The Perception of Autonomous Driving in Rural Communities

A Thesis
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Abstract

The project examines the perceptions of autonomous vehicles in rural communities. The definition used in this study to determine whether respondents were in rural areas came from the United States Department of Agriculture (USDA) and was described as “open countryside and settlements with fewer than 2,500 residents.” A survey was created and distributed to respondents across the United States and 1,247 valid responses were analyzed. Based on the responses, rural respondents were more likely than non-rural respondents to commute further if they owned a self-driving vehicle. Older people and those with lower levels of education tended to have lower levels of trust in self-driving vehicles. Male respondents were associated with a decrease in the relative probability of “never” purchasing an AV over “buy[ing] at some point” but also a decrease in the relative probability of being “unsure” over “buy[ing] at some point” when other variables were held constant. Lastly, rural and non-rural respondents had similar levels of trust when choosing self-driving vehicles over human driven vehicles.

Acknowledgments

I wish to acknowledge the funding provided for this work. It was provided by Center for Safety Equity in Transportation (CSET) (PTE Federal Award No. 69A3551747129). My advisor and committee were instrumental in the development of this thesis. I would like to include a few words to the professors who challenged me, thank you. I have grown personally and educationally from your refusal to lower the bar.

Dedication

This thesis is dedicated to my parents, significant other, and close friends for supporting me on my educational journey. Finally, I would like to dedicate this to my small-town community members that reminded me I can reach higher education goals, even being from a disadvantaged rural community.

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Chapter 1: Introduction

In the United States 97% of the land area is considered rural but is home to only 19% of the population. On the contrary, urban areas make up 3% of the entire land area but represent over 80% of the population (Ratcliffe et al. 2016). While much of the population resides in these densely populated areas, rural communities still face challenges that are unique to them.

These rural challenges include lower average household income, longer commute distances, and a higher rate of aged community members. Rural communities are further from large metropolitan areas, resulting in their definition from the United States Department of Agriculture (USDA) as "open countryside and settlements with fewer than 2,500 residents." According to the same source, rural communities can be "based on administrative, land-use, or economic concepts, exhibiting considerable variation in socioeconomics" (Cromartie and Bucholtz 2008). Rural areas tend to be "sparsely populated, have low housing density, and are far from urban centers" (America Counts Staff 2017). The United Census Bureau defines rural areas as all territories that do not fall into an urban area. The minimum qualifying threshold for urban areas are those that have at least 2,000 housing units or a population at least 5,000. There are also qualifiers for areas close to already identified urban areas ("Urban Area Criteria for the 2020 Census-Final Criteria" 2022).

According to the Insurance Institute for Highway Safety (IIHS), rural areas account for more passenger and large vehicle occupant fatalities, as well as fatalities on high-speed roads, than urban areas. Due to increased speeds, crashes in rural areas tend to be more deadly. Most of the total mileage traveled in vehicles (vehicle-miles) occur in urban areas, but almost half of crash fatalities occur in rural areas (IIHS.org 2021). The Bureau of Transportation Statistics reported that the fatality rate per 100 million vehicle-miles for rural areas (1.68) is higher than urban areas (0.86). There are more pedestrian and bicyclist deaths in urban areas.

To understand the next advancements in vehicle technologies, one must understand the goals that the advancements are trying to achieve and the problems they will help solve. A technological advancement that is currently on the horizon is autonomous or self-driving vehicles. Autonomous vehicles (AVs) strive to replace a human driver partially or entirely in the navigation to a destination, along with a response to traffic conditions and avoidance of road hazards (Center for Sustainable Systems, University of Michigan 2021).

More information needs to be provided to the public to bridge the gap in knowledge for what autonomous vehicles will bring in the future. Understanding the likelihood and timing of adoption of AVs by rural drivers and passengers will help policy makers and manufacturers.

Research Objectives and Hypothesis

The fatality statistics suggest that autonomous vehicles (AVs) could make a significant difference in the crash rates by reducing the number of crashes caused by driver error at higher speeds. This study focuses on rural residents and examines four related hypotheses on their adoption of autonomous vehicles.

H1: Rural drivers would be more hesitant to adopt self-driving or autonomous vehicles when compared to non-rural drivers.

H2: Drivers in general would think autonomous vehicles are more dangerous than human drivers (due to moral concerns, technology failures, and differing roadway geography).

H3: More education would lead to a higher likelihood of adoption of self-driving vehicles.

H4: Older people would be less likely to adopt AVs due to their perceived apprehension of newer technologies.

Thesis Organization

Chapter 2 provides an in-depth background of autonomous vehicles and explores peoples' confidence in autonomous vehicles based on prior literature. It also draws together the impact of AVs on the lives of their users. Chapter 3 details the way data were collected, including required criteria set forth for response gathering and the statistical methods used. It also gives a description of the statistical tests. Chapter 4 provides general frequencies from the data and descriptive results. Chapter 5 describes the statistical models and the inferences made from the results of the models. Finally, Chapter 6 provides the conclusions of the thesis along with the survey gaps. It also provides recommendations for areas of research that could benefit from more attention.

Chapter 2: Literature Review

This chapter will cover the background, including the five eras of safety and levels of automation. It will also detail studies focused on confidence in technology and likelihood of adoption. Lastly, it will describe how AVs could impact the current lifestyles of potential users.

Background

There are five eras of safety according to the National Highway Traffic Safety Administration. As vehicle technology has advanced, the duration of the eras has shortened in years. The eras and their titles are shown in Table 2-1.

Table 2-1. Evolution of Automated Safety Technology in Vehicle.

1950-2000	• Safety/Convenience Features
2000-2010	• Advanced Safety Features
2010-2016	• Advanced Driver Assistance Features
2016-2025	• Partially Autonomous Safety Features
2025+	• Fully Automated Safety Features

During the first era, cruise control, seat belts, and antilock brakes became the norm in vehicles. As the path for driverless vehicles was not clear at this time, there were not many studies that researched the topic. One publication from the early 1990s discussed features like autonomous intelligent cruise control. The study found that communication between vehicles was not required because the intelligent cruise control system operated only on information from its own sensors (Rao and Varaiya 1993). This article was limited in depth and scope because traditional cruise control had only recently been introduced in vehicles.

By 2010, electronic stability control (traction control), blind spot detection, forward collision warning, and lane departure warnings were available. Between 2010 and 2016, advanced features like rearview video systems, automatic emergency braking, rear cross traffic alert, and lane centering assist became standard in higher end brands. For 2016 to 2025, lane keeping assist, adaptive cruise control, traffic jam assist, and self-parking are now or will become available. Fully automated safety features, like highway autopilot, are expected to hit the market post-2025 ("Automated Vehicle Safety | NHTSA" n.d.).

Levels of Autonomy

There are six levels of vehicle automation, which are shown in Table 2-2.

Table 2-2. Levels of Automation, provided by NHTSA

Level	Description
0 - No Automation	•Zero autonomy: the driver performs all driving tasks
1 - Driver Assistance	•Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.
2 - Partial Automation	•Vehicle has combined functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.
3 - Conditional Automation	•Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.
4 - High Automation	•The vehicle is capable of performing all driving functions under certain conditions. The drivers may have the option to control the vehicle.
5 - Full Automation	•The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.

Currently, most vehicles are already equipped with autonomous features at Levels 1 and 2, like lane assist and cruise control. Some vehicles, like the 2023 Tesla Model S, have Level 3 automation, including the autopilot feature that can switch lanes and functions from on-ramp to off-ramp in interstate scenarios ("Model S" n.d.). For Level 5 automation, manufacturers could choose to forego a steering wheel. Future policy will determine whether this would be acceptable or not.

Continuing the Research

It is still not completely clear when level 4 and level 5 self-driving vehicles will be introduced to the public, but surveys are relevant to helping understand the timeline of adoption. Some studies were done in survey form to gauge public perceptions, while others were interviews or a combination of a field study and interviews. The following sections present a summary of research related to perceptions of autonomous vehicles.

Confidence in Technology

To understand the confidence in technology, assorted studies examined the beliefs of potential users. An internet poll found that only 21% of U.S. adults surveyed were willing to ride in a self-driving car. The survey was weighted using age, gender, and region factors similar to the population estimated by the U.S. Census Bureau (West 2018).

Transportation users, planners, and government officials in another survey were asked if they knew about the classifications of AVs, and roughly 70% of them did not. The same study found that 59% of the respondents had deemed AVs beneficial. More than half of the respondents also said that they would be afraid of AVs (Alsalman et al. 2021). The sample for this study was ninety-five participants.

Older drivers have been surveyed about their perceptions and ideas regarding autonomous vehicles. Researchers found that after exposure to AV technology, both through autonomous shuttles and simulations, older drivers had increased positive perceptions in safety, trust, and perceived usefulness. The researchers recommended that future studies should investigate geographical contexts and how that may influence opinions of older drivers (Classen et al. 2021).

Participants of all ages (20 to 75 years old) were surveyed by Hilgarter and Granig in a study like the one conducted by Classen et al. on older drivers. Participants rode in an autonomous shuttle on a closed course and were then interviewed. More older adults perceived benefits to AVs when compared with younger adults after riding in the shuttle. The same study identified a pattern in which autonomous vehicles were regarded more positively in rural areas than in urban areas (Hilgarter and Granig 2020). This study had a limited sample size of 19 people, although the authors explained that because it was a qualitative study, the sample size was sufficient.

One rural Nebraska study found that a shift in public opinion is needed before AVs can succeed. Part of the study assessed farmers that have implemented auto navigation and self-driving features on farm equipment. Some of the participants had firsthand experiences where the technology failed, either with GPS and/or a cellular signal. Issues often occurred in inclement and severe weather. These failures led to a wariness in adoption of self-driving vehicles on highways and other public roads. There was a concern as to how the systems would handle roads that were not paved, like gravel roads, or had obstacles in the road, like deer. There are numerous households along unpaved roads in rural areas, which may present an issue with adoption of vehicles with this technology. One respondent expressed a concern that if an AV encountered a mechanical or system issue, the lay person would be unable to diagnose or fix it, leaving them stranded (Piatkowski et al. 2020).

In their study of public perception after riding in an autonomous shuttle, Hilgarter and Granig (2020) found that autonomous vehicles carry perceived societal, legal, economic, and technological challenges, like lack of social justice and reliability. An example of social justice would be the prioritization of the life of a vehicle passenger versus that of a pedestrian. The prioritization could happen in a scenario when a vehicle had to choose between hitting a pedestrian or veering off the road, potentially endangering its passengers. Reliability was also referenced by the individuals that participated in the study performed on rural Nebraska farmers (Piatkowski et al. 2020).

Likelihood of Adoption

In the study done by Classen et al. (2021), they found that the intention of older drivers to use AVs was not statistically significant between before and after exposure to autonomous vehicle technology. Lack of statistical significance suggests that while people will perceive autonomous vehicles as beneficial, perceptions may not be an indication of their intent to use. While many people will rightfully have concerns, their concerns should lessen with exposure to AVs, allowing automakers to target other ways to encourage rural communities to adopt AVs, like making them more attractive than human driven vehicles.

Another study that follows the applicability of mobility on demand systems noted that adoption could be limited by financial constraints rather than road network capacity constraints in rural areas (Sieber et al. 2020). Decreasing the purchase price and operating costs is another way automakers could encourage rural community members to adopt their autonomous vehicles.

Influence on Current Lifestyle

The benefits of AVs only come after their adoption, so opinions on the likelihood of adoption must be gauged to understand how large the benefit could be and how adoption would influence the current lifestyles of rural dwellers.

Not all the comments from the rural Nebraska survey were negative. When asked about adoption of self-driving features in their farm equipment, some respondents found that they were pleasantly surprised by the features and abilities that they did not know they needed, like more accuracy in locating the tractor in the field. Another positive aspect mentioned was the lowering of driver fatigue, which is a statistic that contributes to numerous crashes yearly on domestic roads (Piatkowski et al. 2020). Lowering the fatigue allows drivers to drive for longer periods of time. Fully autonomous vehicles could lend to higher productivity since there would not need to be too much focus on driving, if any at all. While the focus was on farmers in the Nebraska study, the opinions of others who live in rural areas are also needed.

There are potential benefits for road users that are older. According to Smith and Trevelyan (2019), of the older people in the US, there is a higher percentage of elderly in rural areas compared to those that live in urban areas, even though the total number of older people living in rural areas is smaller than those living in urban areas. With an increase in the average age of Americans, the aged members of society may be among those that benefit most from the introduction of AVs. The elderly in rural areas could especially benefit from more mobility options and having more freedom that would come with fully autonomous vehicles. This may encourage some older community members to move to more rural areas.

In the 2020 study done by Hilgarter and Granig, results suggested that AVs may shift transportation modes from personal vehicles to public or shared transportation. The shift may be true in urban areas as work and personal schedules may line up for more people using shared or public transportation through AVs. They also hypothesized that AVs would be an alternative versus a substitute for existing means of transportation. Since more older adults perceived benefits of AVs after riding in the shuttle, the positive perceptions support the fact that AVs can provide mobility for the elderly (Hilgarter and Granig 2020).

While driverless vehicles may be safe, some people are concerned that human drivers and other road users would act more carelessly than before AVs were around. This behavior could exhibit itself in more reckless driving, walking, or cycling. For example, pedestrians might be more likely to dart in front of traffic or human drivers might turn or slow down more abruptly. This thought process is tied to the mentality that to pedestrians, AVs are safer than driver-controlled vehicles. By comparison, vehicle passengers thought that driver-controlled vehicles would be safer than driverless AVs (Hulse, Xie, and Galea 2018).

A study specifically done to estimate commuters' value of travel time estimated that time spent in the vehicle would become more productive and appealing. The travel time could be more productive in a situation where passengers could work while traveling or appealing by enjoying a past time like reading or sleeping. Urban sprawl would be more likely with AVs. While the overall value would be changed, there was a perceptible difference between rural, urban, and suburban areas (Zhong et al. 2020). Comparable results from the study done in Nebraska showed that individuals believed that operator fatigue is less common with driver assistance or features that could be standard in AVs and that individuals could travel for longer distances (Piatkowski et al. 2020).

Next Steps

The results of the surveys and studies suggest a higher perceived benefit and acceptance of autonomous vehicles, particularly among older adults and those living in urban areas. The possibility of using AVs as part of daily transport is a question that can be answered by further exploring the viewpoints of the public, and specifically of rural respondents. In the next chapter, the methodology for examining these viewpoints will be discussed.

Chapter 3: Methodology

Survey Development

A survey was created to acquire autonomous vehicle opinion data in rural areas. The first step in creating the survey included identifying questions pertinent to the research objectives. To brainstorm survey questions, a group of three individuals with experience relating to transportation topics and social data analysis met regularly over a twenty-two week period.

The survey was broken into three main sections, demographics, behavior, and values. (See Appendix A for full survey.) The demographic section asked general questions such as, "What is the highest level of education you have completed?" Respondents were also asked which state they lived in. If the response of "I do not reside in the United States" was selected, then respondents would be shown the final screen of the survey thanking them for their time in taking the survey. The demographic topics are shown in Figure 3-1.

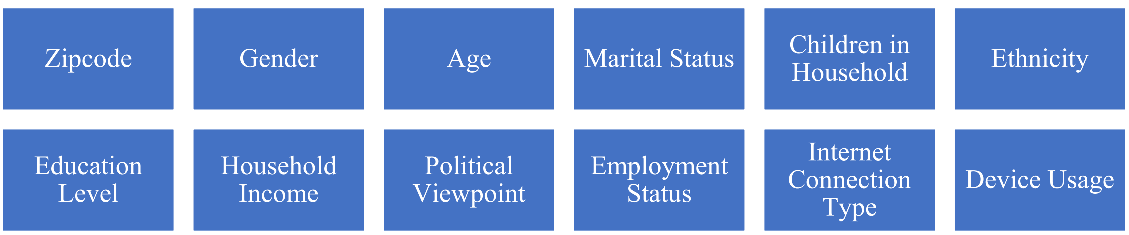

Figure 3-1. General Demographic topics used in survey

The definition used to separate rural and urban responses was from the USDA. It referred to rural areas as those in open-countryside and settlements with less than 2,500 people. All other areas were considered urban. For this survey, no distinction was made between urban and suburban. Respondents were asked to self-identify if they lived in a rural area with the options, "yes", "no", and "unsure." "No" and "unsure" responses were grouped together as non-rural.

For the behavior section, respondents were asked questions relating to their actions with vehicles, like how many years of driving experience they had or their level of comfort with nighttime driving. Past, present, and future behavior questions were asked. An example of a present behavior question was, "Do you own or have daily access to a vehicle?" For the past behavior questions, an example was, "Recall your last vacation in which you traveled by vehicle. How many miles did you travel one way?" To test future timelines to purchase an autonomous vehicle, respondents were asked, "If a fully self-driving vehicle (i.e., a vehicle that does not need driver input or attention) was available, then how long would you wait to buy after the first model was released?" The response options for the question were

"'1 year or less', '2 to 5 years', '6 to 10 years', '11 years or more', 'I would never buy a self-driving vehicle', and 'Unsure'." This question ties back to information found during the literature review, where adoption of AVs or mobility on demand systems could be limited by financial constraints rather than road network capacity constraints in rural areas (Sieber et al. 2020). Figure 3-2 shows the topics covered in the behavior section. .

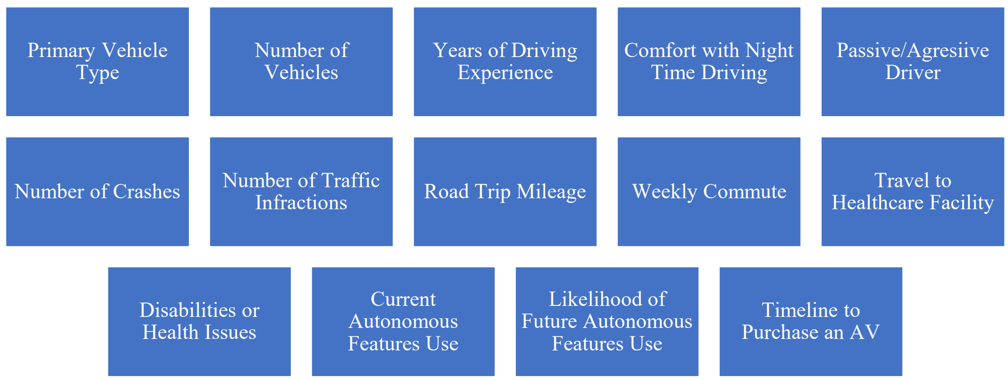

Figure 3-2. Topics covered in Behavior section of survey

For the last section, respondents were asked questions to determine the level at which they would value certain features or activities relating to autonomous vehicles. There were seven questions, and most consisted of multiple parts using a Likert scale. For example, the question shown in Figure 3-3 was used. The Likert scale options were, "'extremely unlikely', 'somewhat unlikely', 'neither likely nor unlikely', 'somewhat likely', and 'extremely likely'."

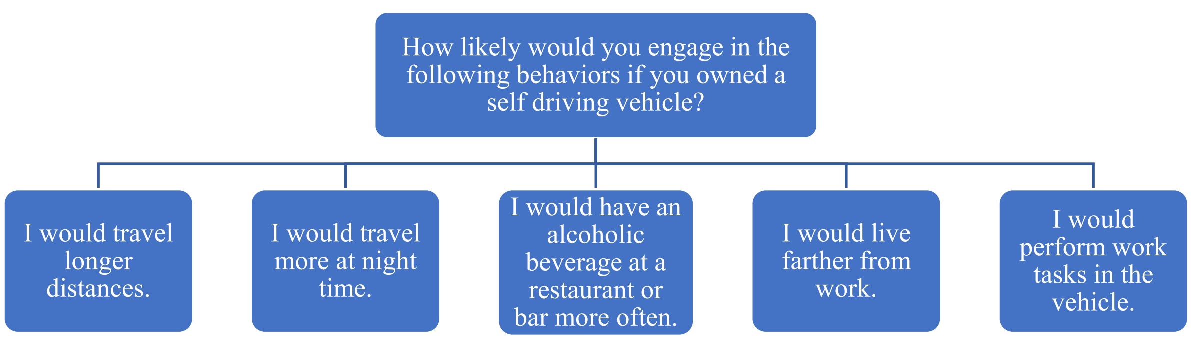

Figure 3-3. Sample question and answer options from survey

This question was meant to determine the possible behavioral changes that resulted from values held by respondents. In the case of, "I would have an alcoholic beverage at a restaurant or bar more often," if respondents wanted to be able to enjoy alcohol without worrying about the possibility of driving intoxicated, then they may be more likely to buy an AV. The responses can be used to understand what motivates potential buyers of AVs. Another question that was asked in the values section of the survey was about common concerns relating to self-driving vehicles, or those vehicles that do not need driver input or attention. Respondents chose a level of concern for each category. The categories were technology failures, sensor failures, hacking, moral concerns, maintenance costs, effect on driver employment, no human interaction, and cost of purchase. The choices for each category were

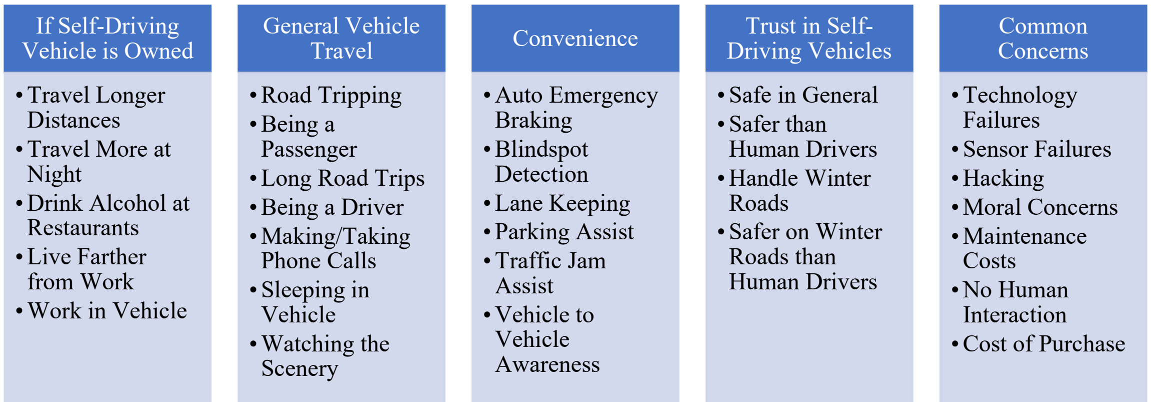

Figure 3-4. Example of some topics listed in the values section of the survey.

"'extremely concerned', 'somewhat concerned', 'neither concerned not unconcerned', 'somewhat unconcerned', and 'extremely unconcerned'." Figure 3-4 shows some of the topics covered in the values section of the survey.

During the iteration process some questions were removed and others were changed from the initial question. A question that was removed was, "What is your preferred mode of travel?" and respondents would have been given the options of "'car', 'train', 'plane', 'bus', 'bicycle', or 'walking'. The question was removed because the focus was on rural areas and while many may prefer to ride a bus or train, those modes are typically unavailable in rural areas. Another question that was removed was, "What is your immigration status?" The options were "'Foreign born' or 'U.S. born'" and while this could show the effects of area of origination on attitudes towards autonomous vehicles, it was argued that response rate for the question would be low or incorrect due to the sensitivity of the subject. Researchers decided it was a question that was best left out.

The question "What was your total household income from all sources before taxes last year?" was reworded. It was changed to "What was your total household income last year?" There were many minor tweaks made in other questions like the income question to improve readability. Some questions were adjusted to include a definition. For example, "a vehicle that does not need driver input or attention" was added to a question following the words "fully-self driving" to provide clarity for survey takers.

Survey Distribution and Data Collection

The primary focus of the survey was on rural community members, and as such, respondents were from rural states across the United States to represent a broad geographic region and to provide a more comprehensive view into the opinions of rural community members.

An online company was used to create and distribute the survey. This company, Qualtrics, was hired to find respondents that matched criteria set by researchers. The criteria included the following parameters:

- minimum of 1200 respondents
- 70-80% from rural areas
- 20-30% from urban areas
- minimum of 800 responses from Idaho, Montana, Wyoming, Oregon, Washington, Nevada, Colorado, and Utah
- 400 responses representing the remaining US states
- no more than 250 responses from one state
- no less than 40% of survey takers of each gender, male or female
- 18 years of age or older to avoid legal issues

Before the survey was sent to respondents, a copy was sent to the University of Idaho's Institutional Review Board (IRB), and they replied with their approval. A copy of IRB's approval letter is included in Appendix B.

The survey included multiple choice questions, single choice questions, and matrix style questions. There were only two fill in the blank questions. One question asked for respondents' zip code for further categorization of the area where the respondent lived. The second provided a space for clarification to an "other" response in the occupational field.

Qualtrics performed a professional data scrub to identify and remove inadequate quality responses, such as choosing the same response for every question, partial responses, or duplicates. There was also no length limit placed on the survey. The research team was less worried about respondent fatigue because the survey company compensated the survey takers.

Analytical Strategy

Once the survey period expired, results were sent to researchers in comma separated values (.csv) format. Due to the population size, Microsoft Excel was not the ideal choice for data management. A statistical program, SPSS (by IBM, Statistical Package for the Social Sciences), was used to parse data and perform statistical analysis. The data were then summarized and are presented in the following sections.

Measures of central tendency and frequency analyses were determined on most questions and multiple linear regression and multinomial logistic regression analyses were used for more in-depth analysis. Student T-Tests were also done on some questions of the survey. Examples of central tendency include mean, mode, median, and standard deviations. Multiple linear regression, multinomial logistic regression, and chi-squared analyses were used to answer questions and verify hypotheses that were posed by researchers before analysis began.

The regression methods allowed for multiple independent variables to be held constant to determine strength of effect of each variable on the dependent variable and were used to compare one dependent variable with different independent variables. An alpha of 5% or 0.05 was used in most tests, which is standard practice in survey-based studies. This means that researchers were willing to accept a 5% chance of making a type 1 error in analysis. This is a common value because an alpha of 1%, or 0.01, is difficult to achieve, especially in social and behavioral data analysis. In the multivariate regression models, the dependent variables that are on Likert scales were treated as interval-ratio measures. While there is controversy behind treating Likert scale questions this way, it was found by Sullivan and Artino that parametric tests such as regressions can be used when analyzing Likert scale (2013).

The survey results, including frequencies, were examined to determine the types of analysis to be used and how to present the data. Several of the frequencies are discussed in Chapter 4. Measures of central tendency include mean, median, and mode, and the mean values were used in the T-Test and to obtain Chi-Square values.

The purpose of the T-Test for Independence is to determine if there is a difference in the means of two independent groups on a continuous dependent variable. This test is also called the Student's T-Test or the Independent Samples T-Test (name used in SPSS). This test can be used on Likert Scale questions. There are six assumptions for this test: a continuous dependent variable, a categorical independent variable with two groups, independence of observations, no significant outliers in the independent variable, a normally distributed dependent variable, and an equal variance in each group of the independent variable.

The purpose of a Chi-Square Test of Independence is to determine if there is a significant association between two variables in the population. An assumption of the test is that no more than 20% of cells will have a value less than 5 in the cross-tabulation table. Another assumption of Chi-Square tests is that both variables are categorical.

Multiple linear regression tests are useful in determining the relationship between one dependent variable and multiple independent variables. The dependent variable is also called the outcome and the independent variables can be called the predictors. The relationships are turned into weighted values that explains the effect of the independent variables on the dependent variable. The multiple linear regression model provides an overall effect as well as a relative contribution of each predictor. There are several assumptions that apply to a linear regression model:

1. one dependent continuous variable (Likert scales work here),
2. two or more independent continuous or categorical variables,
3. independence of observations,
4. linear relationship between dependent variable and each independent variable,
5. equal error variances,
6. no multicollinearity,
7. no significant outliers, and
8. approximately normally distributed errors.

Multinomial Logistic Regression is a type of logistic regression model that is used to predict outcomes of a nominal dependent variable. There are six general assumptions for this test:

1. nominal dependent variable,
2. continuous, ordinal, or nominal independent variables,
3. independence of observations,
4. no multicollinearity,
5. a linear relationship between continuous independent variables and the logit transformation, and
6. no outliers or highly influential points.

Pertaining to this test, “the chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0” (SPSS 2021).

Chapter 4: Results

General Demographics

A total of 1,247 valid responses were collected from the survey. One of the first questions asked was whether respondents self-identify as living in a rural area. “Rural areas can be defined as settlements with less than 2,500 people or open countryside. Based on this definition, do you live in a rural area?” Respondents were also asked to provide home zip codes. A map showing the response’s zip code area is shown in Figure 4-1.

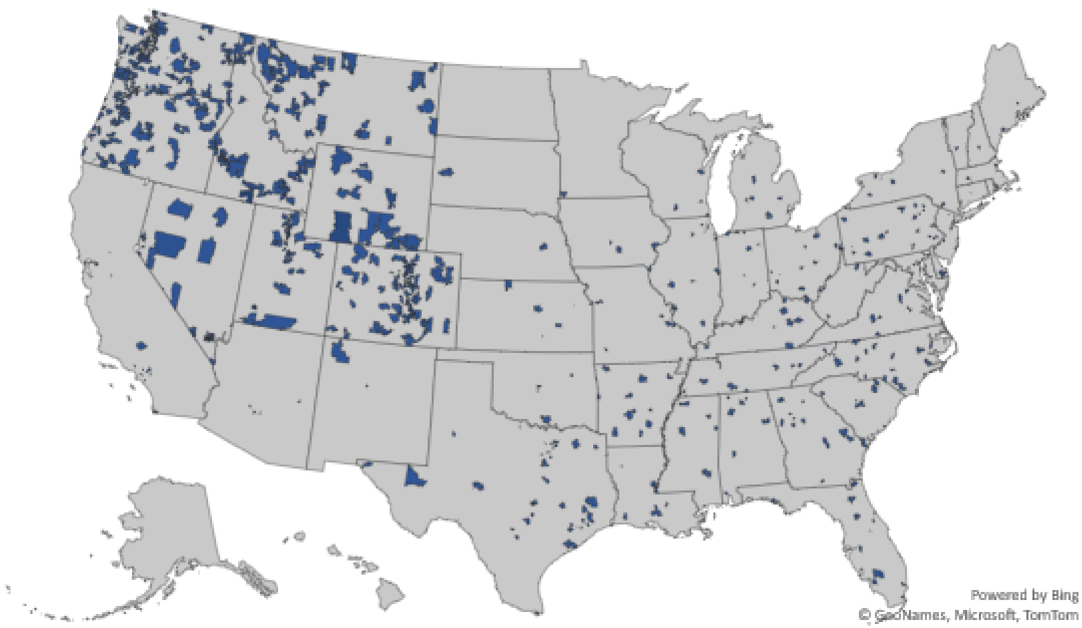

Figure 4-1. U.S. with highlighted regions of respondents' home zip codes

In the general demographic section, questions like age, ethnicity, and gender were asked. A summary of the questions asked and responses is provided in Figure 4-2. For example, 913 (73.2%) respondents were from rural areas, 334 (26.8%) were non-rural, and 737 (59.1%) were female. While demographics are normally provided at the end of surveys, they were placed near the beginning of this survey to allow Qualtrics to initially screen respondents before they proceeded too far into the survey. Geographic location and gender were among the criteria that Qualtrics used to fill pre-determined quotas. In comparison to US Census data, where 50.5% of the population is female, the survey was 8.6% different (US Census 2022). The difference in female respondents to US population is expected as more women answer surveys than men. According to the USDA only 14% of the country’s population is in a rural area (Dobis 2021). The focus of the study was rural respondents, so the overall percentage of rural residents in the US and rural respondents in the survey were not planned to be the same.

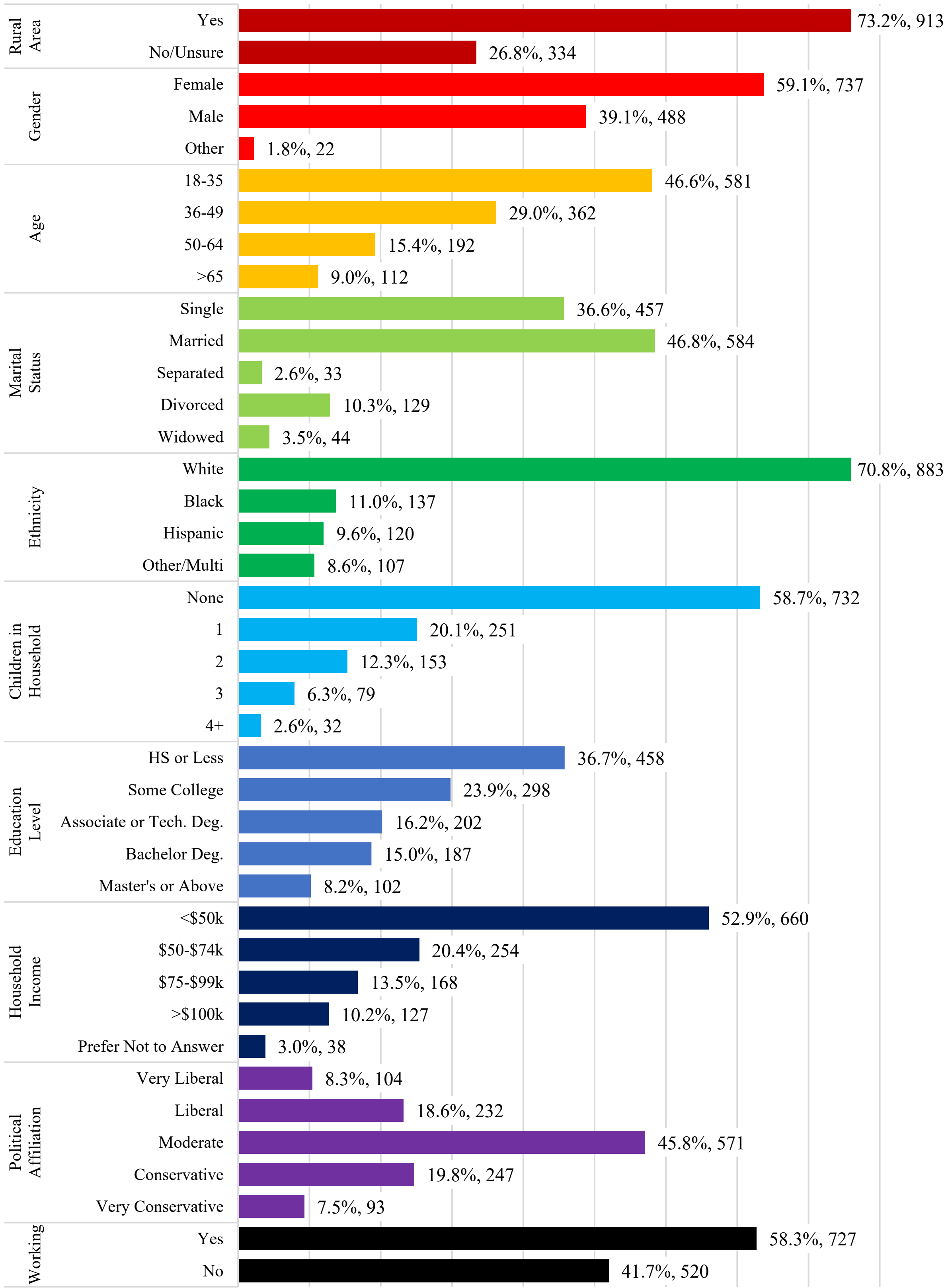

Figure 4-2. General demographics of respondents

Internet connection can be indicative of how connected and likely autonomous vehicle infrastructure will be in rural areas. Table 4-1 shows the internet connection types of rural and non-rural survey-takers. Cable had the most responses, whereas dial up had the fewest. A crucial factor to keep in mind is that some rural areas are limited on the types of internet connection available.

Table 4-1. Internet connection types by rural and non-rural responses

Connection Type	Rural		Non-Rural		Total	
Cable	303	(33%)	126	(38%)	429	(34%)
Fiber Optic	161	(18%)	51	(15%)	212	(17%)
DSL	110	(12%)	44	(13%)	154	(12%)
Satellite	96	(11%)	20	(6%)	116	(9%)
Hotspot	81	(9%)	16	(5%)	97	(8%)
Dial Up	17	(2%)	4	(1%)	21	(2%)
No Internet	33	(4%)	6	(2%)	39	(3%)
Unsure What Kind	112	(12%)	67	(20%)	179	(14%)
Total	913		334		1247	

The table shows that cable (n=429, 34%), fiber optic (n=212, 17%), and DSL (n=212, 12%) were the most popular choices of internet connection. The same results were true for the individual categories of rural and non-rural residents as well, with 33% (n=303) of rural residents having a cable connection to internet and 38% (n=126) of non-rural residents having cable. A fairly substantial number of respondents (n=179, 14%) were "unsure what kind" of internet connection type they had.

Behaviors and Characteristics of Drivers

Respondents were asked about their driving behaviors and characteristics. Figure 4-3 provides a summary of the questions asked and the total number of responses in each category. The figure includes a question about ownership of vehicles, type of vehicle, number of vehicles, years of driving experience, comfort driving at night, type of driver, and number of traffic infractions. Most of the respondents owned vehicles or had daily access (n=1115, 89.4%) and 69.1% (n= 862) said their primary vehicle was a passenger car or SUV. Most respondents (n=632, 50.7%) owned one vehicle. Nearly the same number (n=633, 50.8%) had 16+ years of driving experience. There was variation in the level of comfort in nighttime driving, but the largest number of responses felt "very comfortable" with 407 (32.6%) responses. A shape similar to a bell-curve occurs in the responses to passive or aggressive driving with a slight skew towards passive driving.

In addition to those questions, respondents were asked about the number of miles they traveled on their last vacation by vehicle. Sixty-two people (37.0%) said they traveled "101-500 miles" one way and

25.4% (n=317) traveled "501+ miles" one way. The survey also inquired about weekly commutes to work or school and 63.3% (n=789) travel 0-20 miles in a week. A total of 36.8% (n=459) said that they travel to a healthcare facility (i.e., doctor's office, dentist, hospital, or pharmacy) once a month and 30.4% (n=379) do not travel to at least one healthcare facility each month. Finally, respondents were asked about health issues or disabilities that affect their ability to drive and only 13.2% (n=165) said yes.

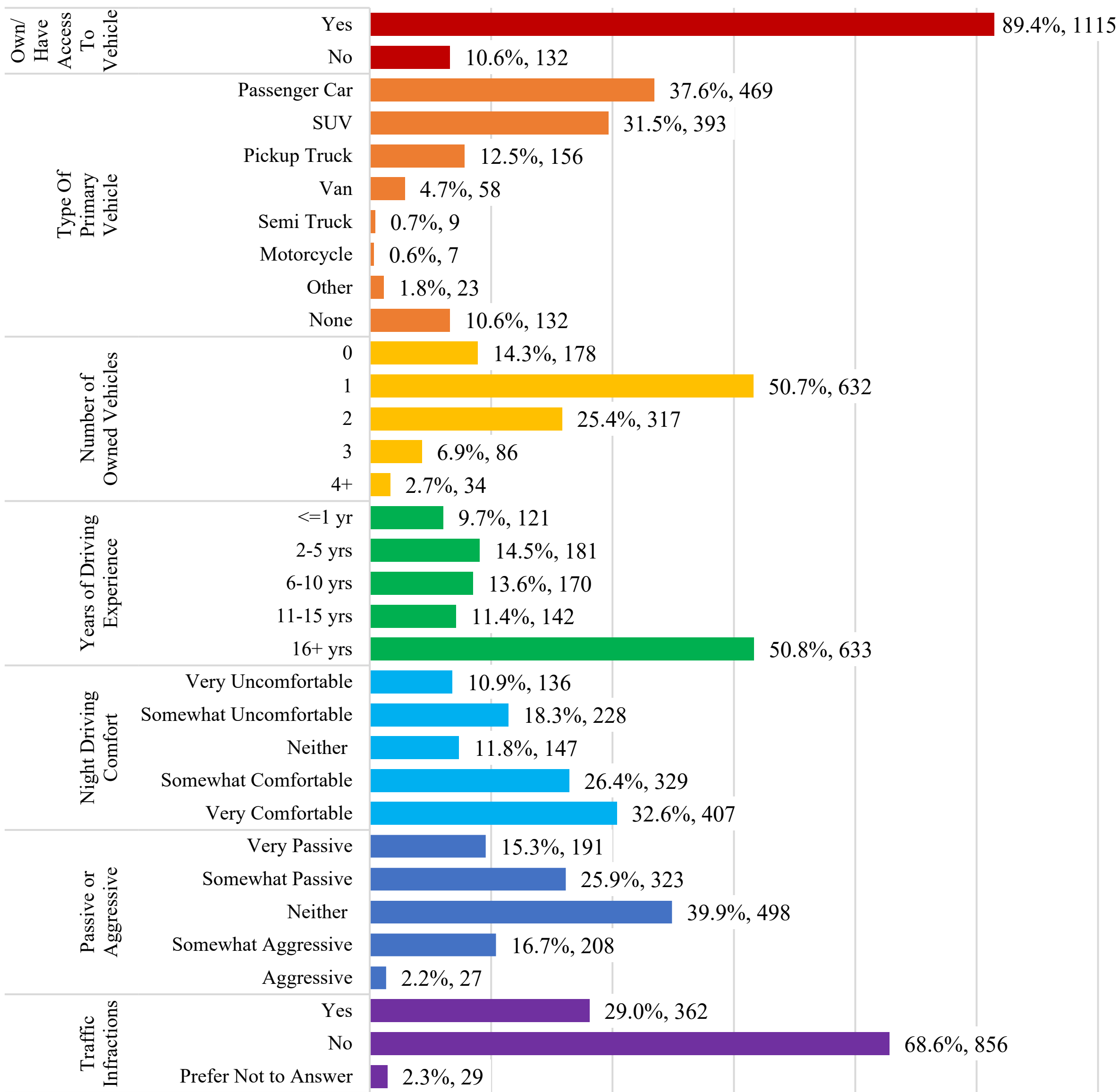

Figure 4-3. Driver characteristics and behaviors of respondents

Autonomous Vehicle Demographics

Following the demographic questions, respondents were asked questions about autonomous vehicles. Of the 1,247 respondents, 42.2% (n=526) said they were “familiar” or “somewhat familiar” with autonomous vehicles, and the remaining 57.8% (n=721) said they were “neither familiar nor unfamiliar”, “somewhat unfamiliar”, or “unfamiliar”. Respondents were asked about whether their current vehicle(s) has AV features like cruise control, lane assist, or self-parking. A total of 69.2% (n=772) said that their current vehicle(s) had those features and 30.8% (n=343) said no. Vehicle owners that responded yes to the previous question were asked specifically about use of autonomous features. The most used autonomous feature was traditional cruise control. Another question asked about features available in autonomous vehicles and respondents were asked to share their usage level from the choices of, “never, rarely, sometimes, often, or always.” Cruise control had the highest usage at 92.1% (n=711) and only 7.9% (n=61) chose “never”. For lane assistance, 53.6% (n=414) of survey responders said they “never” use it. By comparison 546 people (70.7%) said they “never” use self-parking, and 52.8% (n=408) said the same about adaptive cruise control use.

After asking about features that are commonly available, respondents were asked about features that will be available in future vehicles or those that are brand new. The features were self-driving (driver takeover option) and a vehicle without a steering wheel. Of the 772 respondents, 349 (45.2%) said that they would be “extremely unlikely” or “somewhat unlikely” to use a vehicle that has self-driving with a driver takeover option and only 12.4% (n=96) said they would be “extremely likely” to use that kind of vehicle. For the vehicle that has no driver takeover option (no steering wheel), 57.9% (n=447) said they would be “extremely” or “somewhat” unlikely to use the vehicle. The percentage that would be “extremely likely” to use the vehicle with no steering wheel was 10.0% (n=77), a slight decrease from the percentage that provided a positive response to the previous question.

Opinions

Individuals that did not have autonomous features in their vehicle were also asked about autonomous features that are or will be available in the future. For adaptive cruise control, 177 of the 343 (51.6%) said they would be “extremely likely” or “somewhat likely” to use. Lane assist and self-parking had 48.1% (n=165) and 48.6% (n=167) positive responses, respectively. When asked about self-driving vehicles, 42.0% (n=144) said they would be unlikely to use a vehicle with a takeover option and 50.4% (n=173) said they would be unlikely to use a vehicle with no takeover option.

The survey contained a question to determine a general timeline of adoption. The question asked was “If a fully self-driving vehicle (i.e., a vehicle that does not need driver input or attention) was available, then how long would you wait to buy after the first model was released?" The responses were spread out among six options. There were 179 (14.4%) responses that were "Unsure." The remaining response answers and their occurrences are shown in Figure 4-4.

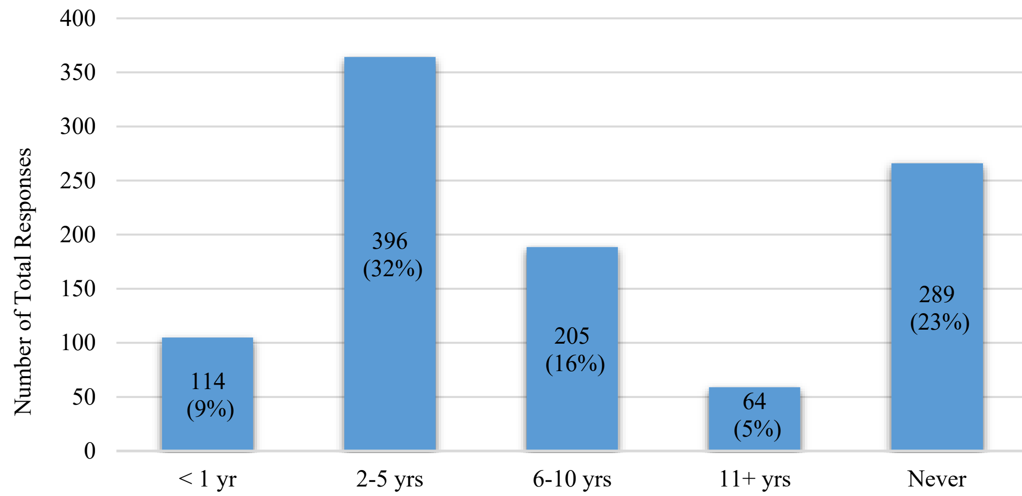

Figure 4-4. Timeline of respondents to purchase a fully self-driving vehicle

When asked the question "How comfortable would you be if your rearview or sideview mirror was replaced with a camera image?", 41.9% (n=523) respondents said they were comfortable and 30.8% (n=386) said they were uncomfortable. The remaining 19.9% (n=340) said they were "neither comfortable nor uncomfortable." Figure 4-5 shows a visual comparison of respondents' level of agreement with other statements relating to self-driving vehicles.

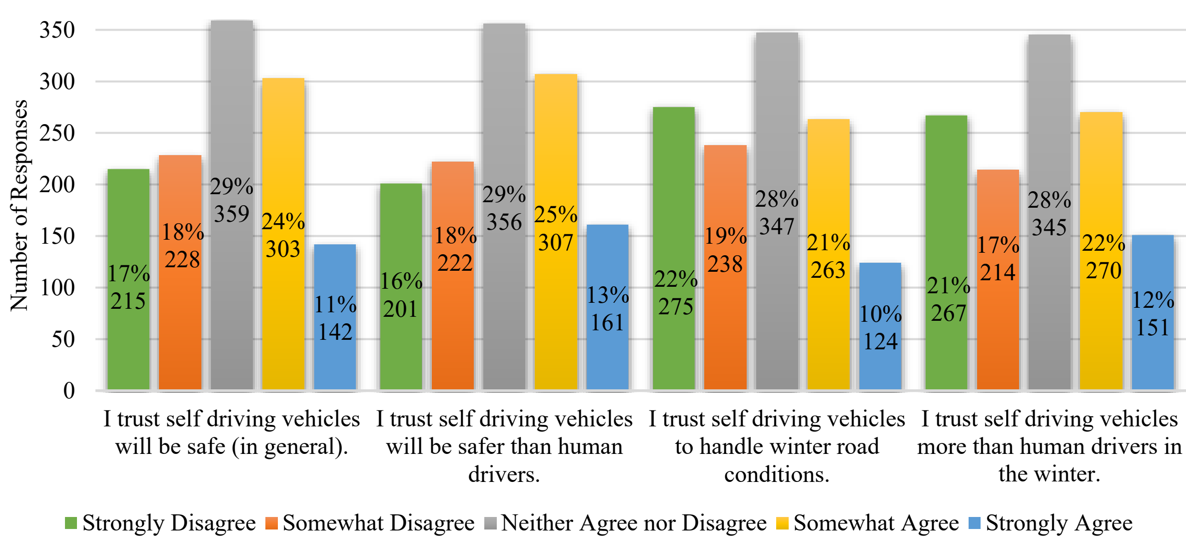

Figure 4-5. Levels of Agreement with statements about Self-Driving Vehicles

For a comparison between rural and non-rural respondents, Table 4-2 shows the level of agreement that respondents felt with the statement "I trust that self-driving vehicles will be safer than human driven vehicles."

Table 4-2. Levels of Agreement with the statement "I trust that self-driving vehicles will be safer than human driven vehicles."

Level of Agreement	Rural	Non-Rural	Total
Strongly Disagree	148 (16%)	53 (16%)	429 (34%)
Somewhat Disagree	163 (18%)	59 (18%)	212 (17%)
Neither	256 (28%)	100 (30%)	179 (14%)
Somewhat Agree	225 (25%)	82 (25%)	154 (12%)
Strongly Agree	121 (13%)	40 (12%)	116 (9%)
Total	913	334	1247

The percentages between rural and non-rural respondents are very similar. For example, 12% (n=40) of respondents that identified as non-rural strongly agreed with the statement, whereas 13% (n=121) of rural respondents chose "strongly agree". Drivers were asked about common concerns relating to self-driving vehicles. The results are summarized in Figure 4-6 and Figure 4-7.

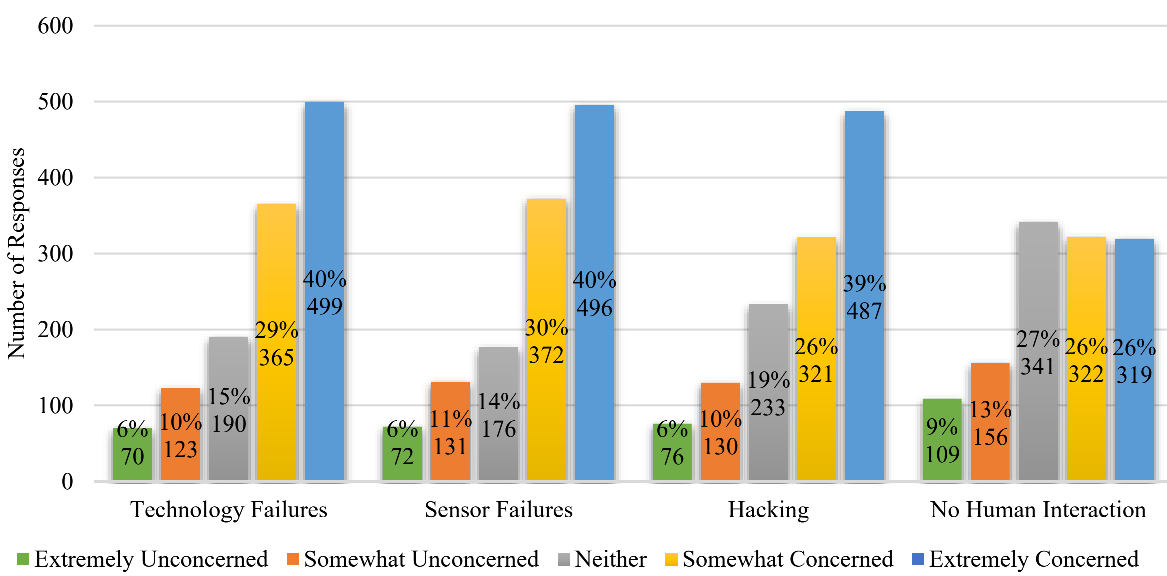

Figure 4-6. Common Concern (Part 1)

Figure 4-7 shows that many respondents were worried about technology and sensors failures as well as hacking. There was less extreme concern expressed when it came to lack of human interaction (such as having no steering wheel). It also shows that cost of purchase is something that respondents (541 out of 1,247 respondents) are extremely concerned about. Moral concerns are comparably less of a concern.

An example of moral concerns would be in a situation where an autonomous vehicle had to choose between the lives of passengers and those of pedestrians or other drivers. The programming of the vehicle can be a cause for concern.

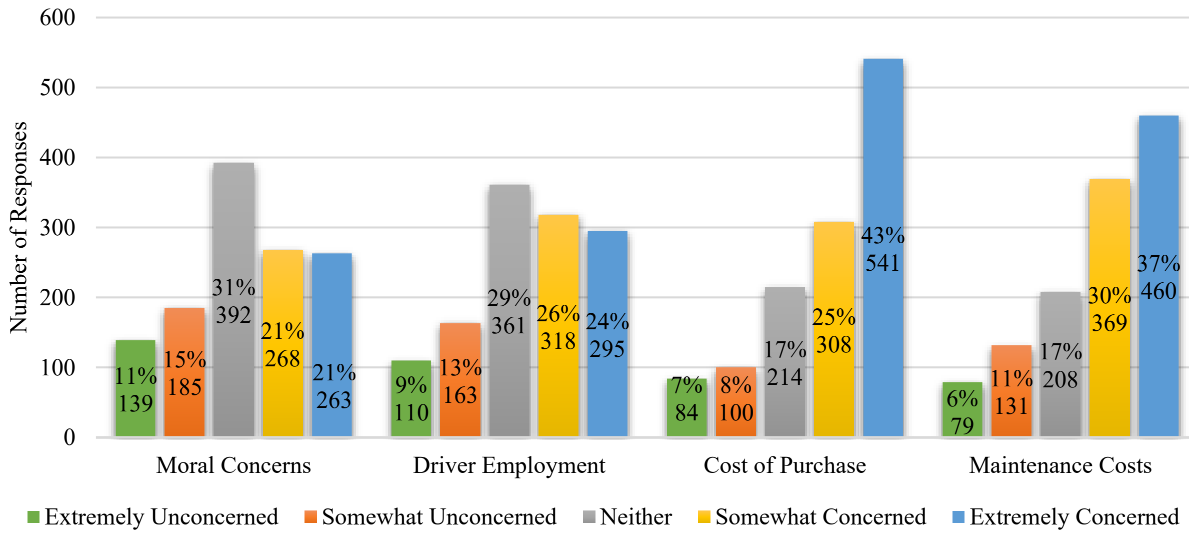

Figure 4-7. Common Concerns (Part 2)

Finally, respondents were asked about their preference of sharing the road with autonomous vehicles. First, they were asked about their level of agreement with the statement, "I would prefer to share the road with self-driving semi-trucks over driver controlled." Of the 1247 respondents, 564 (45.2%) did not agree with the statement and 305 (24.4%) did agree. Exactly 30.3% (n=378) neither agree nor disagreed. Pertaining to sharing the road with self-driving passenger vehicles, 36.8% (n=459) had negative reactions and 32.2% (n=401) had positive reactions to the statement.

Chapter 5: Analysis

In this section, an analysis of the original research hypotheses is presented. As a reminder, the hypotheses are:

> H1: Rural drivers would be more hesitant to adopt self-driving or autonomous vehicles when compared to non-rural drivers.
>
> H2: Drivers in general would think autonomous vehicles are more dangerous than human drivers (due to moral concerns, technology failures, and differing roadway geography).
>
> H3: More education would lead to a higher likelihood of adoption of self-driving vehicles.
>
> H4: Older people would be less likely to adopt AVs due to their perceived apprehension of newer technologies.

Variables that seemed to be stereotypically bound to living in rural areas were also tested, such as longer commute distances, to provide a beginning for further analysis and to provide quality assurance that the assumptions were on target. A further commute distance may increase the likelihood of adoption.

Theoretical Ownership of AVs and Commute Distances

Student's t-tests were performed on various variables to predict whether respondents were "'extremely unlikely,' 'somewhat unlikely', 'neither likely nor unlikely', 'somewhat likely', and 'extremely likely'" to act a certain way if they theoretically owned a self-driving vehicle, depending on place of residence (rural or not). There were three different behaviors that were compared with place of residence including "likelihood to travel longer distances," "live farther from work," and "travel more at night." A summary of the test outcomes is provided in Table 5-1.

There were 913 rural respondents and 334 non-rural/unsure respondents. While the "likelihood to travel longer distances" and "travel more at night" tests did not yield statistically significant results, the "live farther from work" test did. For this test (Test 2), the values were normally distributed on a quartile Q-Q plot and there was homogeneity of variances from Levene's test for equality of variance ($p=.151$). It was determined that there were no outliers in either category of yes or no/unsure from inspection of a boxplot. Rural respondents were more likely to live farther distances from work (1.53 ± 1.290) than non-rural/unsure (1.33 ± 1.206) if they owned a self-driving vehicle. The rural respondents mean response was .202 (95% CI, 0.043 to 0.361) higher than non-rural/unsure respondents where the results were statistically significant, $t\,(1245) = 2.494$, $p = .013$. The p-value for the t-test significance was two sided (tailed).

Table 5-1. Summary of T-Test for Mean Difference

Test Number	Dep. Variable	Ind. Variable	Category	Mean	STD	N	p-val
1	Travel Longer Distances*	Place of Residence	Rural	2.159	1.294	913	0.970
			Non-Rural/Unsure	2.156	1.240	334	
2	Live Farther from Work*	Place of Residence	Rural	1.534	1.290	913	**0.013**
			Non-Rural/Unsure	1.332	1.206	334	
3	Travel More at Night*	Place of Residence	Rural	2.123	1.298	913	0.467
			Non-Rural/Unsure	2.063	1.252	334	
Notes:	* denotes behavior of theoretical ownership of self-driving vehicle						
	bolded denotes significance at 95% confidence level						

To assess the relationship between weekly commute to work or school and place of residence (rural or not) a Chi-Square Test of Independence was performed. There was a significant relationship between the two variables, X^2 (4, N=1247) = 30.517, p = < .001. Longer commute distances were more likely tied to selecting rural residence areas. Only one cell (10.0%) had an expected count of less than five. The minimum expected was 4.29.

Based on the results from the t-tests and Chi-Square test, rural residents, who already live farther from work than their urban counterparts, may choose to live even further if they own a self-driving vehicle. However, it is important to keep in mind that a mean of 1.534 implies that most rural residents are still "unlikely" to choose to live farther from work.

In summary, pertaining to theoretical ownership of a self-driving vehicle, respondents that live in rural areas are slightly more likely to live farther from work than respondents that do not live in rural areas. It was shown rural residents already have a comparably longer distance to commute than their non-rural counterparts. While living farther away, a little more distance might not feel like it would make a difference. The differences in likelihood to travel more at night or travel longer distances (in general) were not statistically significant between rural and non-rural respondents.

Building off previous literature that suggested that while people will perceive AVs as beneficial, perceptions may not be an indication of intent to use (Classen et al. 2021), the results of this analysis seem to support that observation. Even when provided with theoretical ownership of AVs, respondents were unlikely to live farther from work or school.

Factors Affecting Trust in Self-Driving Vehicles

A multiple linear regression model (n=772) was run to predict the level of "trust that self-driving vehicles are safer than human driven vehicles" using the independent variables listed in Table 5-2. The dependent variable was measured using a five-point Likert scale. It was found that there were no non-linear relationships by assessment of partial regression plots and a plot of studentized residuals (quotient from division of a residual by an estimate of standard deviation) against the predicted values. There was independence of residuals (observations), and the Durbin-Watson statistic was 2.084 number (a close to two shows no correlation between residuals). There was homoscedasticity from a plot of studentized residuals versus unstandardized predicted values, but there were no collinearity problems (VIF values were all less than 10, and no correlations were greater than 0.7). There were no residuals more than three standard deviations away from the mean in a positive or negative direction and the residuals were all normally distributed from an assessment of Q-Q plots. The model predicted a statistically significant relationship between the dependent variable and independent variables, $F(12,759) = 26.611$, $p < 0.001$, adj. $R^2 = 0.285$. The regression coefficients, standard errors, and significant variables (bolded) can be found in Table 5-2.

For this model, there was a positive correlation between those who currently used autonomous features in their vehicles and those who trust that self-driving vehicles would be safer than human driven vehicles. Cruise control, lane assist, and self-parking were the features that respondents were using. Those respondents felt positively toward self-driving vehicles. This indicates a correlation between current use of AV features and feelings of safety toward self-driving vehicles. If drivers have already adopted autonomous features, then they will likely accept bigger changes in the future. Respondents in the subset that were older had less trust in self-driving vehicles than those that were younger.

Table 5-2. Linear regression analysis for “trust that self-driving vehicles are safer than human driven vehicles” (subset)

Variable	β (unstandardized)	Std. Error	β' (standardized)	Sig.
Constant	1.225	0.165	-	**<0.001**
Rural (0=No/Unsure, 1=Yes)	-0.076	0.092	-0.026	0.411
Gender (0=Other,1=Male)	-0.004	0.083	-0.001	0.963
Age (0=18-35, 1=36-49, 2=50-64, 3=65+)	-0.081	0.040	-0.065	**0.045**
Education (0=HS or Less, 1=Some College, Associate's, Technical Deg., 2=Bachelor's Deg, 3=Master's, PhD, Professional Deg)	0.025	0.043	0.018	0.570
Political Affiliation (0=V. Liberal, 1=Somewhat Liberal, 2= Moderate, 3= Somewhat Conservative, 4=V. Conservative)	-0.102	0.040	-0.081	**0.011**
Familiarity with AVs (0=Unfamiliar, 1=Somewhat Unfamiliar, 2=Neither, 3= Somewhat Familiar, 4=Familiar)	0.092	0.030	0.104	**0.002**
Cruise Control* (0=Never, 1=Rarely, 2=Sometimes, 3=Often, 4=Always)	0.080	0.036	0.070	**0.029**
Lane Assist* (0=Never, 1=Rarely, 2=Sometimes, 3=Often, 4=Always)	0.093	0.036	0.096	**0.010**
Self-Parking* (0=Never, 1=Rarely, 2=Sometimes, 3=Often, 4=Always)	0.118	0.041	0.107	**0.004**
Technology Failure** (0=Extremely Unconcerned, 1=Somewhat Unconcerned, 2=Neither, 3=Somewhat Concerned, 4= Extremely Concerned)	-0.262	0.038	-0.239	**<0.001**
Moral Concerns** (0=Extremely Unconcerned, 1=Somewhat Unconcerned, 2=Neither, 3=Somewhat Concerned, 4= Extremely Concerned)	-0.041	0.037	-0.041	0.270
No Human Interaction** (0=Extremely Unconcerned, 1=Somewhat Unconcerned, 2=Neither, 3=Somewhat Concerned, 4= Extremely Concerned)	-0.194	0.037	-0.191	**<0.001**
Notes:	bolded denotes significance at 95% confidence level	* denotes current use of AV features	ANOVA p-val: <0.001	
		** denotes level of concern	adjusted R^2: 0.285	

A second multiple linear regression model (n=1247) was run to predict the level of “trust that self-driving vehicles are safer than human driven vehicles” from the independent variables listed in Table 5-3. This new test included a removal of three variables that measured the current use of “Cruise Control,” “Lane Assist,” and “Self-Parking.” This revised model was run so researchers could see how all respondents answered, rather than just the subset of 772 respondents that currently used autonomous vehicle features. The adjusted R^2 value decreased from 0.285 to 0.245.

The model predicted a statistically significant relationship between the dependent variable and independent variables, $F(9,1237) = 44.617$, $p < 0.001$, adj. $R^2 = 0.240$. The regression coefficients, standard errors, and significant variables (bolded) can be found in Table 5-3.

This statistically significant model was created to predict how much respondents trusted the safety of self-driving vehicles versus human driven vehicles. The variables that were used were “rural,” “gender”, “age”, “education level”, “political affiliation”, “familiarity with AVs”, and level of concern of “‘technology failures’, ‘moral concerns’, and ‘no human interaction.’” The statistically significant indicators (independent variables) were “education level,” “political affiliation”, “familiarity with AVs”, and level of concern of “‘technology failures’ and ‘no human interaction.’” Education level had a positive correlation where respondents with higher education levels had stronger trust in AVs. Political affiliation showed that the more conservative respondents were less likely to trust self-driving vehicles. Those that were more familiar with AVs were more likely to have trust in self-driving vehicles. Finally, pertaining to levels of concern, the higher the level of concern respondents had for technology failures or no human interaction, the less likely they were to agree that self-driving vehicles would be safer than human driven vehicles. The variables “rural,” “gender,” “age,” and “moral concerns” were not statistically significant, so a postulation could not be made regarding those variables.

Table 5-3. Linear regression analysis for "trust that self-driving vehicles are safer than human driven vehicles" (all responses)

Variable	β (unstandardized)	Std. Error	β' (standardized)	Sig.
Constant	3.509	0.140	-	**<0.001**
Rural (0=No/Unsure, 1=Yes)	-0.011	0.071	-0.004	0.874
Gender (0=Other,1=Male)	-0.026	0.067	-0.010	0.699
Age (0=18-35, 1=36-49, 2=50-64, 3=65+)	-0.051	0.033	-0.040	0.128
Education (0=HS or Less, 1=Some College, Associate's, Technical Deg., 2=Bachelor's Deg, 3=Master's, PhD, Professional Deg)	0.074	0.035	0.054	**0.036**
Political Affiliation (0=V. Liberal, 1=Somewhat Liberal, 2= Moderate, 3= Somewhat Conservative, 4=V. Conservative)	-0.092	0.032	-0.074	**0.004**
Familiarity with AVs (0=Unfamiliar, 1=Somewhat Unfamiliar, 2=Neither, 3= Somewhat Familiar, 4=Familiar)	0.106	0.023	0.122	**<0.001**
Technology Failure** (0=Extremely Unconcerned, 1=Somewhat Unconcerned, 2=Neither, 3=Somewhat Concerned, 4= Extremely Concerned)	-0.297	0.029	0.283	**<0.001**
Moral Concerns** (0=Extremely Unconcerned, 1=Somewhat Unconcerned, 2=Neither, 3=Somewhat Concerned, 4= Extremely Concerned)	-0.058	0.030	0.058	0.053
No Human Interaction** (0=Extremely Unconcerned, 1=Somewhat Unconcerned, 2=Neither, 3=Somewhat Concerned, 4= Extremely Concerned)	-0.198	0.031	0.195	**<0.001**

Notes:	bolded denotes significant at 95% confidence level	* Denotes current use of AV features	ANOVA p-val: <0.001
		** denotes level of concern	adjusted R^2: 0.245

Between the two models, one with the full value of respondents (n=1247), and one with a subset (n=772), they mostly had the same statistically significant independent variables. The difference between the two came from the variables "age" and "education level". In the full model, a higher education level lent to a stronger trust in self driving vehicles. For the model with a subset of respondents (those that currently use AV features) age was a significant predictor. The older a respondent was, the less likely they were to trust self-driving vehicles over human driven vehicles.

While it came from a subset of respondents, the results of this analysis align with previous literature that find older drivers are more hesitant to trust AVs, particularly those with self-driving capabilities. It also shows that, as hypothesized, higher educated people were more likely to trust AVs (with self-driving capabilities). Further work can be done to improve outlooks of those with lower levels of education and the older population.

Determining Likelihood to Adopt an Autonomous Vehicle

To determine the independent variables that would influence the likelihood to buy an autonomous vehicle, multinomial logistic regression models were developed. Survey takers were asked, "If a fully self-driving vehicle (i.e., a vehicle that does not need driver input or attention) was available, then how long would you wait to buy after the first model was released?" The options were "'1 year or less', '2 to 5 years', 6 to 10 years', '11 years or more', 'I would never buy a self-driving vehicle', and 'Unsure'". For the models, the dependent variable was combined into three categories, "'buy at some point', 'never', and 'unsure.'" This combination made the variable nominal and fulfilled the first assumption of the model.

While many models were run, only four had viable results. The remaining models had some dependent variable levels by subpopulation with zero frequencies. This created an error and rendered the results of the model unreliable and incorrect. The four models (A, B, C, and D) that were viable are shown as Table 5-4 to Table 5-7.

The reference category for these models (which is dropped from the model to see the effects of other variables) was "buy at some point". The purpose of the reference category is to leave a category out so that the regression model does not provide a redundant result that comes from multicollinearity. This category was selected because it had the most observed frequencies. For example, Model B used the independent variables, "rural" (which asked if respondents lived in a rural area), "gender", and "age."

For each model, the model significance was <0.001, and p-values that are bolded denote significance at 95% confidence levels. Some independent variables were categorical. While "gender" and "age" are demographic factors that are typically considered as controls in models measuring attitudes/beliefs, the current models treated them as covariates given the theoretical reasons to expect gender and age-based variations in attitudes towards novel technologies. Based on a study done in Florida, males were less likely to have concerns with AVs and more likely to have an eagerness to adopt them. They also had a higher level of willingness to relinquish control of the vehicle. For age, younger people had a lower level of concern with AVs and a higher eagerness to adopt than those in a middle-aged group. There was also a higher willingness to relinquish control to the driving system than those that were middle aged (Charness et al. 2018). For these reasons, age and gender were treated as covariates. “Education level” and “familiarity with autonomous vehicles” were treated as continuous variables which follows the standard covariate definition.

Table 5-4. Multinomial Logistic Regression Model A

Variable	P-Val (likelihood)
Rural (0=No, 1=Yes)	0.138
Gender (0=Other, 1=Male)	**<0.001**

Each of the working models had “gender” and area of residence as independent predictor variables. Model A was used as a baseline for the other models and its -2 log likelihood was 44.759. After this model was developed other variables, such as “age”, were added for Model B, which had a -2 log likelihood value of 82.294.

Table 5-5. Multinomial Logistic Regression Model B

Variable	P-Val (likelihood)
Rural (0=No, 1=Yes)	0.142
Gender (0=Other, 1=Male)	**<0.001**
Age (0=18-49,1= 50+)	**<0.001**

With the higher value, Model B represented a better fit of the variables than Model A. For Model C, the variable of “age” was switched with “education level” to compare results. The variables included in Model C are shown in Table 5-6.

Table 5-6. Multinomial Logistic Regression Model C

Variable	P-Val (likelihood)
Rural (0=No, 1=Yes)	0.083
Gender (0=Other, 1=Male)	**<0.001**
Education Level (0=HS or Less, 1=Some College, Associate's, Technical Deg., 2=Bachelor's Deg, 3=Master's, PhD, Professional Deg)	**<0.001**

Between Models C and D, the predictor (independent) variable "education level" was switched out for "familiarity with AVs" to determine how a driver's personal experience with this technology would perform in the model. Model C had statistically significant variables "gender" and "education level," whereas Model D included "gender," "age," and "familiarity with AVs" as statistically significant variables.

Table 5-7. Multinomial Logistic Regression Model D

Variable	P-Val (likelihood)
Rural (0=No, 1=Yes)	0.145
Gender (0=Other, 1=Male)	**0.018**
Age (0=18-49,1= 50+)	**<0.001**
Familiarity with AVs (0=Unfamiliar, 1=Neither, 2=Familiar)	**<0.001**

For Model C, the variables "gender" and "education level" were significant for those respondents who plan to "never" adopt a self-driving vehicle as shown in Table 5-8. For those that were "unsure" about adoption, "place of residence", "gender", and "education level" were significant. The -2 log likelihood for Model C was 147.69.

Table 5-8. Multinomial Logistic Regression Model C results

Ind. Vars.	B	Std. Error	Wald Coeff.	Sig.	Exp(B)	95% Confidence Int. Exp(B) Lower Bound	95% Confidence Int. Exp(B) Upper Bound
Never							
Intercept	-0.444	0.171	6.76	**0.009**			
Rural	-0.014	0.162	0.01	0.929	0.986	0.717	1.355
Gender	-0.495	0.147	11.32	**0.001**	0.610	0.457	0.813
Education Level	-0.390	0.083	22.29	**<0.001**	0.677	0.576	0.796
Unsure							
Intercept	-0.626	0.190	10.84	**0.001**			
Rural	-0.404	0.183	4.89	**0.027**	0.667	0.466	0.955
Gender	-0.542	0.178	9.23	**0.002**	0.581	0.410	0.825
Education Level	-0.395	0.100	15.65	**<0.001**	0.674	0.554	0.819
Notes:	reference category is "at some point"				-2 Log Likelihood: 147.69		
	bolded denotes significance at 95% confidence					Model Sig: <0.001	

In Model D, statistically significant variables that would predict someone never adopting a self-driving vehicle were “gender”, “age”, and “familiarity with AVs.” The same predictor variables were significant for those respondents who were unsure. For the four models, the -2 log likelihood increased from Model A to D, with Model D having the highest, or best, value. The -2 log likelihood was 199.60.

As the reference category was “buy at some point,” two equations were created for the other categories of the dependent model. The equations were based on the exp(B) values and the significance of variables. For the variables that are significant (bolded), predictions of the population can be made. Exp(B) values that are less than one indicate a higher likelihood of falling into the reference category than the comparative category. The predictions are only accurate for respondents who have the same responses to other independent variables than those being compared.

An example scenario would be a dependent variable of favorite type of ice cream with the options strawberry, chocolate, and vanilla and the reference category as vanilla. The predictor (independent) variables could be age, gender, and enjoyment of games (on a scale of 1 to 5). A comparison between those that liked vanilla or chocolate could be made or a comparison of those that liked vanilla or strawberry could be made. A comparison could not be made between those that like strawberry or chocolate. While making comparisons within types of ice cream, the independent variables, age, gender, and enjoyment of games, would be tested for significance and then assumptions could be made based on the significant variables. For example, if age was a significant factor in the comparison of chocolate to vanilla and the exp(B) value of age was 1.10, then it could be said that regarding respondents with the same gender and level of enjoyment of games, older respondents would be more likely to like chocolate over vanilla. The relative probability of choosing chocolate over vanilla would be 10% higher per increase in age in respondents with the same gender and level of enjoyment of games. The comparative category was chocolate for that example and vanilla was the reference category.

Table 5-9. Multinomial Logistic Regression Model D results

						95% Confidence Int. Exp(B)	
Ind. Vars.	**B**	**Std. Error**	**Wald Coeff.**	**Sig.**	**Exp(B)**	**Lower Bound**	**Upper Bound**
Never							
Intercept	-0.757	0.169	20.02	**<0.001**			
Rural	0.015	0.166	0.01	0.929	1.015	0.734	1.404
Gender	-0.332	0.155	4.59	**0.032**	0.717	0.529	0.972
Age	1.101	0.156	49.85	**<0.001**	3.006	2.214	4.080
Familiarity w/ AVs	-0.458	0.082	31.42	**<0.001**	0.632	0.539	0.742
Unsure							
Intercept	-0.862	0.183	22.09	**<0.001**			
Rural	-0.346	0.182	3.61	0.058	0.708	0.495	1.011
Gender	-0.418	0.184	5.18	**0.023**	0.658	0.459	0.943
Age	0.510	0.196	6.77	**0.009**	1.665	1.134	2.446
Familiarity w/ AVs	-0.325	0.095	11.68	**0.001**	0.722	0.599	0.870
Notes:	reference category is "at some point"			-2 Log Likelihood: 199.60			
	bolded denotes significance at 95% confidence					Model Sig: <0.001	

For the model pertaining to level of trust in self-driving vehicles, the first equation was for those that selected “Never” (comparative category) when asked about their intent to purchase an autonomous vehicle in the future. Based on Model D (Table 5-9), the relative probability of “never” purchasing a fully self-driving vehicle rather than “buy[ing one] at some point” was 28.3% lower for male respondents than non-male respondents with the same choices in rural, age, and familiarity with AVs. More generally, if a respondent were male, it is expected that they would be more likely to “buy at some point” versus “never” buying. For age, the older a respondent was, the more likely they were to “never” buy a self-driving vehicle than “buy at some point.” There was a 200.6% relative probability that respondents would choose “never” over “buy[ing] at some point” with the change from age groups

“18-49” to “50+.” Finally, with age, gender, and living location constant, each one-point increase in familiarity with AVs had a decrease of 0.632 in relative risk of choosing “never” versus “buy at some point.” In other words, those that were more familiar with AVs were more likely to buy at some point than choosing to never buy a self-driving vehicle.

The second equation was for the demographic that was “unsure” (comparative category) whether they would purchase a fully self-driving vehicle. The relative probability of being “unsure” rather than “buy[ing] at some point” was 34.2% lower for male respondents than non-male respondents with the same choices in living location, age, and familiarity with AVs. In short, male respondents are associated with a decrease in the relative probability of “never” purchasing a self-driving vehicle over “buy[ing] at some point” but also a decrease in the relative probability of being “unsure” over “buy[ing] at some point.” Older respondents of the same living location (rural or not), gender, and level of familiarity with AVs, had an increased likelihood of being “unsure” whether they would purchase a self-driving vehicle over “buy[ing] at some point.” There was a 66.5% increase in relative probability in those that were “unsure” over “buy[ing] at some point” with a change in age categories from “18-49” to “50+.” Lastly, respondents that were more familiar with AVs would be more likely to choose “buy at some point” over being “unsure” when they would purchase a fully self-driving vehicle.

While the more fitting model based on the -2 log likelihood was Model D, some insight can be gathered from Model C. A prediction about influence of educational level on likelihood of purchasing a self-driving veihcle can be made. In the comparison between respondents that chose “buy at some point” and those that chose “never”, it was observed that respondents with higher levels of education would be more likely to choose the first option. There was a relative probability that each one-point increase in education level (between categories shown in Table 5-6) would lead to a 32.3% increased likelihood of choosing “buy at some point” over “never” purchasing a self-driving vehicle. In a comparison between “buy[ing] at some point” and being “unsure” about adoption time, respondents with higher levels of education were more likely to “buy at some point” than be “unsure.” In conclusion, respondents with the same gender and living location (rural or not) that have higher levels of education are more likely to buy a self-driving vehicle at some point than those with lower levels of education. This may be that those with higher levels of education are more trusting of technology or that they are less skeptical of newer technologies.

Since the independent variable “rural” was not statistically significant, a conclusion about the variable could not be made. In the future, a different combination of independent variables may allow for an emergence of “rural” to be statistically significant. Since the data is provided in a relative term, it is important to keep in mind that general blanket statements cannot be made about the singular effect of an independent variable on likelihood to buy an autonomous vehicle without mentioning that other independent variables are held constant based on these models.

Chapter 6: Conclusion and Future Work

In this study, the research focused on rural residents and their perceptions of autonomous vehicles. Through a literature review, a basis of understanding pertaining to rural residents and autonomous vehicles was completed. With the understanding of literature, hypotheses were created to predict perceptions of rural residents. With the hypotheses in mind, a survey was created by a team of researchers over a period of time and by a survey company, Qualtrics. Quotas were created to create a representative sample of rural respondents. Age, gender, and self-identification of living location (rural or non-rural, state, etc.) were among the quota requirements. The survey was approved by the University of Idaho's Institutional Review Board before it was distributed.

A total of 1,247 valid responses were collected with 73.2% (n=913) responding that they lived in a "settlement with less than 2,500 people or open countryside." There were 737 (59.1%) responses that chose female as their gender. This percentage is representative of the total percentage of females living in the United States (50.5%), according to the US Census Bureau as of 2022. Most of the survey identified as white (n=883, 70.8%). The most common level of education was high school or less with 458 (36.7%) responses and for age, 18 to 35 years old (n=581, 46.6%) was the most popular response range.

Respondents were asked questions about their behaviors and characteristics as drivers. For example, most of the respondents owned vehicles or had daily access (n=1115, 89.4%) and 69.1% (n= 862) said their primary vehicle was a passenger car or SUV. Following questions about driver behaviors and characteristics, respondents were asked about autonomous vehicles. Of the 1,247 respondents, 42.2% (n=526) said they were "familiar" or "somewhat familiar" with autonomous vehicles. When asked about usage of specific autonomous driving features, the most used autonomous feature was traditional cruise control. Of the 772 respondents that had autonomous vehicle features in their current vehicle, 349 (45.2%) said that they would be "extremely unlikely" or "somewhat unlikely" to use a vehicle with self-driving with a driver takeover option and only 12.4% (n=96) said they would be "extremely likely" to use that kind of vehicle.

Of the concerns that respondents expressed relating to self-driving vehicles, 43.3% (n=541) were "extremely concerned" about the cost of purchasing a self-driving vehicle. The next most concerning categories were technology and sensor failures based on number of responses in the "extremely concerned" category.

Through statistical analysis, it was found that if respondents theoretically owned a self-driving vehicle, those that live in rural areas are slightly more likely to live farther from work than they already do when compared with respondents that do not live in rural areas. While they were slightly more likely to choose to live further, most rural respondents were still "unlikely" to live farther. This means that those in non-rural areas were closer to the "extremely unlikely" side of the Likert scale than rural respondents. Overall, it can be said that most respondents, regardless of living location, were unlikely to live farther from work even when owning a self-driving vehicle. For future studies, actual distances that rural residents would be willing to live should be examined. A higher number of distance options with smaller ranges, such as 0 to 5 miles, 6 to 10 miles, etc., is recommended for investigation.

While determining the level of trust in self-driving vehicles, it was found that there was a group of people that felt that autonomous vehicles were more dangerous, or had less trust toward autonomous vehicles, than human driven vehicles. This group included those that were older and those that had lower levels of education. There was a decrease in the likelihood to trust self-driving vehicles with age and an increase in those with more education. There was a positive correlation between those that currently used autonomous features in their vehicles and their trust that self-driving vehicles would be safer than human driven vehicles.

Two statistical models were developed to determine levels of trust in self-driving vehicles. One model included the full population of respondents (n=1,247) and the other model included a subset (n=772). The subset was comprised of respondents who currently use autonomous vehicle features. In the full model, a higher education level lent to a stronger trust in self-driving vehicles. In the subset model, age was a significant predictor. Those that were older were less likely to trust self-driving vehicles over human drivers. It proved an initial research hypothesis, specifically that higher educated people were more likely to trust AVs (with self-driving capabilities). To improve the outlook of those with lower levels of education and the older population, more work can be done to understand how autonomous vehicles are currently, and in the future, perceived. Older drivers are a demographic that should be the focus of more educational outreach to increase comfort levels and outlooks. Looking at the initial hypothesis that rural drivers would be more hesitant to adopt self-driving vehicles, the wariness that was observed in rural drivers seemed to be comparable to that of non-rural respondents. For example, they had similar levels of trust that self-driving vehicles would be safer than human driven vehicles.

Finally, a model was developed to determine the likelihood of adopting a fully self-driving vehicle. Two comparisons were made in the model. One comparison tested the categories "buy at some point" and "never" and the other compared "buy at some point" to "unsure." In the first comparison, it was found that male respondents were more likely to “buy at some point” than to choose to “never” buy a self-driving vehicle if they had the same living location (rural or not), age, and familiarity with AVs. There was a 200% increase in likelihood that respondents that were older would choose to “never” purchase a self-driving vehicle rather than “buy at some point.” Finally, those that were more familiar with AVs were more likely to “buy at some point” than choosing to “never” buy a self-driving vehicle.

In a second comparison, the categories “buy at some point” and “unsure” about buying a self-driving vehicle were compared. Male respondents were less likely than non-male respondents to be “unsure” whether they would buy a self-driving vehicles. There was a 66.5% increase in relative probability in those that were “unsure” over “buy[ing] at some point” with a change in age categories from “18-49” to “50+.” This means older respondents were more “unsure” than being sure they would “buy at some point.” Respondents that were more familiar with AVs exhibited higher levels of likelihood to buy a self-driving relative to people of the same age, gender, and living location (rural or non-rural).

The final hypothesis that researchers examined was an increased likelihood to adopt self-driving vehicles in respondents that were more highly educated, and this was proven true as well. As expressed earlier, an outreach to those that have lower levels of education, such as with high school diplomas or less, could be a niche of the public who would benefit from educational outreach to improve trust and likelihood of adoption.

Tying into research that shows the influence AVs might have on respondents’ current lifestyles, those that are older or disabled may be among those that could benefit the most from self-driving vehicles. This research showed that there is a greater reluctance as people age to adopt fully self-driving vehicles. Work can be done in the future to explain the benefits and to introduce people to the technology, which would in turn strengthen their trust in self-driving vehicles. Some studies have introduced self-driving technology to small populations, but a greater expansion of the effort might be beneficial in terms of adoption rates. As with any technology, those in rural areas are likely to be further down the line in adoption, but as adoption rates become more widespread, these communities should follow suit. This analysis was unable to determine a realistic timeline of adoption of self-driving vehicles based on location of residence (rural or not), so expanded efforts on the topic will benefit future prediction models. Another area that would benefit from further exploration is how autonomous vehicles would be accepted in areas with extreme temperature climates, such as heavy snowfall.

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Appendix A: Survey

University of Idaho

Opening Statement

Researchers from the University of Idaho's Department of Civil and Environmental Engineering are conducting a study that examines public perceptions of autonomous vehicles.

Your participation will involve answering an online survey that should take about eight to ten minutes to complete. Your involvement in the study is voluntary, and you may choose not to participate. You can refuse to answer any of the questions at any time. No names will be associated with your responses.

The findings from this project will provide information on various behaviors and perceptions. If published, results will be presented in summary form only with no personal identifiers.

If you have any questions about this research project, please feel free to call Kevin Chang at (208) 885-4028. If you have questions regarding your rights as a research subject, or if you want to obtain information or offer input you may call the Office of Research Assurances at (208) 885-6340 or irb@uidaho.edu.

By clicking the arrow, you certify that you are at least 18 years of age and agree to participate in the above-described research study. Thank you in advance.

Screening Questions

Rural areas can be defined as settlements with less than 2,500 people or open-countryside. Based on this definition, do you live in a rural area?

- ○ Yes
- ○ No
- ○ Not sure

Demographics

Which state do you live in?

What is your home zipcode?

What is your gender?

- ◯ Female
- ◯ Male
- ◯ Non-binary
- ◯ Other
- ◯ Prefer not to answer

How old are you?

- ◯ Under 18
- ◯ 18-35
- ◯ 36-49
- ◯ 50-64
- ◯ 65 or over

What is your marital status?

- ◯ Single and never married
- ◯ Married or domestic partnership
- ◯ Separated
- ◯ Divorced
- ◯ Widowed

How many children (under 18) live with you in your household?

- ◯ None
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4 or more

What is your ethnicity?

- White/Caucasian
- American Indian/Alaskan Native
- Asian/Pacific Islander
- Black/African American
- Hispanic/Latino
- Multiple/Other

What is the highest level of formal education you have completed?

- Did not graduate high school
- High school diploma or equivalent (GED)
- Some college, no degree
- Technical Degree
- Associate's Degree
- Bachelor's Degree
- Master's Degree
- Doctorate Degree
- Professional Degree

What was your total household income last year?

- Less than $50,000
- $50,000 - $74,999
- $75,000 - $99,999
- $100,000 - $149,999
- $150,000 or higher
- Prefer not to answer

From a political viewpoint do you think of yourself as liberal or conservative?

- Very liberal
- Liberal
- Moderate
- Conservative
- Very conservative

Are you currently employed?

- ◯ Yes
- ◯ No

What type of industry do you work in?

- ◯ Private Sector
- ◯ Public Sector
- ◯ Self Employed
- ◯ Retired
- ◯ Other (may be without pay)

What occupational field do you work in?

- ◯ Agriculture
- ◯ Architecture, Planning & Environmental Design
- ◯ Arts & Entertainment
- ◯ Business
- ◯ Communications
- ◯ Education
- ◯ Engineering & Computer Science
- ◯ Environment
- ◯ Government/Military
- ◯ Health & Medicine
- ◯ International
- ◯ Law & Public Policy
- ◯ Sciences - Biological & Physical
- ◯ Social Impact
- ◯ Transportation
- ◯ Trade/Construction
- ◯ ________ Other

General

What kind of internet connection do you have?

- ◯ Dial up
- ◯ Cable
- ◯ Fiber optic
- ◯ Satellite
- ◯ DSL
- ◯ Hotspot
- ◯ No internet connection
- ◯ Have internet - unsure what kind it is

Do you use any of the following devices?

	Yes	No
Smart phone	◯	◯
Tablet	◯	◯
Laptop	◯	◯
Desktop computer	◯	◯
Television	◯	◯

How familiar are you with the term "autonomous vehicles"?

- ◯ Unfamiliar
- ◯ Somewhat unfamiliar
- ◯ Neither unfamiliar nor familiar
- ◯ Somewhat familiar
- ◯ Familiar

Behavior

Do you own or have daily access to a vehicle?

- ◯ Yes
- ◯ No

What kind of vehicle is your primary vehicle?

- ◯ Motorcycle
- ◯ Passenger car
- ◯ SUV
- ◯ Van
- ◯ Pickup truck
- ◯ Semi-truck
- ◯ [ ] Other

How many vehicles do you own?

- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4 or more

How many years of driving experience do you have?

- ◯ 1 or less
- ◯ 2 to 5
- ◯ 6 to 10
- ◯ 11 to 15
- ◯ 16 or more

How comfortable are you with driving in night time conditions?

- ◯ Very uncomfortable
- ◯ Somewhat uncomfortable
- ◯ Neither comfortable nor uncomfortable
- ◯ Somewhat comfortable
- ◯ Very comfortable

Based on the descriptions below, would you typically consider yourself to be a passive or aggressive driver?

- ◯ Very passive
- ◯ Somewhat passive
- ◯ Neither passive nor aggressive
- ◯ Somewhat aggressive
- ◯ Very aggressive

How many crashes have you been involved in as a driver in the last five years?

- ◯ 0
- ◯ 1
- ◯ 2 or more

How many crashes have you been involved in as a passenger in the last five years?

- ◯ 0
- ◯ 1
- ◯ 2 or more

Have you experienced any of the traffic infractions below as a driver in the last 5 years?

- ◯ Moving violation (like a speeding ticket)
- ◯ Nonmoving violation (like a parking ticket)
- ◯ Vehicle maintenance violation (like a broken tail light)
- ◯ Prefer not to say
- ◯ None

Recall your last vacation in which you traveled by vehicle. How many miles did you travel one way?

- ◯ 0-50 miles
- ◯ 51-100 miles
- ◯ 101-500 miles
- ◯ 501+ miles
- ◯ Haven't vacationed by vehicle

What is your weekly commute distance (to work or school) in miles?

- ◯ 0-20 miles
- ◯ 21-50 miles
- ◯ 51-150 miles
- ◯ 151-300 miles
- ◯ 301+ miles

In a typical month how often do you travel to a healthcare facility (i.e., doctor's office, dentist, hospital, or pharmacy)

- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4+

Do you have any health issues or disabilities that affect your ability to drive?

- ◯ Yes
- ◯ No
- ◯ Prefer not to answer

Does your current vehicle have any autonomous features (i.e., cruise control, lane assist, self parking, etc.)?

- ◯ Yes
- ◯ No

Listed below are some features that are available in autonomous vehicles. Choose how often you use each feature.

	Never	Rarely	Sometimes	Often	Always
I use cruise control	◯	◯	◯	◯	◯
I use lane assist	◯	◯	◯	◯	◯
I use self parking	◯	◯	◯	◯	◯

	Never	Rarely	Sometimes	Often	Always
I use adaptive cruise control (keeps distance between you and vehicle in front of you by decreasing or increasing speed)	○	○	○	○	○

Listed below are some features that are available or will be available in autonomous vehicles. Choose your likelihood of using these features.

	Extremely unlikely	Somewhat unlikely	Neither likely nor unlikely	Somewhat likely	Extremely likely
Self driving (with driver takeover option)	○	○	○	○	○
Self driving (no steering wheel)	○	○	○	○	○

Listed below are some features that are available or will be available in autonomous vehicles. Choose your likelihood of using these features.

	Extremely unlikely	Somewhat unlikely	Neither likely nor unlikely	Somewhat likely	Extremely likely
Adaptive cruise control (keeps distance between you and vehicle in front of you by decreasing or increasing speed)	○	○	○	○	○
Lane assist	○	○	○	○	○
Self parking	○	○	○	○	○
Self driving (with driver takeover option)	○	○	○	○	○
Self driving (no steering wheel)	○	○	○	○	○

If a fully self-driving vehicle (i.e., a vehicle that does not need driver input or attention) was available, then how long would you wait to buy after the first

model was released?

- 1 year or less
- 2 to 5 years
- 6 to 10 years
- 11 years or more
- I would never buy a self driving vehicle
- Unsure

Values

How likely would you engage in the following behaviors if you owned a self driving vehicle?

	Extremely unlikely	Somewhat unlikely	Neither likely nor unlikely	Somewhat likely	Extremely likely
I would travel longer distances.	○	○	○	○	○
I would travel more at night time.	○	○	○	○	○
I would have an alcoholic beverage at a restaurant or bar more often.	○	○	○	○	○
I would live farther from work.	○	○	○	○	○
I would perform work tasks in the vehicle.	○	○	○	○	○

Listed below are statements related to vehicle travel. Select the answer that represents your level of agreement with each statement.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I enjoy road tripping.	○	○	○	○	○
I enjoy being a passenger in a vehicle.	○	○	○	○	○

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I enjoy traveling by vehicle for long periods of time.	○	○	○	○	○
I enjoy being the driver of a vehicle.	○	○	○	○	○
I enjoy eating in a vehicle.	○	○	○	○	○
I enjoy making personal or business calls in a vehicle.	○	○	○	○	○
I enjoy taking/receiving personal or business calls in a vehicle.	○	○	○	○	○
I enjoy sleeping in a vehicle.	○	○	○	○	○
I enjoy holding conversations in a vehicle.	○	○	○	○	○
I enjoy watching the scenery in a vehicle.	○	○	○	○	○

Listed below are features of autonomous vehicles. Select the answer that represents how you feel about the level of convenience for each feature.

	Extremely inconvenient	Somewhat inconvenient	Neither inconvenient nor convenient	Somewhat convenient	Extremely convenient
Autonomous emergency braking	○	○	○	○	○
Blindspot detection	○	○	○	○	○
Lane keeping assist	○	○	○	○	○
Reverse parking assist	○	○	○	○	○

	Extremely inconvenient	Somewhat inconvenient	Neither inconvenient nor convenient	Somewhat convenient	Extremely convenient
Reverse cross traffic assist	○	○	○	○	○
Parallel parking assist	○	○	○	○	○
Vehicle guidance system (steering without driver input)	○	○	○	○	○
Traffic jam assist (low speed adaptive cruise control)	○	○	○	○	○
Vehicle to vehicle communication (creates 360 degree awareness)	○	○	○	○	○

How comfortable would you be if your rearview or sideview mirror was replaced with a camera image?

- ○ Extremely uncomfortable
- ○ Somewhat uncomfortable
- ○ Neither comfortable nor uncomfortable
- ○ Somewhat comfortable
- ○ Extremely comfortable

Listed below are statements about self-driving vehicles. Select the answer that most closely represents your level of agreement.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	St a
I trust self driving vehicles will be safe (in general).	○	○	○	○	
I trust self driving vehicles will be safer than human drivers.	○	○	○	○	

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	St a
I trust self driving vehicles to handle winter road conditions.	○	○	○	○	
I trust self driving vehicles more than human drivers in the winter.	○	○	○	○	

Listed below are common concerns relating to "self driving" vehicles (vehicles that don't need driver input or attention). Select your level of concern for each category.

	Extremely concerned	Somewhat concerned	Neither concerned nor unconcerned	Somewhat unconcerned	Extremely unconcerned
Technology Failures	○	○	○	○	○
Sensor failures	○	○	○	○	○
Hacking	○	○	○	○	○
Moral concerns	○	○	○	○	○
Maintenance costs	○	○	○	○	○
Affect on driver employment	○	○	○	○	○
No human interaction	○	○	○	○	○
Cost of purchase	○	○	○	○	○

Listed below are statements relating to "self driving" vehicles (vehicles that don't need driver input or attention). Select your level of agreement for each statement.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I would prefer to share the road with self driving semi trucks over driver controlled.	○	○	○	○	○
I would prefer to share the road with self driving passenger vehicles over driver controlled.	○	○	○	○	○

Appendix B: IRB Approval Letter

University of Idaho
Office of Research Assurances

Institutional Review Board
875 Perimeter Drive, MS 3010
Moscow, ID 83844-3010
Phone: 208-885-6162
Fax: 208-885-6014
Email: irb@uidaho.edu

January 12, 2022

To: Kevin Chang

Cc: Jade Williams

From: University of Idaho Institutional Review Board

Approval Date: January 12, 2022

Title: The Perception of Autonomous Driving in Rural Communities

Protocol: 21-237, Reference: 015673

Exempt under Category 2 at 45 CFR 46.104(d)(2).

On behalf of the Institutional Review Board at the University of Idaho, I am pleased to inform you that the protocol for this research project has been certified as exempt under the category listed above.

This certification is valid only for the study protocol as it was submitted. Studies certified as Exempt are not subject to continuing review and this certification does not expire. However, if changes are made to the study protocol, you must submit the changes through VERAS for review before implementing the changes. Amendments may include but are not limited to, changes in study population, study personnel, study instruments, consent documents, recruitment materials, sites of research, etc.

As Principal Investigator, you are responsible for ensuring compliance with all applicable FERPA regulations, University of Idaho policies, state and federal regulations. Every effort should be made to ensure that the project is conducted in a manner consistent with the three fundamental principles identified in the Belmont Report: respect for persons; beneficence; and justice. The Principal Investigator is responsible for ensuring that all study personnel have completed the online human subjects training requirement. Please complete the *Continuing Review and Closure Form* in VERAS when the project is completed.

You are required to notify the IRB in a timely manner if any unanticipated or adverse events occur during the study, if you experience an increased risk to the participants, or if you have participants withdraw or register complaints about the study.

IRB Exempt Category (Categories) for this submission:
Category 2: Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met: i. The information obtained is recorded by the investigator in such a manner that the identity

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of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects; ii. Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or iii. The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by .111(a)(7).