decrease over time. However, women who are interested in CAVs tend to maintain their interest in the technology across age categories.

Two other variables, income and educational level, are often correlated because high-income earners tend to have a greater likelihood of a higher level of education (Cunningham et al., 2019). Regarding income, Punj (2012) found that high-income earners in the U.S. are more likely to be interested in saving time than money, which can lead to the assumption that they are more likely to invest in the technology, and Whillans et al. (2017) showed that for U.S., Denmark, Canada, and the Netherlands, spending money to save time leads to greater happiness. Furthermore, the high cost associated with the ownership of CAVs means that the technology may be unaffordable to low-income households (Nunes et al., 2020). Although higher earners are more likely to want to own CAVs and to be able to do so, Litman (2020), using Canadian data, argued that low-income individuals can also benefit from ride-sourcing services that use CAVs.

With respect to education, Duncan et al. (2015) found that in the U.S., highly educated respondents showed greater familiarity with CAVs, a more positive opinion, and higher comfort levels. Additionally, Cunningham et al. (2019) found that Australians with a higher level of education tend to agree with the positive benefits of CAVs and are more likely to want to adopt the technology, but they show less agreement with the prospect of being completely dependent on CAVs.

With respect to race and ethnicity, Duncan et al. (2015) found that in the U.S., race (White vs. non-White) was not significantly related to any of the dependent variables (familiarity, general opinion of CAVs, personal comfort in CAVs, placing a loved one in a CAV, and willingness to use CAVs). However, the study showed that Hispanics consistently held more positive views towards CAVs compared to non-Hispanics. Considering that Hispanic identity is an important predictor mostly in North America, more specifically the U.S., this variable is not likely to be important in other geographical regions.

In the broader social science literature, researchers have found complex relationships between some of the variables above (e.g., education, race) and political views (e.g., Meyer, 2017). Building on such background research, it is possible that public interest in CAVs and public concerns about CAVs could be shaped in part by ideological preferences, especially in a country where many policy-related views have become politically polarized. However, we also note that the existing literature does not provide guidance on what kind of association to expect with respect to the relationship between political views and public acceptance or concerns.

Public concerns and safety, privacy, and data security. This study builds on existing research using demographic independent variables to bring a more focused attention to how different demographic variables are associated with three areas of public concern as the dependent variables. Although there is a social science literature on CAV regulations on safety (Lee and Hess, 2020), and there are also some discussions of privacy and security of CAVs (Barnes, 2018; Bonnefon et al., 2020; Chowdhury et al., 2020), the literature on CAVs and public opinion has not provided a comprehensive analysis of the relationships between demographic differences and concerns with safety, privacy, and data security.

Safety. As discussed above, the concept of safety in the context of CAVs is not limited to technology design but includes the interaction of CAVs with humans and the driving environment. Generally, the research on public opinion and safety of CAVs is divided. To some degree, the differences may be due to how "safety" is conceptualized. Safety for CAVs has two components: the mechanical notions of safety that are defined by technological reliability, and human elements of safety, which include driver behavior and the perception of safety among road users. The studies of CAVs usually consider both elements of safety.

Several studies found that safety and convenience were the most attractive features of CAVs in both North America (Howard and Dai, 2014) and Europe (Cohen et al., 2020). Likewise, Begg (2014) found that 60% of respondents in London agreed or strongly agreed that CAVs would increase the overall safety of road conditions. Lustgarten and LeVine (2018) also found that their respondents in the U.S. ranked the "highest possible level of safety" as the single most important benefit of CAVs (Lustgarten and LeVine, 2018: p. 78).

Other researchers found that the public's attitudes towards CAV safety tend to be negative and also to show concern with accidents and technology failures. Regan et al. (2017) showed that less than a half of the respondents in Australia thought that CAVs could be safer than a vehicle manually controlled by a human, and Schoettle and Sivak (2014) found that safety-related questions represented the highest type of concern from the public in the U.S., U.K., and Australia. The safety-related statements from their study include "safety consequences of equipment failure or system failure" and "self-driving vehicles getting confused by unexpected situations" (Schoettle and Sivak, 2014: p. 14). Similarly, Liljamo et al.'s (2018) study in Finland identified safety as the biggest reason for concern. Overall, we find that safety is considered as one of the central—if not the central—issues of public concern in many countries that have started developing and testing CAVs.

There is currently a gap in the literature on how demographic factors affect views on safety for CAVs. However, there are some related studies on two demographic factors (gender and age) and the broader topic of safety-related driving practices. For example, Gwyther and Holland (2014) found that female drivers in the U.K. are more likely to self-regulate, which refers to driving behavior that minimizes risk and avoids challenging driving conditions (e.g., poor weather conditions, nighttime, or during rush hours). Gender is also found to be a statistically significant variable in understanding safety in public transport, with women being more likely to feel unsafe in the U.K. (Ouali et al., 2020). Gender has also been an important demographic characteristic in the U.S. regarding safety and transportation. Women in the U.S. also register negative safety associations with CAVs (Charness et al., 2018; Pyrialakou et al., 2020). Moreover, Yavuz and Welch (2010) found that women are more likely to be affected by safety-related problems than men for train transit in Chicago.

Furthermore, age is an important variable in both the U.K. and the U.S. Gwyther and Holland (2014) found that younger and older drivers are more likely to self-regulate compared to the middle-age group in the U.K. The association between safety and age was slightly different in the U.S., where younger drivers were found to feel safer in CAVs compared to older respondents (Pyrialakou et al., 2020). In summary, these findings of driving behavior indicate that gender and age could also affect perceptions of CAV safety.

Privacy. Cyber-physical systems depend on extensive data collection and processing, and CAVs are no exception. Privacy concerns for CAVs include driving location and routes; data

collected on drivers, passengers, and other road users; and for shared automated vehicles, records of using the service. Furthermore, Atmaca et al. (2019) and He et al. (2017) claimed that location data can be used in data science to correlate with identity. Other temporal data can be used to infer additional personal information, such as home/work locations, age, job, behavioral features, habits, and social relationships. This discussion of data brings in privacy-related social questions of "data bias, data ownership, data use, and data sharing," which have become one of the central themes in the politics of CAVs (Cohen et al., 2020).

Despite the potential for new forms of data collection about individual identities and mobility patterns, privacy tends to be a secondary concern in comparison with other societal implications such as safety. Several studies have shown that privacy is currently of relatively low concern for respondents regardless of their geographical location (Cunningham et al., 2019; Kyriakidis et al., 2015; Liljamo et al., 2018; Schoettle and Sivak, 2014). It is possible that the relatively low current concern with privacy will change as the vehicles become more widely used and as the public becomes more aware of the privacy issues. Nevertheless, survey respondents located in the U.S. who show a higher level of privacy concern about CAVs or about using Internet or Internet-enabled technologies are also less likely to want to use CAVs (Zmud, 2016).

Although studies indicate that CAVs pose significant new challenges to privacy, there is little research on public opinion and privacy for CAVs. Schoettle and Sivak's (2014) international study found that respondents in China and India are more concerned about privacy, such as location and destination tracking, compared to respondents in more economically advanced countries, such as Australia, Japan, the U.K., and the U.S. To date, there are no studies published yet on how demographic variables affect privacy concerns for CAVs. Regarding gender and privacy, there is some dispute. Studies of social media and privacy show that women have a stronger preference for privacy (Lewis et al., 2008) and that men are more willing to disclose their basic information compared to women (Chang and Heo, 2014). However, in the ride-sourcing literature, Lavieri and Bhat (2019) found that the relationship between gender and an individual's level of privacy-sensitivity was found to be statistically insignificant. Regarding age, older or middle-aged adults are more likely to be concerned about privacy compared to younger age groups (Van den Broeck et al., 2015).

Furthermore, there is some research that suggests that for a new technology, people with conservative political views are especially concerned about privacy and governmental intrusion. This social trend is shown in a study that focused on right-wing groups' privacy concerns over smart meters in the U.S. (Hess, 2014). Again, the topic is not well researched in the public opinion literature of CAVs. Thus, we would expect that demographic variables such as gender and age would be related to privacy concerns, but we do not know if political views have any relationship with privacy for CAVs.

Data security. Data security is different from privacy because it primarily concerns hacking and other criminal activities associated with data collected by cyber-physical systems such as CAVs. Although security breaches can entail privacy breaches, they also pose other risks to individuals and society. Several studies found that in Europe, the public has concerns regarding system and vehicle security of CAVs (Cunningham et al., 2019; Wicki and Bernauer, 2018). Kyriakidis et al. (2015) collected data from 109 countries and showed that software hacking and misuse rank first among concerns over fully automated driving, which was then followed by legal, safety, joy (not being able to enjoy driving), and privacy. Schoettle and Sivak (2014) showed that U.S. consumers are more likely to be concerned about system and vehicle security from hackers compared to the consumers located in the U.K. or Australia.

Although the current literature does not provide insight into the demographic factors that are associated with data security concerns, the broader literature on computers and human behavior suggests that women tend to be more anxious about hacking than men (Elhai et al., 2017 for the U.S. and Korea). Similarly, Wilkowska and Ziefle (2012) found that in Germany, regarding health data, females and healthy adults tend to have higher standards for security compared to males and people in poorer health.

Hypotheses and research questions. Although some studies have already discussed a few of the demographic differences in relationship to CAVs and public concerns, there is little systematic discussion of how different demographic variables are associated with the issues of safety, privacy, and data security. We also consider a wider range of demographic variables than is presently in discussion in the literature (e.g., rural-urban location and political views).

Using the patterns found in the background literature as a reference point, we propose hypotheses for gender, age, education, and income. For other independent variables (i.e., non-White, Hispanic, urban/rural residence, political views) used in this study, the background literature does not have any evidence to suggest a specific relationship with the dependent variables (i.e., the public opinion on safety, privacy, and data security), and we leave them open ended as research questions. Regarding urban/rural residence, this variable is not widely discussed in the CAV literature. Nevertheless, we believe this variable to be salient because it has implications regarding public transportation access and ride-sourcing (Beojone and Geroliminis, 2021; Yu et al., 2020). Although the CAV survey literature does not examine this variable, residential environments could have a significant impact on how people perceive CAV technologies because access to public transportation and ride-sourcing could affect an individual's perception of CAVs.

Safety. H1-1: Female respondents tend to be more concerned about CAV safety compared to their male counterparts.

H1-2: Older respondents tend to be more concerned about CAV safety compared to their younger counterparts.

H1-3: Respondents with higher educational attainment tend to be more concerned about CAV safety compared to the respondents with lower educational attainment.

H1-4: Respondents with higher income tend to be more concerned about CAV safety compared to the respondents with lower income.

Privacy. H2-1: Female respondents tend to be more concerned about CAV privacy compared to their male counterparts.

H2-2: Older respondents tend to be more concerned about CAV privacy compared to their younger counterparts.

H2-3: Respondents with higher educational attainment tend to be more concerned about CAV privacy compared to the respondents with lower educational attainment.

H2-4: Respondents with higher income tend to be more concerned about CAV privacy compared to the respondents with lower income.

Data security. H3-1: Female respondents tend to be concerned about CAV security compared to their male counterparts.

H3-2: Older respondents tend to be more concerned about CAV security compared to their younger counterparts.

H3-3: Respondents with higher educational attainment tend to be more concerned about CAV security compared to the respondents with lower educational attainment.

H3-4: Respondents with higher income tend to be more concerned about CAV security compared to the respondents with lower income.

Additional research questions. We add additional research questions that involve demographic issues that are particularly important in the U.S. context but that may have some relevance for other countries. Definitions of the terms and the rationale for including them follow in the methods section.

1. What is the relationship between CAV safety, privacy, security and being White/non-White?
2. What is the relationship between CAV safety, privacy, security and being Hispanic/non-Hispanic?
3. What is the relationship between CAV safety, privacy, security and urban/rural residence?
4. What is the relationship between CAV safety, privacy, security and political views?

Methods

Data collection. In order to collect data on public opinion, two existing survey platforms were used: REDCap to create the survey and Amazon Mechanical Turk (MTurk) as the survey distributor. To pilot the survey, internally four undergraduate and two graduate students took the survey on REDCap. After receiving feedback from the pilot study's participants, we edited some of the questions to make the phrasing clearer and easier to read. Furthermore, we changed some questions from "choose all that apply" to only providing the option to choose one answer. We had four inclusion criteria for the survey: (1) respondents must be 21 years old or older; (2) respondents must not have taken this survey before; (3) respondents must be residing in the U.S. as a citizen or a legal alien; and (4) respondents must know what self-driving cars (autonomous or automated vehicles) are. (The fourth item was used as a preliminary screen; we then provided respondents with our working definition when the relevant questions begin at question #14.) On MTurk, four separate batches were created to collect the total of 1000 observations. All participants who completed the survey were rewarded $1.00, which is considered a standard amount for a survey of this length.

Using MTurk has both advantages and disadvantages. One of the most important advantages of using MTurk is that it does not have the same high-cost barrier to entry like other paid survey platforms, and it is now widely used in the peer-reviewed literature, especially to collect data on public perceptions of social and technological issues. In particular, MTurk has been widely used to collect data on public perceptions due to the lack of existing data on this topic (Hewitt et al., 2019; Li et al., 2016; Mason et al., 2021; Winter et al., 2018). We argue that MTurk is a widely used online platform for surveys that provide a scientific understanding of the general public. A number of studies have used MTurk for social science research (e.g., Buhrmester et al., 2018; Hess and Maki, 2019). Nevertheless, we understand that MTurk has been criticized in the past for providing a sample that is skewed toward college educated respondents. In order to correct for this bias, we include educational attainment in all of our analysis. The educational attainment variable serves as a variable of interest (i.e., independent variable), but it also functions as a control variable that corrects educational bias that can occur. Furthermore, we note that using MTurk might also lead to some unidentifiable sampling biases such as survey accessibility, respondent characteristics, and prior interest in the survey topic. Consequently, we clarify that our descriptive and univariate statistics are not generalizable to the wider public as they do not account for this sampling bias.

In cleaning the data, we deleted the following observations: incomplete survey responses (76 responses, but they would not have been included in the list of 1000 completed survey responses); survey responses without identifiable worker ID (10 responses), which is provided by Amazon; and respondents who had completed the survey in more than one batch, or duplicates (56 responses). Identifiable worker ID is important in making sure that there are no duplicates, and the respondents who had completed more than one survey were deleted completely because the validity of their responses could not be trusted. In order to test response validity, two questions were asked to check the consistency of the respondents' answers (questions 10 and 12; refer to the Supplementary appendix for the questions). Respondents who answered the questions inconsistently were deleted from the sample. The check resulted in 20 responses being deleted. In short, we started with 1,000 completed responses, and after removing unidentifiable responses (10), duplicates (56), and unreliable responses (20), our final N was 914.

Variables of interest

Dependent variables. This study has three dependent variables, which measure public opinion on safety, privacy, and security. In order to measure respondents' views on safety, the survey asked, "In general, how safe do you feel about riding a car that is completely automated with no driver?" The ordinal options provided were "Very safe," "Somewhat safe," "Neutral," "Somewhat unsafe," and "Very unsafe." The question asked to measure privacy is: "Assume that you own a car with Internet connectivity such as Bluetooth or map connections. How concerned are you that IT companies are collecting information about where you are driving?" To obtain data on security, the survey asked: "Assume that you own a car that has Internet connectivity and remote updating from the manufacturer. Remote updating means that the computer on your car can be updated automatically via its wireless Internet connection. How concerned would you be about your car's system getting hacked?" For the questions on privacy and security, the response options remained the same: "Very concerned," "Somewhat concerned," "Neutral," "Not very concerned," and "Not concerned at all." We also had a question on ride-sourcing security, which asked, "Assume that in 10 years, all ride sharing services will be completely automated without a driver." The findings of this dependent variable were the same as for the general security question; therefore, the results are not included in this study.

During the formulation of the survey questions, we thought that the respondents may not find the distinction between privacy and security to be very clear. To make the distinctions abundantly clear without taking up too much space or require extensive reading, we added what each concept means in the questions (e.g., 17 and 18). Refer to the Supplementary appendix for these questions.

Independent variables. We include the following demographic variables to measure whether some groups show different attitudes towards automated vehicles.

Gender. Many studies in the past have indicated that male respondents are more likely to be familiar with and interested in CAVs. In order to control for gendered differences and also to provide further analysis on how gender affects interestedness in

automated vehicles and concerns over safety, privacy, and security, we add gender to our models. Females are coded as 1 and male is coded as 0.

Age. Previous studies found that younger people generally show more familiarity and interestedness in CAVs. The respondents were asked to choose one of the age categories, which are 21–30, 31–40, 41–50, 51–60, 61–70, and Over 70. Once the survey was completed, we decided to merge the 61–70 to over 70 group because we only had 7 participants who were over 70 (61 respondents had selected 61–70). Therefore, the oldest group was changed to "over 60."

Race and ethnicity. There are two race and ethnicity variables that we include in the analysis: non-White and Hispanic. The survey question on race asked the respondents to check all race groups that they identified with. This resulted in several dummy variables such as White/non-White and Black/non-Black. Initially, we had included the most commonly used race dummy variables, which were non-Black and non-White. Furthermore, other race dummy variables did not have enough variance to be added to the model. However, due to multicollinearity, we decided to drop non-Black. We kept non-White instead of non-Black because the non-White variable is used to show whether identity as a racial minority leads to different perceptions on automated vehicles. For the final analysis, we only used the non-White variable to indicate race. Furthermore, we used the non-White variable to incorporate the level of privilege that respondents maybe accustomed to and how this may affect their views on automated vehicles. With the non-White variable, we assigned the value of 1 to all respondents who did not choose White as one of their race groups, and the rest were coded as 0.

Hispanic (Latinx) is the ethnicity variable included in this study. In the U.S. context, adding Hispanic as a variable for demographic characteristics is standard practice. Furthermore, some studies claim that Hispanic identity can affect individual's perception towards CAVs (Duncan et al., 2015, Rahimi et al., 2020). Hispanics can be White or non-White and are considered as a separate demographic variable from race. Hispanics are coded as 1 and non-Hispanics are coded as 0.

Education. The education variable is divided into four groups, "High School Graduates," "Some College," "Bachelors," and "Masters." "Doctorate" was also an option in the survey but the response rate to the doctorate category was 0.

Income. In the survey, we divided income into five groups: "Less than $10,000," "$10,000–$49,000," "$50,000–$99,999," "$100,000–$149,999," and "More than $150,000." In order to simplify interpretation of the income variable, we collapsed the categories into three groups: "less than $50,000," "$50,000–$100,000," and "more than $100,000." In our survey, the income variable did not correlate highly with the education variable using Spearman's rank order correlation, with $\rho = 0.077$. Therefore, there is no multicollinearity problem with adding both income and education in the models.

Political views. Although the CAV survey literature does not include this variable, we include it in our models because there is some research in general that indicates a connection between political views and beliefs in privacy with more conservative groups showing greater concern for individual privacy (Hess, 2014). Moreover, in the context of a broader literature on the politics of CAVs, this variable is of interest. In the survey, the variable was grouped into five categories: "Very Conservative," "Conservative," "Moderate," "Liberal," and "Very Liberal." In the U.S. context, the term "Liberal" means progressive or left-leaning. For the purpose of data analysis and to not use up unnecessary degrees of freedom, we binned the five categories into three groups: "Conservative," "Moderate," and "Liberal."

Urban and rural. Although the CAV survey literature does not examine this variable, residential environments could have a significant impact on how people perceive CAV technologies because access to public transportation and ride-sourcing can affect individual's perception of CAVs. This is particularly the case in the U.S., where many rural areas do not have any public transit infrastructure, whereas urban areas often do not require an ownership of a vehicle. Furthermore, CAVs are expected to change urban infrastructure with a reduced need for parking space, but it can also impact rural drivers, who are generally expected to drive longer than urban residents. This variable is grouped into three categories: "Urban/City," "Suburbs," and "Rural."

Data analytic strategies and missing data. As the dependent variables include ordinal variables, we use proportional odds ordered logistic regression analysis (polr function in MASS package in R). We used the Lipsitz goodness-of-fit test for ordinal response models and the Hosmer and Lemeshow test for model fit, which were acceptable for all models. In order to rectify the multicollinearity problem, we deleted car ownership. All other variables' $GVIF^{\left(\frac{1}{2df}\right)}$ range was between 1.05 and 2.73, with most of them below 2.

To account for missing data (refer to Table 1), we used Bayesian multiple imputation to fill in any missing responses, which is available in the Hmisc package in R under aregImpute function. Here, we are assuming that our missing data are missing at random (MAR), and although statistical significance does not change with the imputation, coefficients do change. This understanding of multiple imputation follows Harrell's (2015) arguments on dealing with missing data, who stated that casewise deletion for missing data "results in regression coefficient estimates that can be terribly biased, imprecise, or both" (2015: p. 47). Consequently, we do not conduct casewise deletion for missing data and instead use bootstrap to approximate predicted values from a full Bayesian predictive distribution.

Table 1 shows the counts and the numbers of missing observations for all variables used in this study. Overall, the descriptive statistics show that the respondents are divided on the issue of safety, with a slightly greater number of people considering automated vehicles to be at least "somewhat safe." For privacy and security, there is a greater number of people stating that they are at least "somewhat concerned." Overall, Table 1 shows that the public has diversified public perception. The next section shows how demographic variables relate to public opinion.

Results

This section shows the results of the proportional odds ordered logistic regression analyses. Because of the large number of variables included in the analyses, we only discuss the variables that are statistically significant at 5%. Additionally, we also show the AIC to enable the comparison of model fit for each analysis. Table 2 shows the coefficients of the ordered logistic regression model using safety (defined above) as the dependent variable. For women, the odds of being more concerned about safety are 1.4 times that of men. Respondents in the age group of over 60 are 2.2 times more likely to be concerned about safety compared to the 21–30 age group. However, in comparison with the age group 21–30, other age groups are not found to be statistically

Table 1 Descriptive statistics.

Variable	Sub-category	Count	Percentages	Missing observations
Safety	Very safe	115	12.6	2
	Somewhat safe	337	37.0	
	Neutral	160	17.5	
	Somewhat unsafe	200	21.9	
	Very unsafe	100	11.0	
Privacy	Not concerned at all	52	5.7	1
	Not very concerned	200	21.9	
	Neutral	149	16.3	
	Somewhat concerned	348	38.1	
	Very concerned	164	18.0	
Security	Not concerned at all	46	5.0	1
	Not very concerned	222	24.3	
	Neutral	128	14.0	
	Somewhat concerned	365	40.0	
	Very concerned	152	16.7	
Gender	Female	387	42.6	5
	Male	522	57.4	
Age	21–30	225	24.7	2
	31–40	372	40.8	
	41–50	161	17.7	
	51–60	86	9.4	
	Over 60	68	7.5	
Race and ethnicity	Non-White	136	14.9	0
	White	778	85.1	
	Hispanic	63	6.9	6
	Non-Hispanic	845	93.1	
Education	High school	96	10.3	3
	Some college	247	27.2	
	Bachelors	548	60.3	
	Masters	20	2.2	
Income	Less than $50,000	482	52.8	1
	$50,000 - $100,000	337	36.9	
	More than $100,000	94	10.3	
Urban and rural	City/urban	267	29.6	13
	Suburbs	480	53.3	
	Rural	154	17.1	
Political views	Conservative	248	27.3	4
	Moderate	211	23.2	
	Liberal	451	49.6	

significant. In other words, the only statistically significant difference regarding age is between the youngest and the oldest group. For non-White respondents, the odds of being more concerned about safety are 1.4 times than that of their White counterparts, holding all other variables constant. Hispanics show a reverse trend, where the odds of being more concerned about safety are 54.8% lower than for non-Hispanics. Furthermore, we also find that those who live in rural areas and the suburbs are more likely to be concerned about safety compared to their counterparts that reside in urban areas. The odds of rural residents being more concerned about safety are 1.5 times higher compared to urban residents, and the odds of suburban residents being more concerned about safety is 1.5 times higher compared to urban residents.

Table 3 shows the ordered logistic regression model that uses privacy as the dependent variable (defined above). For Hispanic respondents, the odds of being more concerned about privacy are 1.8 times that of non-Hispanic respondents. Furthermore, respondents' political views are also important indicators for their perspective on privacy. Compared to conservative respondents, Liberals and Moderates show 45.4% and 38.3% lower odds of being concerned about privacy, respectively.

Regarding the respondents' perspective on the variable security, which is specifically related to hacking, Table 4 shows the results of ordered logistic regression model that uses security as the dependent variable (defined above). It shows that the odds of being more concerned about security are 1.7 times higher among non-White respondents compared to White respondents. Regarding income, we also find that those who earn more than $100,000 have 48.3% lower odds of being concerned about safety compared to people that earn less than $50,000. Furthermore, compared to the respondents with conservative political leanings, liberals have 44.7% lower odds of being more concerned about security, and moderates have 35.4% lower odds of being concerned about security.

Discussion

Summary. Regarding safety, female respondents, non-White respondents, those over 60, and those living in rural and urban areas are more likely to be concerned. (See Table 5.) The reason for greater caution among female respondents could be related to the lower overall interest that female respondents have shown for automated vehicles ($\rho = -0.633$). Furthermore, Yavuz and Welch (2010) argued that women have a heightened sense of safety compared to men.

Other findings regarding safety are intriguing and present opportunities for future research. The non-White population's concern about safety is consistent with the racial disparities and

Table 2 Ordered logistic regression model estimates of the public's perception of safety.

						Confidence intervals	
	Value	Std. error	*t*-value	*p*-value	Odds ratio	2.5%	97.5%
Gender							
Female	0.355	0.124	2.868	0.004	1.427	1.119	1.820
Age: reference group = 21–30							
31–40	−0.027	0.153	−0.174	0.862	0.974	0.721	1.315
41–50	0.060	0.193	0.310	0.756	1.062	0.727	1.550
51–60	0.238	0.239	0.996	0.319	1.269	0.794	2.027
Over 60	0.805	0.256	3.141	0.002	2.236	1.354	3.701
Race and ethnicity							
Non-white	0.350	0.173	2.027	0.043	1.419	1.011	1.990
Hispanic	−0.794	0.239	−3.322	0.001	0.452	0.282	0.720
Education: reference group = high school							
Some college	0.127	0.218	0.581	0.561	1.135	0.740	1.743
Bachelors	−0.235	0.209	−1.126	0.260	0.790	0.524	1.192
Masters	0.020	0.426	0.046	0.963	1.020	0.440	2.349
Income: reference group = less than 50 K							
$50,000 - $100,000	−0.215	0.138	−1.559	0.119	0.807	0.616	1.057
More than $100,000	−0.219	0.208	−1.050	0.294	0.803	0.533	1.208
Urban/rural: reference group = urban							
Rural	0.432	0.189	2.294	0.022	1.541	1.065	2.231
Suburbs	0.420	0.143	2.932	0.003	1.522	1.150	2.018
Political views: reference group = conservative							
Liberal	−0.066	0.147	−0.447	0.655	0.936	0.702	1.250
Moderate	0.053	0.173	0.308	0.758	1.055	0.751	1.482
Intercepts							
VerySafe|SomewhatSafe	−1.728	0.277	−6.246	0.000			
SomewhatSafe|Neutral	0.265	0.268	0.989	0.323			
Neutral|SomewhatUnSafe	1.037	0.269	3.849	0.000			
SomewhatUnSafe|VeryUnsafe	2.484	0.282	8.795	0.000			
Residual deviance: 2694.872							
AIC: 2734.872							

conflicts that the U.S. is currently experiencing. Black drivers are more likely to be stopped and searched, and non-White drivers are more likely to suffer discrimination during driving (Baumgartner et al., 2017; Pierson et al., 2020). Thus, one might investigate if safety concerns are related to racial profiling and racism. Likewise, Brunette (2015) argued that the lack of safety and health training and unsafe working conditions affect the level of safety awareness for Hispanics. Our finding that Hispanics (Latinx) are less likely to be concerned about safety could lead to future research on differences across demographic categories in safety awareness or safety risk exposure. Likewise, we find that city residents are less concerned about safety compared to rural and suburb residents. One potential explanation that could provide hypotheses for future research is that the absolute time spent in the vehicle is generally less for city residents and that accidents occurring in city centers or urban areas tend to be relatively minor compared with those on interstates and two-lane highways.

Regarding privacy, we find that Hispanics are more concerned than non-Hispanics. Again, future research might investigate the extent to which privacy concerns are related to ethnic identity and the immigration status of individuals or their families. We also find that people with conservative political views tend to be more concerned about privacy than those who are liberal or moderate. This finding is consistent with the literature discussed above, which suggested that politically conservative groups were concerned about government access to data and "big brother" control over individual freedom (Hess, 2014). The finding suggests a potentially fruitful area of future research on the politics of CAVs and political differences.

Finally, for security, non-White respondents tend to be more concerned about security compared to their White counterparts. Considering that "driving while Black" has been a widely discussed topic within critical race studies and the transportation literature (Bell et al., 2014; Harris, 1999), an area of possible future research might again relate security concerns to racial profiling and racism. In this study, we also find that people who earn more than $100,000 are less likely to be concerned about security compared to the respondents that earn less than $50,000. Hypotheses for future research that emerge from this finding are that households with high income have more resources to handle security breaches (e.g., additional funds and vehicles). The findings also show that the respondents with conservative political views are more likely to be concerned about security compared to liberals and moderates, again a topic for future research in the politics of CAVs.

Limitations. One of the limitations of the study is its focus on the U.S., and the findings may not necessarily generalize to other regions in the world where CAV technologies are quickly advancing. Although some variables, such as gender, tend to have similar relationships across different geographical locations, other variables (e.g., race, Hispanic, political views) are more likely to be very culture-specific. For example, it is possible that European residents are more likely to be concerned about safety and privacy compared to U.S. residents. This trend can be inferred by the cautious approach that some European countries have taken for other cyber-physical systems such as smart meters. Thus, although the study is limited to the U.S., it can be used to identify

Table 3 Ordered logistic regression model estimates of the public's perception of privacy.

						Confidence intervals	
	Value	Std. error	*t*-value	*p*-value	Odds ratio	2.5%	97.5%
Gender							
Female	−0.167	0.123	−1.361	0.174	0.846	0.665	1.076
Age: reference group = 21–30							
31–40	−0.125	0.153	−0.816	0.414	0.883	0.654	1.191
41–50	0.159	0.196	0.809	0.418	1.172	0.798	1.722
51–60	0.024	0.240	0.102	0.919	1.025	0.641	1.640
Over 60	−0.354	0.256	−1.382	0.167	0.702	0.425	1.160
Race and ethnicity							
Non-White	0.250	0.173	1.450	0.147	1.284	0.916	1.803
Hispanic	0.578	0.241	2.394	0.017	1.782	1.112	2.867
Education: reference group: high school							
Some college	0.108	0.220	0.490	0.624	1.114	0.723	1.715
Bachelors	0.200	0.211	0.950	0.342	1.222	0.808	1.849
Masters	0.225	0.438	0.514	0.607	1.253	0.530	2.968
Income: reference group: less than 50 k							
$50,000–$100,000	−0.053	0.138	−0.386	0.699	0.948	0.724	1.242
More than $100,000	−0.423	0.221	−1.913	0.056	0.655	0.425	1.011
Urban/rural: reference group: urban							
Rural	0.325	0.187	1.735	0.083	1.384	0.959	2.000
Suburbs	−0.175	0.140	−1.245	0.213	0.840	0.637	1.105
Political views: reference group = conservative							
Liberal	−0.606	0.150	−4.046	0.000	0.546	0.406	0.731
Moderate	−0.483	0.173	−2.797	0.005	0.617	0.440	0.865
Intercepts							
NotConcernedAtAll|NotVeryConcerned	−3.260	0.300	−10.853	0.000			
NotVeryConcerned|Neutral	−1.401	0.273	−5.126	0.000			
Neutral|SomewhatConcerned	−0.656	0.270	−2.435	0.015			
SomewhatConcerned|VeryConcerned	1.173	0.272	4.316	0.000			
Residual deviance: 2640.267							
AIC: 2680.267							

opportunities for future comparative research on the relationships between demographics and specific political or policy issues.

Another limitation of this study is that it does not consider other societal concerns associated with CAVs, such as governance, sustainability, equity, and effects on public transportation (Milakis and Müller, 2021). Deploying CAVs is an enormous infrastructural undertaking and will likely result in significant societal and political changes. Thus, the study opens up the topic of research that connects demographic positions with public concerns and associated policy issues, but there is much more research that could be done with a more expansive set of issues.

Conclusion

As CAVs become more widely adopted and as higher levels of automation become more evident in street traffic, public opinion is likely to become more developed, and advocacy groups will begin to demand greater attention to public concerns such as safety, privacy, and security. Consumer and other advocacy organizations in the U.S. have already mobilized to call for more extensive safety regulation of CAVs, and they have paid some attention to privacy and security issues. Furthermore, because the technology is likely to be widely diffused internationally, it will be necessary to pay more attention to the global harmonization of policies for CAVs, which can entail challenges because of differences in regulatory cultures for vehicles (e.g., Lee and Hess, 2020). There is also a need for CAV-specific privacy regulation and guidelines, which should address some of the leading privacy principles discussed in the Fair Information Practice Principles and the General Data Protection Regulation. Our findings imply that privacy and security concerns may also be higher among marginalized ethnic and racial groups, and the increasing capacity to track individual mobility will require strong safeguards to protect marginalized groups from even greater surveillance.

The study can do more than point to the need for both private and public governance on areas of public concern such as safety, privacy, and security. As our study shows that demographic variables not only affect concerns about emerging technologies such as CAVs, but also that the demographic relationships vary across the different types of public concern, the study can also contribute to attempts in the social sciences and humanities to anticipate the future politics of CAVs. For example, the demographics of safety may make it easier to achieve political consensus because safety concerns are especially high among women, older adults, and marginalized groups. As women and older adults in the U.S. tend to be positioned across the political spectrum and because political views in this study are not significantly associated with safety concern, the demographics suggest that safety could be a relatively non-divisive issue. Moreover, safety concerns can also be linked to relatively neutral political concerns (such as effects on children, the elderly, pedestrians, and bicyclists).

In contrast, in our data set, privacy is of greater concern among Hispanics and lower for liberals (left-leaning in the U.S.) and moderates in comparison with conservatives, and security is of greater concern for non-Whites and again lower for liberals and moderates. This demographic configuration suggests that two important potential sources of mobilization (marginalized ethnic and racial groups and political conservatives) for these issues are located in social positions that have tended not to be partners in other coalitions. In the U.S. (as in some other countries), conservatives tend to be anti-immigration and have increasingly adopted racist political stances. Thus, this current configuration

Table 4 Ordered logistic regression model estimates of the public's perception of security.

						Confidence intervals	
	Value	Std. error	*t*-value	*p*-value	Odds ratio	2.5%	97.5%
Gender							
Female	−0.007	0.124	−0.058	0.954	0.993	0.778	1.266
Age: reference group = 21–30							
31–40	−0.049	0.156	−0.317	0.752	0.952	0.701	1.293
41–50	0.300	0.194	1.546	0.122	1.350	0.923	1.975
51–60	0.252	0.240	1.048	0.295	1.286	0.803	2.061
Over 60	0.108	0.257	0.423	0.673	1.115	0.675	1.847
Race and ethnicity							
Non-White	0.554	0.176	3.140	0.002	1.740	1.232	2.462
Hispanic	−0.051	0.238	−0.216	0.829	0.950	0.596	1.516
Education: reference group: high school							
Some college	0.246	0.222	1.109	0.267	1.279	0.828	1.976
Bachelors	0.258	0.211	1.220	0.222	1.294	0.855	1.959
Masters	−0.136	0.431	−0.316	0.752	0.873	0.375	2.043
Income: reference group: less than 50k							
$50,000–$100,000	−0.108	0.138	−0.783	0.433	0.898	0.685	1.176
More than $100,000	−0.659	0.220	−2.997	0.003	0.517	0.336	0.796
Urban/rural: reference group: urban							
Rural	0.260	0.189	1.376	0.169	1.296	0.896	1.878
Suburbs	−0.177	0.142	−1.250	0.211	0.838	0.635	1.105
Political views: reference group = conservative							
Liberal	−0.592	0.150	−3.935	0.000	0.553	0.412	0.742
Moderate	−0.437	0.172	−2.535	0.011	0.646	0.460	0.905
Intercepts							
NotConcernedAtAll|NotVeryConcerned	−3.208	0.305	−10.530	0.000			
NotVeryConcerned|Neutral	−1.109	0.273	−4.066	0.000			
Neutral|SomewhatConcerned	−0.469	0.271	−1.732	0.083			
SomewhatConcerned|VeryConcerned	1.476	0.275	5.366	0.000			
Residual Deviance: 2574.144							
AIC: 2618.144							

Table 5 Summary of the results.

Independent variable	More concerned about safety	More concerned about privacy	More concerned about security
Gender (female)	S (+)	NS	NS
Age (older)	S (+)	NS	NS
Race (non-white)	S (+)	NS	S (+)
Ethnicity (hispanic)	S (−)	S (+)	NS
Education (higher)	NS	NS	NS
Income (higher)	NS	NS	S (−)
Urban/Rural (rural suburban)	S (+)	NS	NS
Political views (liberal moderate)	NS	S (−)	S (−)

NS non-significant, *S* significant, + = positive direction, − = negative direction.

of public opinion suggests that it may be more difficult to mobilize public opinion for these areas than for safety. The situation could change as the extent of personal mobility data and the risks of privacy breeches become more widely known.

Because of the complexity of the current and future politics of CAVs, prediction is a nearly impossible task. However, the approach developed here, which connects current knowledge about demographic differences with specific types of public concern and policy issue areas, provides a way to think empirically about the issue. We suggest that further theoretical work is needed to develop social science research on the multidimensionality of the politics of CAVs. This work requires not only breaking down the category of politics of CAVs into a range of opinion positions on specific issues and societal implications but also exploring and analyzing the relationships between these categories. In order to for the multidimensional politics of CAVs to have practical and policy impact, there is a need to link these issues to demographic positions in social space. The approach can help policymakers and advocates to identify where societal concerns are concentrated, and it can help them to identify potential coalition partners.

Data availability

In order to ensure full anonymity, confidentiality, and data protection for the participants, the full survey data cannot be made accessible to the public. Interested researchers may contact the corresponding author.

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Competing interests

The authors declare no competing interests.

Ethical approval

The survey questionnaire and method were reviewed by the Vanderbilt University Institutional Review Board, which determined that the study met the 45 CFR 46.104 (d) category (2) criteria for exempt status.

Informed consent

Informed consent was obtained from each participant prior to accessing the survey instrument.

Additional information

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