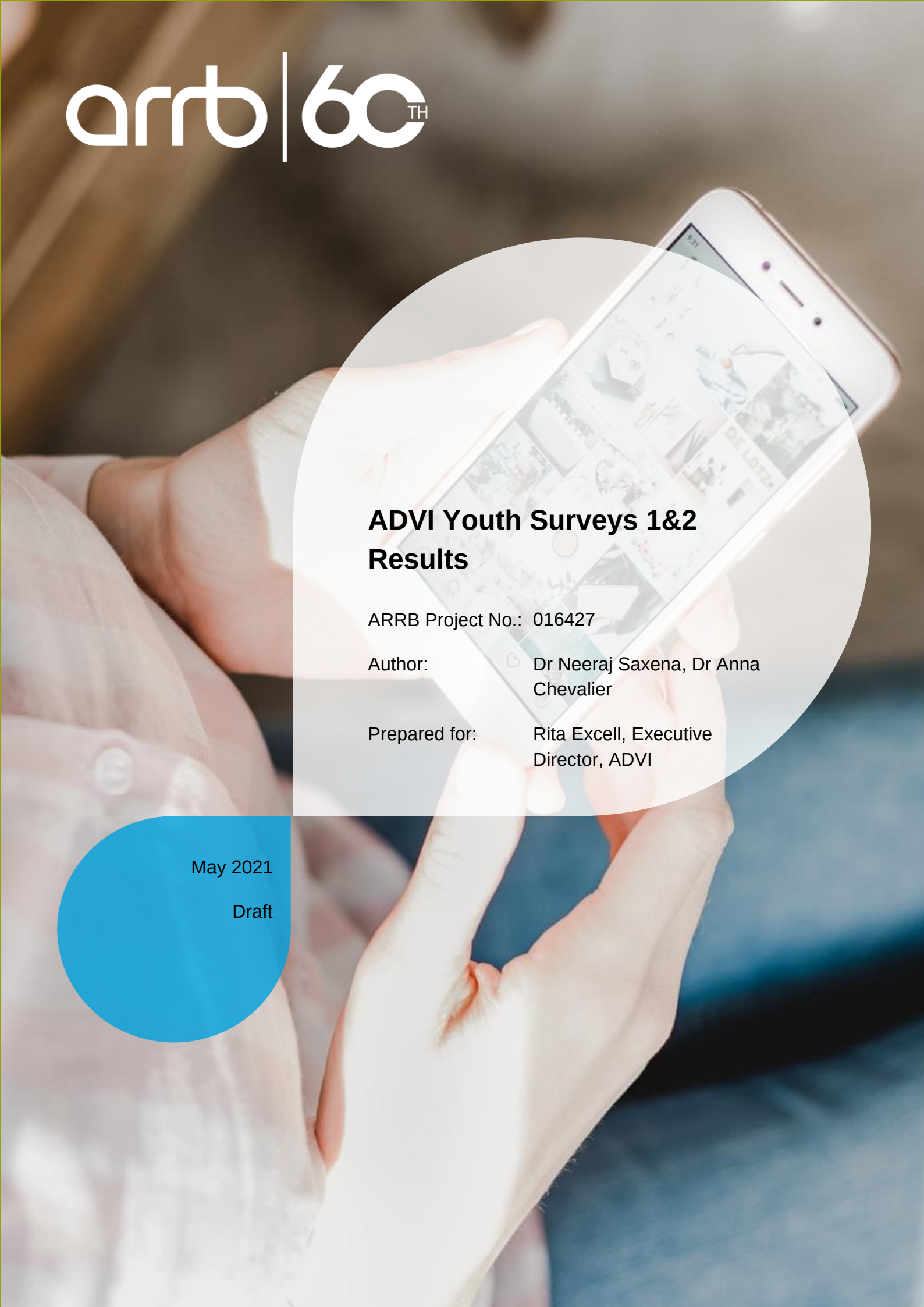

ADVI Youth Surveys 1&2 Results

ARRB Project No.: 016427

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EXECUTIVE SUMMARY

Automated vehicles (AVs) have the potential to provide various societal and environmental benefits, including improved road safety, mobility, traffic efficiency and reduced fuel emissions. There has been increased focus on research investigating public opinion and acceptability of AVs in the last five years. A majority of these studies have included samples aged 18 years and older, while opinions of AVs for those aged under 18 years is largely not understood. This study aimed to gain a preliminary understanding of the exposure to and perceptions of AVs on five survey questions, and how responses differ by age, specifically comparing young pre-drivers aged between 13 and 15 years to individuals aged 25 years or older.

The first ADVI Youth Survey was conducted during November 2019 and January 2020 via Instagram to gain perceptions of individuals across Australia and New Zealand. The survey asked participants to provide responses to:

1. Have you heard about driverless road vehicles before? *[Awareness]*
2. Have you ever ridden in a car, mini-bus or shuttle that can drive itself? *[Exposure]*
3. If you had the choice to use a driverless road vehicle or human-driven road vehicles in the future, how likely would you be to use driverless vehicles? *[Willingness to adopt]*
4. Overall, how do you feel about driverless road vehicles? *[Overall perceptions]*
5. When released, how safe do you believe driverless road vehicles will be compared to a road vehicle driven by a human? *[Safety beliefs]*

The valid data obtained from 498 participants across the two age groups were analysed. Responses regarding willingness to adopt, overall perceptions and safety beliefs were found to not be statistically different between the 13 – 15 and 25+ year age groups.

In October 2020 and November 2020, another wave of data collection was undertaken, with a majority of the participants (90%) recruited through a Market Research (MR) firm. This second wave was undertaken to: 1) obtain a larger sample (upon combining data from both waves) to allow greater power to find a statistical difference, 2) investigate if the results were different across the two waves, and 3) whether the method of recruitment had an impact on the results. Valid responses from 322 participants were obtained from the second wave, and the combined dataset (820 participants) was analysed using an ordered logistic regression to investigate the relationship between responses and independent variables (e.g. age, gender and source of recruitment). Overall, the two age groups were quite aware of although had no to little exposure to driverless vehicles. The majority of participants reported being unlikely to transition to driverless vehicles, although most consider driverless vehicles will be safer than human-driven vehicles. The main findings from the ordered logistic regression are:

- 25+ year old participants are more aware (1.3 times) and exposed (1.7 times) to driverless vehicles compared to those aged 13 – 15 years
- No statistically significant differences in willingness to adopt, overall perceptions and safety beliefs between the two age groups
- Instagram recruited participants (in Wave#1) are more aware (1.3 times), yet more negative towards willingness to adopt (3 times) and overall perceptions (2.5 times) of driverless vehicles compared to those recruited via a MR firm

The study findings have potential implications for vehicle manufacturers and policy makers, who may find value in forecasting likely uptake of AVs. The results indicate the participants, regardless of age, appear to maintain similar perceptions about driverless vehicles, and imply adoption rates may not be different among emerging drivers (13 – 15 years) compared to those aged 25+ years. Furthermore, the participants show a tendency to hold negative perceptions about driverless vehicles, despite believing driverless vehicles will be safer than human driven vehicles. These findings could have implications for vehicle manufacturers and government investigating the barriers to the adoption of driverless vehicle technology. Future research could seek to investigate whether increases in education/awareness and experience with the emerging technology

across age groups are useful in alleviating these negative perceptions towards driverless vehicles. It is also suggested future research investigate factors that may influence these perceptions.

1 INTRODUCTION

1.1 BACKGROUND

Automated vehicles (AVs) control at least some safety-critical functions, such as steering or braking, without input from a human driver (National Highway traffic Safety Administration 2013, p.7). AVs have the potential to provide various societal and environmental benefits, including improved road safety, mobility, traffic efficiency and reduced fuel emissions. However, widespread use of valid and reliable technology is required to realise these benefits. Thus, in recently years, with the rapid development in AV technologies, there has been increased focus internationally on research investigating public opinion and acceptability of AVs.

There have been numerous studies which have investigated perceptions of AVs both in Australia and New Zealand (Cunningham et al., 2019; Pettigrew, Talati, & Norman, 2018) and internationally (Kyriakidis, Happee, & Winter, 2015; Lee et al., 2019; Liu et al., 2019; Nordhoff et al., 2018). However, the majority of studies have included samples aged 18 years and older, with few studies surveying younger individuals (for example, Lee et al. (2019) studied the perceptions of participants aged 16 years and above). Of studies which include younger participants, none have had a specific focus on teenagers or youth opinions on AVs nor included analyses specific to this younger age group. Thus, opinions of AVs for those aged under 18 years is largely not understood.

Given individuals aged 18 years and under are members of Australia and New Zealand's current and emerging road users, including drivers, it is necessary to gain an understanding of perceptions of AVs within this group to better inform how adoption of AVs may progress in the future. In recent years, developed countries have seen a decline in driver licensing rates and car use for young people (Hjorthol, 2016; Murray, 2003; Raimond & Milthorpe, 2010). Given this changing relationship with cars and transport for young people, it is possible perceptions of AVs may differ by age.

Understanding the opinions of young people about AVs has implications for relevant stakeholders, such as vehicle manufacturers and policy makers, who may find value in forecasting likely uptake of AVs. If younger people hold more favourable opinions about AVs compared to older people, we may expect accelerated adoption of AVs over time. Conversely, if opinions on AVs do not differ by age, this finding may suggest factors which influence adoption of AVs are similar across all ages. These may include beliefs about the benefits of AVs which may encourage adoption of the technology, or concerns about the technology which may be a barrier to adoption.

A first wave of the ADVI youth survey was recently undertaken to investigate the perceptions of individuals aged 13 – 15 and 25+ years. Over 900 individuals, approached via Instagram, responded to the survey. The findings from this survey indicated fewer differences between the two age groups in the exposure to and opinions about driverless vehicles (Ledger & Chevalier, 2020).

1.2 OBJECTIVE

This study, a combined analysis of responses from the first and second waves of the ADVI youth survey, aimed to gain a preliminary understanding of the exposure to and perceptions of AVs on five survey questions, and how responses differ by age, specifically comparing young pre-drivers aged between 13 and 15 years to individuals aged 25 years or older. Specific questions investigated individuals' awareness of, exposure to, willingness to adopt, overall perceptions of, and beliefs about the safety of AVs. This was done through undertaking ADVI youth survey in two waves. While the first wave was already completed (and involved sourcing volunteer participants from Instagram users), a second wave of the ADVI youth survey was conducted using a different mode of recruitment, which involved sourcing volunteer participants from a market research (MR) panel. The objectives behind the second wave were to: 1) obtain a larger sample (upon pooling data from both waves) to allow rigorous statistical analysis, and 2) investigate if the results are different across the two waves. In other words, whether the method of recruitment (Instagram versus panel participants) had an impact on the perceptions of the participants towards AVs.

2 DATA COLLECTION

Data collection in this study was undertaken through two waves which used different: 1) time periods, and 2) method of participant recruitment. The following sub-sections discuss the process involved in data collection across the two waves. A detailed discussion on data collection involved in wave#1 can be found in Ledger & Chevalier (2020).

2.1 ETHICAL APPROVAL

This study was submitted for and received ethical approval from the University of Wollongong Human Research Ethics Committee (reference no.: 2019/372). The same ethics approval was used to undertake both waves of data collection.

2.2 TARGET SAMPLE SIZE

The sample size calculation for this study was estimated based on previous data pertaining to age differences in the level of awareness of driverless vehicle technology (Cunningham et al., 2019). It was determined a sample size of approximately 550 participants should provide 80% statistical power to detect medium to large effect sizes in awareness differences between younger (13-19 years) and older (24+ years) age groups. To achieve this level of power based on the planned analysis, the younger age groups contained a greater number of participants compared to the older groups. In seeking a representative sample, each group was further broken down into smaller age groups and by gender. The planned response quotas for each age and gender group is presented in Table 2-1 Table 2-1. These quotas were adopted while collecting data during wave#1 of the survey.

Table 2-1 Preferred sample by age group and gender for survey wave#1

	Age group (years)							
Gender	13-15	16-19	20-24	25-34	35-44	45-54	55+	Total
Male	75	75	25	25	25	25	25	275
Female	75	75	25	25	25	25	25	275
Total	150	150	50	50	50	50	50	550

The quotas defined during wave#2 are presented in Table 2-2. The total sample size during wave#2 is smaller when compared to the first wave due to time and budget constraints.

Table 2-2 Preferred sample by age group and gender for survey wave#2

	Age group (years)					
Gender	13-15	25-34	35-44	45-54	55+	Total
Male	100	25	25	25	25	200
Female	100	25	25	25	25	200
Total	200	50	50	50	50	400

2.3 RECRUITMENT

Wave#1

To target the key population group of interest, those aged between 13 and 15 years, Instagram, a popular social media platform, was chosen as the platform on which to promote the survey. As Instagram is widely used amongst this age group, allows links to be embedded in advertisements, and allows targeted promotion by age and gender groups, it was thought Instagram would provide the greatest exposure for the survey to this group of interest.

The promotional materials for the survey were developed in collaboration with the research team and the marketing teams at the Australian Road Research Board (ARRB). The materials were developed to minimise sampling and response bias. This included the use of visual designs created to appeal across age groups, the decision not to assign keywords or use tags in the Instagram posts, and the use of neutral and non-leading language pertaining to AVs. The chosen Instagram campaign type was carousel images, which repeatedly rotate still images while an Instagram user is looking at the post. This campaign type was chosen as it was thought there may be less variability in engagement with this type of material across ages compared to other campaign types. The carousel images developed and used for promotion of the first survey wave are shown in Figure 2-1 and Table 2-3.

Figure 2-1 Carousel images used for survey promotion on Instagram

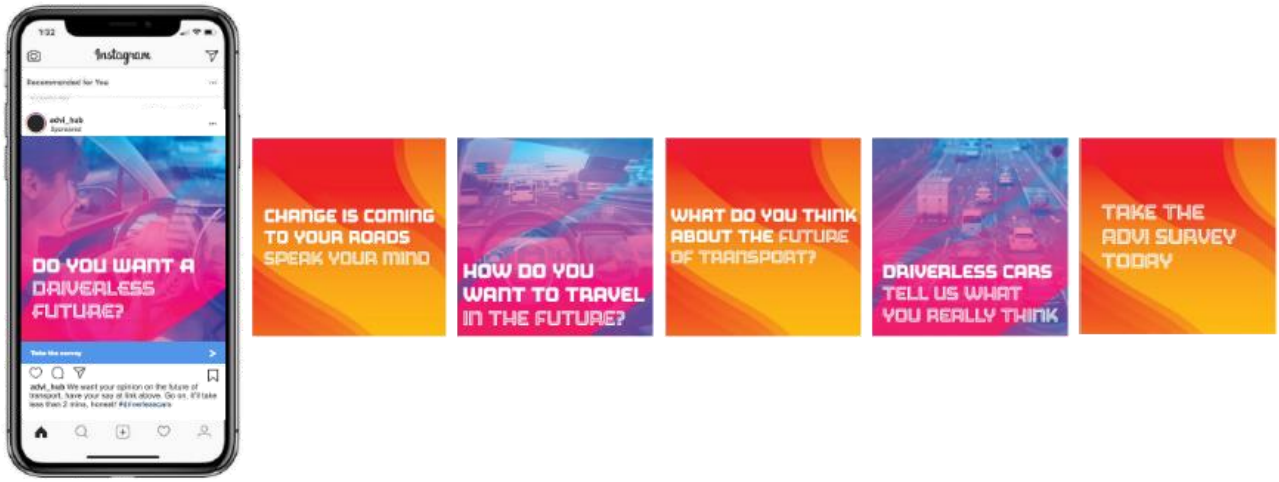


Table 2-3 Wording used in Instagram campaign with carousel images

Location	Wording
Primary text on post	Let your voice be heard! Share your opinion on the future of transport, clink on the link. Go on, it'll take less than 2 mins, honest!
Carousel images	
1	Do you want a driverless future?
2	Change is coming to your roads Speak your mind
3	How do you want to travel in the future?
4	What do you think about the future of transport?
5	Driverless cars Tell us what you really think
6	Take the ADVI survey today

Throughout the data collection period, the number of participants for each age and gender group was monitored. These groups were targeted individually via Instagram, which enabled groups to be closed as the quotas were reached. During recruitment, it was found more males than females were responding to the survey. This resulted in closing the male groups earlier and targeting the female groups for longer to obtain the required responses for each group. However, the function on Instagram which enabled targeted promotion of the survey cannot guarantee the targeted group solely consists of individuals who fit the specifications of the group. Instagram uses Facebook account demographic data where available or Instagram account demographic data to target specific groups, thus, this functionality is vulnerable to inaccuracies where users have inaccurate personal information on Facebook or Instagram. This meant, we continued to receive responses from some groups after recruitment for the group was closed. Given this, the final participant numbers exceed the original planned sample size due to some participant groups exceeding

their required quotas for responses. If the individual has not provided personal details (such as age and gender) on Facebook or Instagram, it is unclear how Instagram determines these personal details.

Finally, all groups with the exception of one group (35-44 year old females, n = 23) met the planned quotas. As 35 to 44 year old females are part of the larger 25+ year old group, being under quota by two responses for this group is not thought to impact interpretation of the results.

Wave#2

The second wave initially started with recruiting participants through Instagram and received 31 responses. However, unlike Wave#1, data collection was slow and costly. It was soon realised the platform usage had undergone changes and it would be challenging to achieve the target sample size within the available time and budget. Furthermore, it was hard to meet the quota for the 13-15 year age group through Instagram. Thus, it was decided to undertake the remaining data collection by recruiting panel participants with a market research (MR) firm. Farron Research was chosen to conduct and administer the remaining wave#2 of the Youth Survey. Farron Research offers custom designed software that assists in connecting with an in-house panel of over 200,000 participants registered nationally. Some macroscopic demographic statistics of the in-house sample are:

- 94% Australian citizens and 78% Australian born
- 41% males and 59% females
- 10% studying at tertiary institutions.

The survey questionnaire was set using Farron Research's software and used a similar promotional material as wave#1. Upon successful completion of the survey, the participants received a small incentive from Farron Research.

At the end of Wave#2, 331 responses were collected through the MR firm, which equates to 91% (331/362) of the total Wave#2 sample. Most of the quotas setfor the age groups (shown in Table 2-2) were satisfied by the end of data collection with the MR firm, except the quota for the 13-15 years group (96 responses received against a quota of 200). This was due to the difficulty in finding and recruitment young individuals. Furthermore, the gender specific quotas could not be met due to budget constraints.

2.4 SURVEY DESIGN

A 9-item online survey was developed to investigate participant awareness of, exposure to, willingness to adopt, overall perceptions of, and perceptions of the safety of AVs. In this survey, the term 'driverless vehicle' was defined to participants as a vehicle which can drive itself, controlling all tasks, and where a human driver is not needed at all. The survey was designed only to ask about fully-automated vehicles to avoid complexity and possible confusion for participants concerning differing levels of automation. Demographic questions were included to identify participant age, gender, country of residence, and driver license status. The full survey is contained in Table 2-4 which was presented to the participants during wave#1 and the Instagram participants during wave#2. A few modifications were made to the survey questions for the participants recruited by the MR firm (in wave#2) which are summarised below:

- The response options presented for the gender question were: male, female and other
- The question on country of residence was removed (since the MR firm controlled for Australian participants)
- A new question was introduced to determine the state of residence within Australia.

Given ethical considerations related to surveying a vulnerable population group (i.e., children aged under 18 years), the survey was designed not to collect any personal information and be short so as not to place any undue burden upon participants. Participants were provided with a brief information and consent statement and provided implicit consent by continuing with the survey. No incentives were provided for participation by ADVI. Instagram participants did not receive any incentive. MR participants were provided with a small incentive by the MR company upon completing the survey.

Table 2-4 Survey questions presented during wave#1 and wave#2 to Instagram participants

Preamble	
You are invited to answer the following few questions on driverless vehicles. It is anticipated this survey will take less than 2 minutes to complete. Responses are voluntary, and you may stop answering the questions any time. Questions you have answered may be used in analysis. No private information will be collected about you. ADVI, the Australian and New Zealand Driverless Vehicle Initiative, is undertaking this research. The findings may be presented in the media, reports, journals and conferences. This research has been approved by the University of Wollongong (UOW) Social Sciences Human Research Ethics Committee (Ethics number: 2019/372). If you have any questions about this research, you may contact xxxxxx xxxxxx via xxxx xxx xxx or xxxx@xxxx.xxx.xx. If you have any concerns or complaints about the research, please contact the UOW Ethics Officer on (xx) xxxx xxxx or xxxxxxxxx@xxx.xxx.xx. To be involved in the study, please answer the following questions.	
Survey question	**Response options [coding]**
In this survey, a driverless vehicle can drive itself, controlling all driving tasks, and a human driver is not needed at all. 1. Have you heard about driverless road vehicles before? *[Awareness]*	No [1] Yes, once [2] Yes, a few times [3] Yes, many times [4]
2. Have you ever ridden in a car, mini-bus or shuttle that can drive itself? *[Exposure]*	No [1] Yes, 1 or 2 times [2] Yes, 3+ times [3]
3. If you had the choice to use a driverless road vehicle or human-driven road vehicles in the future, how likely would you be to use driverless vehicles? *[Willingness to adopt]*	Very likely [1] Somewhat likely [2] Neither likely nor unlikely [3] Somewhat unlikely [4] Very unlikely [5]
4. Overall, how do you feel about driverless road vehicles? *[Overall perceptions]*	Very positive [1] Somewhat positive [2] Neither positive nor negative [3] Somewhat negative [4] Very negative [5]
5. When released, how safe do you believe driverless road vehicles will be compared to a road vehicle driven by a human? *[Safety beliefs]*	Much more safe [1] Somewhat safer [2] The same [3] Somewhat less safe [4] Much less safe [5]
6. What is your age in years?	*Open numerical response between 13 and 120 inclusive with options for Less than 13 and 121+*
7. What is your gender?	Male Female Prefer not to answer
8. Where do you currently live?	Australia New Zealand Other
9. Do you currently hold a driver licence? If so, what type of licence do you hold?	I do not currently have a driver licence Learner licence (‘L’) Provisional licence (‘P’) Full licence

2.5 PARTICIPANTS

The first wave of data collection was completed between November 2019 and January 2020. Similarly, the second wave was completed between October 2020 and November 2020. A total of 910 and 335 responses were received during the first and second waves respectively. The participants were aged between 12 and 121 years for wave#1 and 13 and 85 years for wave#2. For the analyses, data was utilised from respondents who reported being aged between 13 and 15 years inclusive, and age 25 to 99 years inclusive. The following exclusion criteria were also placed on the collected samples to obtain the dataset which was used for analysis in this report:

- The participants reporting gender as “other” (during the first wave) or “prefer not to answer” (during the second wave)
- The participants reporting country of residence as “other” (only asked of wave 1 and wave 2 Instagram recruited participants. The MR firm controlled the participant geography to Australia)
- The participants who did not meet the age eligibility for the licencing category (see Table 2-5). For example, an individual aged 14 years and residing in NSW who reported owning a learner’s licence was excluded from this study as it is not allowed as per the state licensing protocol. While such data points were removed post data collection during wave#1, the MR firm ensured that individuals not meeting this condition are dropped from progressing further with the survey.

The responses from the participants meeting any of the exclusion criteria were dropped from the analysis dataset. Table 2-6 shows a high-level summary of the collected dataset and exclusion criteria applied to obtain the analysis dataset.

Table 2-5 Minimum age at which one is able to obtain a car license by jurisdiction

	Minimum age at which one is able to obtain license		
Jurisdiction	***Ls***	***Ps***	***Full***
Australia			
ACT	15 years 9 months	17 years	20 years
NSW	16 years	17 years	20 years
NT	16 years	16 years 6 months	18 years 6 months
QLD	16 years	17 years	20 years
SA	16 years	17 years	20 years
TAS	16 years	17 years	20 years
VIC	16 years	18 years	22 years
WA	16 years	16 years 6 months	18 years 6 months
New Zealand	16 years	16 years 6 months	17 years 6 months

Table 2-6 Breakdown of overall sample into analysis dataset

		First wave		**Second wave**	
Statistic	**Age group**	**13 – 15**	**25+**	**13 – 15**	**25+**
Overall sample size (A)		186	351	111	219
Gender as “other” or “prefer not to answer” (B)		16	18	2	1
Country of residence as “other” (C)		3	2	0	0
Age ineligibility for licence (D)		2	0	2	3
Analysis sample size (A – B – C – D)		161	331	107	215

3 ANALYSIS METHODOLOGY

This section describes the methodology adopted to analyse the dataset from the ADVI Youth Survey. The methodology applies to individual survey waves (I and II) and both waves pooled into a single dataset. The collected dataset is analysed using the following statistical techniques:

- Descriptive and Inferential Analysis
- Ordered Logistic Regression

The following sections describe each of the above techniques and its relevance in this analysis. Readers can additionally refer to data analysis conducted on wave#1 data in Ledger & Chevalier (2020).

3.1 DESCRIPTIVE AND INFERENTIAL ANALYSIS

The main purpose of conducting a descriptive analysis is to present summaries of data and investigate presence of any trends in the dataset. Descriptive statistics then usually sets the tone for a more detailed statistical investigation (an Ordered Logistic Regression in this study) to quantity the visible trends in the dataset. It generally involves tabulation, graphing and undertaking statistical tests to determine the effect of a given factor (e.g. age, gender, etc.) on the way the participants responded to the survey questions.

Given the five AV related survey questions were measured on a Likert scale, a commonly used ANOVA test is not recommended as it is more suited for the case when the variable of interest (the dependent variable) is continuous. The recommended statistical tests in this situation for each survey question are:

- Shapiro-Wilk test of normality
- Mann-Whitney U test
- Effect size analysis through Eta-squared

3.2 ORDERED LOGISTIC REGRESSION

While the Eta-squared statistic can classify the difference in magnitudes as small, medium and large, it cannot provide a quantification (e.g. marginal effects, direct and cross elasticities, etc.) for this difference. Thus, regression analysis is adopted to determine the odds of an independent variable impacting the outcome variable. An ordered logit model corresponds to a regression which relates the dependent variable, which is measured on an ordinal (Likert) scale, to the independent variables. The outcome of this model is an odds-ratio which corresponds to the change in the outcome (i.e. Likert scale rating) due to a unit change in the independent variable. These odds-ratios give rise to the order of independence variables, by importance, which further aid in understanding the underlying choice making process. Appendix A.3 further discusses the mathematical formulation of the Ordered Logistic Regression model.

4 RESULTS

4.1 DESCRIPTIVE STATISTICS OF DATA

Table 4-1 presents the sociodemographic profile of the participants within the two age groups across the two survey waves. The mean age within a given age group is quite similar across the two waves (13-15 years: 14.42 and 13.72; 25+ years: 46.46 and 47.38). While males represented nearly two-thirds of the total responses for the 25+ years age group in wave#1, the gender balance was more balanced for the same age group in wave#2. This observation indicates that while males who are 25+ years and Instagram users were more active in responding to the survey, both genders were almost equally likely to participate when recruited (largely) through the MR firm. On the other hand, the gender split for the age group 13-15 years remains evenly balanced across the two waves.

Table 4-1 Sociodemographic profile of the participants

Demographic Variable	Wave#1 (n = 498)		Wave#2 (n = 322)	
	13 – 15 years (n = 167)	25+ years (n = 331)	13 – 15 years (n = 107)	25+ years (n = 215)
Age (years)				
Mean	14.42	46.46	13.72	47.38
Std. Dev.	0.71	13.63	0.70	14.21
Gender				
Males	47.3% (79)	63.4% (210)	55.1% (59)	51.6% (111)
Females	52.7% (88)	36.6% (121)	44.9% (48)	48.4% (104)
Country of Residence				
Australia	80.8% (135)	76.7% (254)	98.1% (105)	95.8% (206)
New Zealand	19.2% (32)	13.3% (77)	1.9% (2)	4.2% (9)
Licence Status				
I do not currently own a licence	98.2% (164)	3.6% (12)	100.0% (107)	2.3% (5)
Learner licence (‘L’)	1.8% (3)	1.5% (5)	0	1.9% (4)
Provisional licence (‘P’)	N/A	0.9% (3)	N/A	0.9% (2)
Full licence	N/A	94.0% (311)	N/A	97.9% (204)

Graphed responses to the five survey questions on driverless vehicles are provided below. In addition, a table of the descriptive statistics of the responses to the five survey questions on driverless vehicles across the two waves is provided in Appendix A.1.

Figure 4-1 shows the differences in the awareness levels between the 13-15 and the 25+ years age groups on the pooled (both waves combined) dataset and separated by each wave. In response to the question *'Have you heard about driverless road vehicles before?'*, the majority of participants (93.1% in wave#1; 96.5% in wave#2), regardless of age group, had heard about driverless vehicles at least once.

A much higher proportion of participants across the two age groups in wave#1 (56.9% for 13-15 years; 67.4% for 25+ years) compared to wave#2 (24.3% for 13-15 years; 34.4% for 25+ years) reported having often heard about driverless vehicles (i.e. answering "Yes, many times" to the question *Have you heard about driverless vehicles before* in the survey), despite the wave#2 responses being collected a year later.

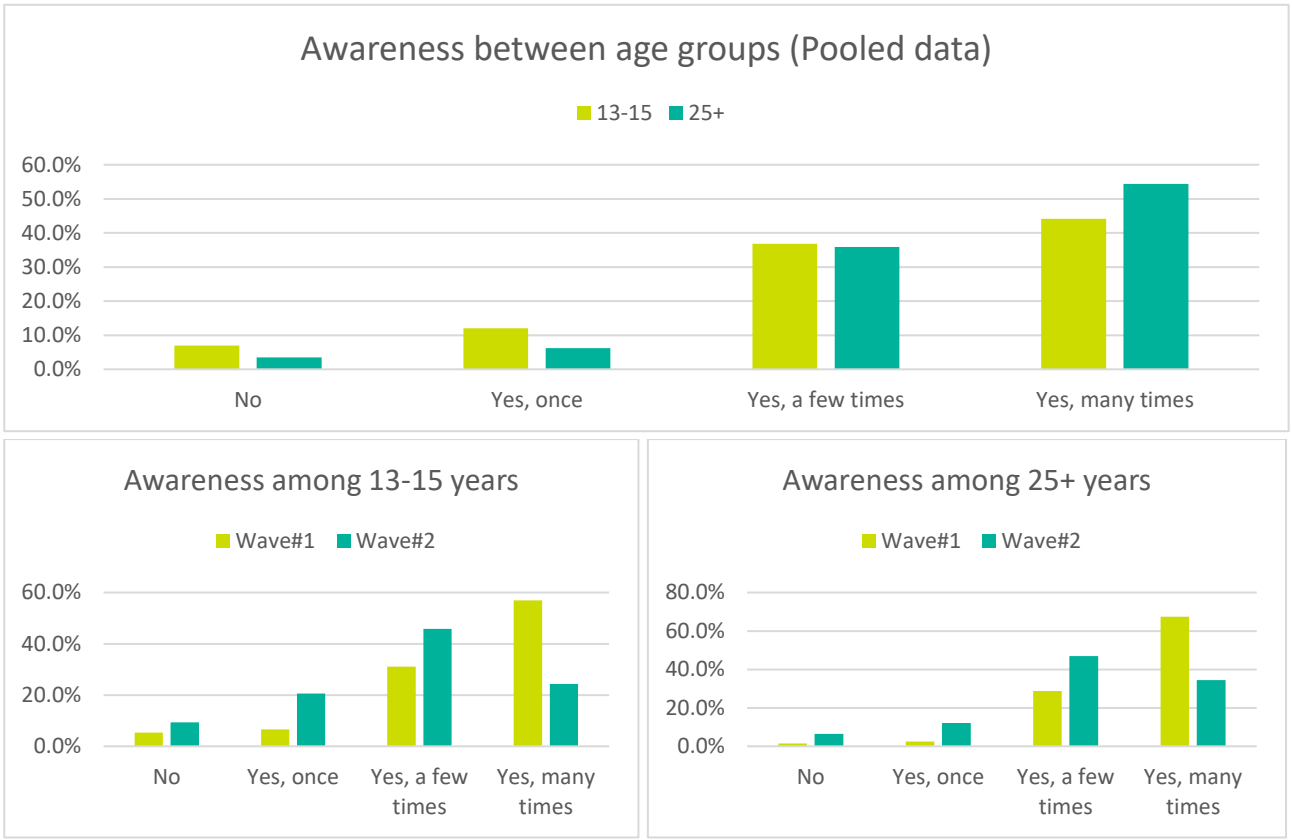


Figure 4-1 Differences in awareness levels between two age groups

Similarly, Figure 4-2 shows the differences observed for the survey question on Exposure. In response to the question '*Have you ever ridden in a car, mini-bus or shuttle that can drive itself*', the majority of participants (at least 80%) reported not having ridden in a driverless vehicle regardless of age group and survey wave.

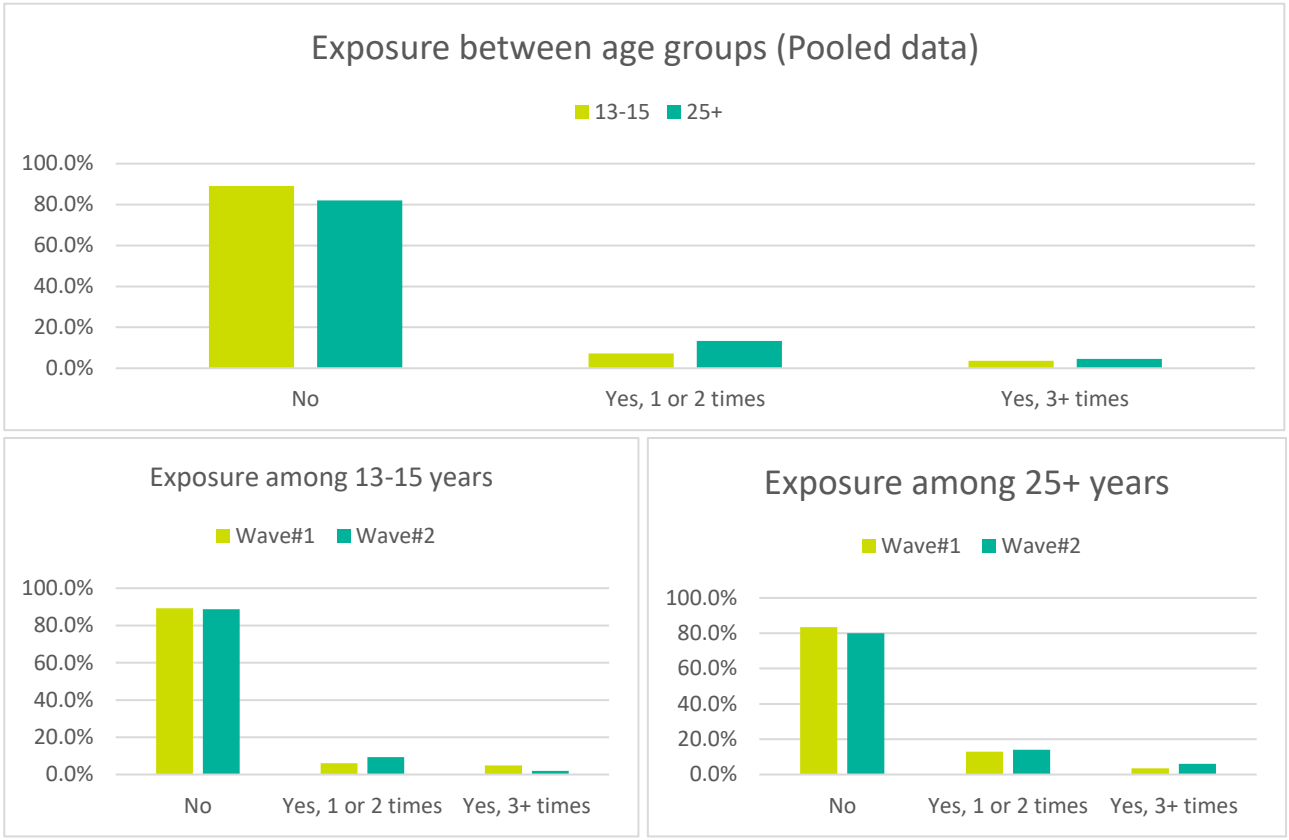


Figure 4-2 Differences in exposure levels between two age groups

Figure 4-3 shows the differences observed for the survey question on Willingness to adopt. For the question *'If you had the choice to use a driverless road vehicle or human-driven road vehicles in the future, how likely would you be to use driverless vehicles?'*, overall pooled responses were fairly similar between the two participant groups, with 45.6% of 13-15 years and 40.1% of 25+ years participants reported being somewhat or very unlikely to use driverless vehicles (when compared to human-driven vehicles), with around 20% remaining neutral.

However, for this question differences between participants in each survey wave appear to be more influential on the results than comparisons between the age groups of participants. More than 50% of participants across the two age groups in wave#1 reported being somewhat or very unlikely to use driverless vehicles in the future compared to human-driven vehicles, while more than a quarter reported being somewhat or very likely to use driverless vehicles (with the remaining being neutral). Conversely, over 50% of participants (across the two age groups) in wave#2 reported being somewhat or very likely to use driverless vehicles over human-driven vehicles in the future, with at least a quarter reporting they are somewhat or very unlikely to use driverless vehicles (compared to human-driven vehicles).

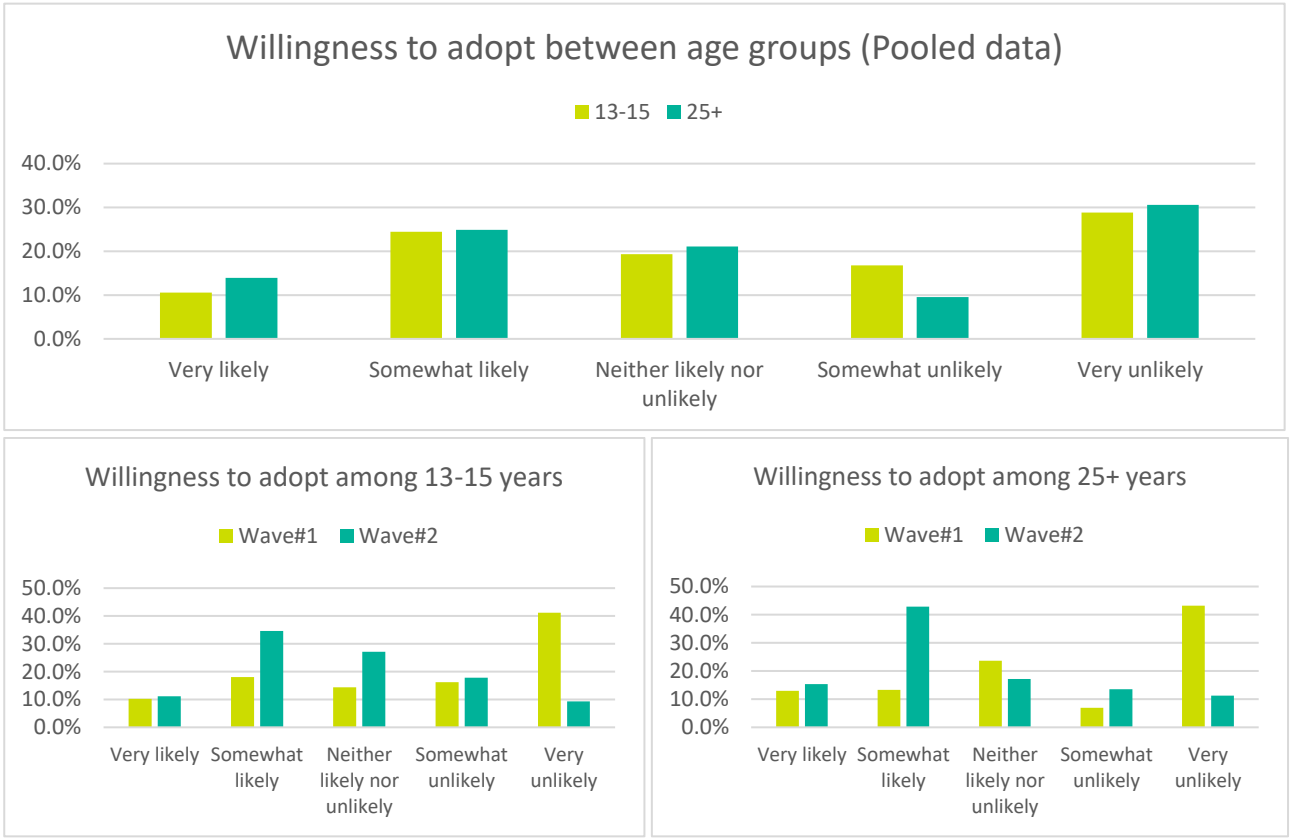


Figure 4-3 Differences in willingness to adopt levels between two age groups

Figure 4-4 shows the differences observed for the survey question on overall perceptions. For the question *'Overall, how do you feel about driverless road vehicles?'*, overall pooled responses from all participants indicate between 40-50% were more likely to report a somewhat or very negative perception of driverless vehicles. When examined by age group, participants aged 13-15 years (47.4%) seem more likely to report a somewhat or very negative perception of driverless vehicles, compared with participants aged 25 years or older (40.5%). More participants aged 25 years and older (21.4%) reported having neither a positive nor negative perception about driverless vehicles, compared to those aged 13-15 years (16.1%)

However, for this question differences between participants to each survey wave also appears to be more influential on the results than comparisons between the age groups of participants. Around 45% of participants across the two age groups in wave#1 reported somewhat or very positive views about driverless road vehicles. However, over 50% of participants in wave#2 reported somewhat or very negative views to the same question. These results appear counter-intuitive when compared with the findings above about participants willingness to adopt driverless vehicles.

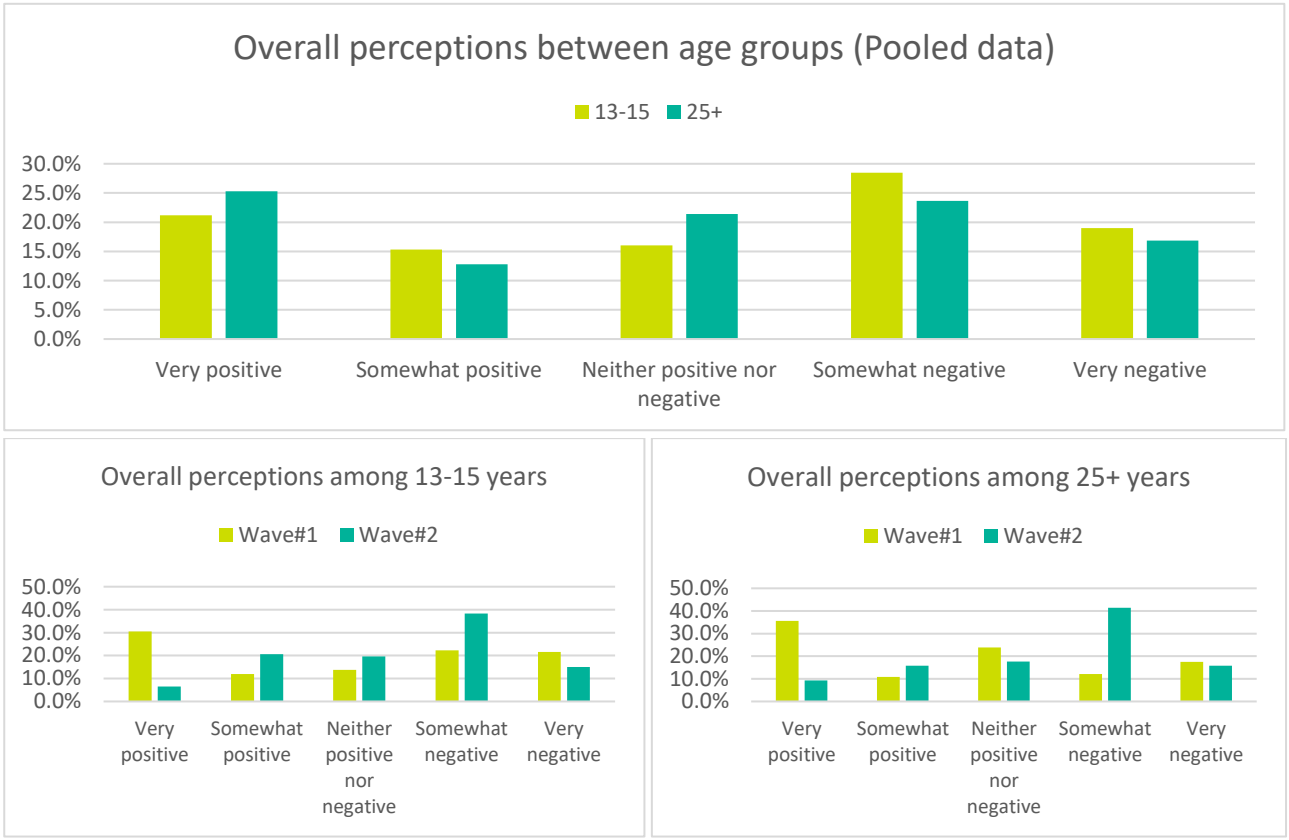


Figure 4-4 Differences in overall perception levels between two age groups

Figure 4-5 shows the differences observed for the survey question on safety beliefs. For the question *'When released, how safe do you believe driverless road vehicles will be compared to a road vehicle driven by a human?'*, overall pooled responses from all participants indicate around 45-50% (50.7% of 13-15 years and 45.8% of 25+ years) were more likely to believe driverless vehicles will be somewhat or much more safe than human-driven vehicles. When examined by age group, participants aged 13-15 years seemed to respond to this question similarly to those aged 25 years or older.

For this question, differences between participants to each survey wave also appears to be more influential on the results than comparisons between the age groups of participants. Across the two age groups, over 40% of wave#1 participants reported believing driverless vehicles will be somewhat or much less safe than a human driven vehicle (with about 20% believing there was no difference in safety, and about 50% believing they will be somewhat or much safer). Less than 30% of wave#2 participants across the two age groups reported believing driverless vehicles will be somewhat or much less safe than a human driven vehicle (with about 8% believing there was no difference in safety, and over 60% believing they will be somewhat or much safer).

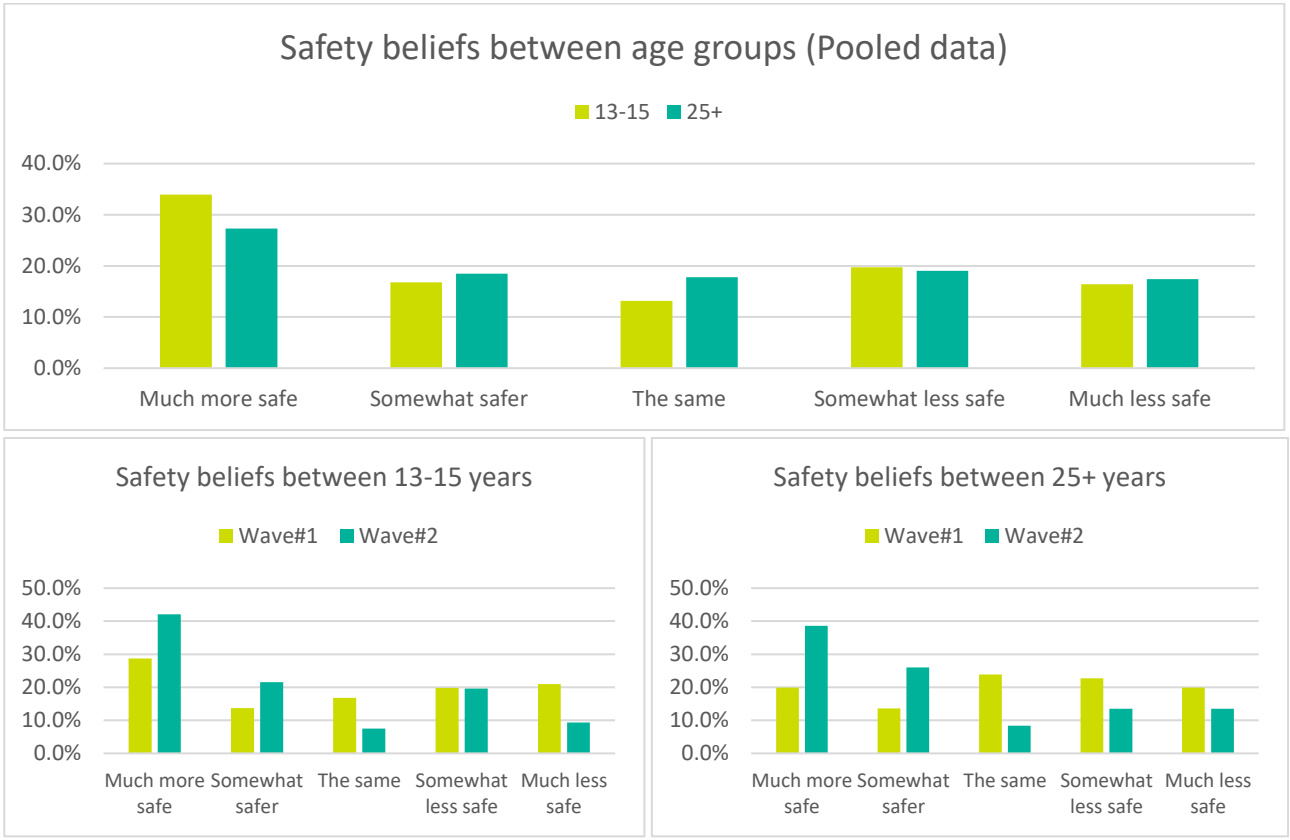


Figure 4-5 Differences in safety belief levels between two age groups

4.2 INFERENTIAL ANALYSIS RESULTS

For further analyses, inferential analysis, responses from the two waves are combined into a single dataset. This is done as the inferential data analysis on each individual wave of data provided similar results. Furthermore, pooling the datasets provided a much larger sample size suitable with greater statistical power to find any differences that may exist. The statistical analysis presented in this section has been carried out using the SPSS package.

Inferential tests like the Shapiro-Wilk test and the Mann-Whitney U test are conducted on the pooled dataset and the key findings are:

- The Shapiro-Wilk test confirms the responses to the five survey questions are not normally distributed
- The Mann-Whitney test shows low to medium effect sizes of the attributes on the five survey questions

- While the effect size provides information of the magnitude of difference between two categories, it does not indicate which category has a greater effect.
- Thus, an ordered logistic regression was undertaken to determine the probability of an outcome for a category.

The detailed results of both the Shapiro-Wilk and Mann-Whitney U tests (including the Eta-squared values) have been presented in Appendix A.2 of this report.

4.3 ORDERED LOGISTIC REGRESSION RESULTS

Ordered logistic regression modelling was undertaken to test if there were statistically significant differences in responses to each of the five survey questions between:

1. those aged 13-15 years and those aged 25 years and older
2. participants recruited through Instagram and those recruited via the MR firm
3. males compared to females.

It is important to note, in the inferential analyses, method of participant recruitment was used, whereas in the descriptive analyses, survey wave was used. As all participants in the first wave were recruited via Instagram, and the majority of participants in the second wave (91%) were recruited via the MR firm, these measures can be seen as somewhat comparable (highly correlated) to each other.

The ordered logistic regression was undertaken using the following dichotomous variables as covariates, which were created to determine the odds for the two age groups, and participant recruitment methods, and genders:

- **Twentyfiveplus:** 1 if the participant belongs to 25+ age group and 0 for 13-15 age group
- **MRSource:** 1 if the participant was recruited through MR firm and 0 through Instagram
- **Female:** 1 if the participant is a female and 0 for a male

The results of the ordered logistic regression for the five survey questions are presented in the Appendix A.3. Table 4-2 summarises the odds-ratio of all five survey questions.

Table 4-2 Odds-ratio summary from ordered logistic regression

Survey Question	Covariates (controlling for the other 2 covariates)		
	13 – 15 age group	**MR participant**	**Female**
Have you heard about driverless road vehicles before? *[Awareness]*	3:4 *** (1.3†)	3:4 *** (1.3)	1:3 *** (3.0)
Have you ever ridden in a car, mini-bus or shuttle that can drive itself? *[Exposure]*	7:12 *** (1.7)	6:5	5:7 ** (1.4)
If you had the choice to use a driverless road vehicle or human-driven road vehicles in the future, how likely would you be to use driverless vehicles? *[Willingness to adopt]*	1:1	1:3 *** (3.0)	6:7
Overall, how do you feel about driverless road vehicles? *[Overall perceptions]*	1:1	2:5 *** (2.5)	1:1
When released, how safe do you believe driverless road vehicles will be compared to a road vehicle driven by a human? *[Safety beliefs]*	5:6	5:6	4:5

*** - Significant at 99%; ** - Significant at 95%; * - Significant at 90%

†Where findings were statistically significant, the reciprocal of the ratio is included in brackets to indicate the size of the effect.

Key findings from Table 4-2 are summarised below:

- Compared to 13 – 15 year old participants, 25+ year old participants were statistically significantly more likely to report a higher level of awareness (reciprocal of the ratio 3:4 as given in Table 4-2, which is 4/3 = 1.3 times) and exposure (12/7 = 1.7 times) to driverless vehicles, when controlling for recruitment method and gender.

- Between the two age groups, no statistically significant differences were found in willingness to adopt (1:1), overall perceptions of (1:1), and safety beliefs (5:6) about driverless vehicles, when controlling for recruitment method and gender. In other words, both age groups hold similar views with regard to the questions on willingness to adopt, overall perceptions and safety beliefs, when controlling for recruitment method and gender.
- Compared to MR participants, Instagram recruited participants were statistically significantly more likely to report: 1) a higher level of awareness (4/3 = 1.3 times), 2) more negative response for willingness to adopt (3/1 = 3 times), and 3) more negative response for overall perceptions (5/2 = 2.5 times) of driverless vehicles, when controlling age group and gender attributes.
- Compared to females, male participants were statistically significantly more likely to report a higher level of awareness (3/1 = 3 times) and exposure (7/5 = 1.4 times) to driverless vehicles, when controlling for age group and recruitment method.

The above findings can be related back to the summary statistics of the survey questions presented in Figure 4-1 to Figure 4-5. For example, Figure 4-1 and Figure 4-2 show 25+ year old participants reported a higher (or similar) level of awareness and exposure across the two waves when compared to the 13 – 15 year group. Although the purpose of this study was investigating if there were differences in perceptions (i.e. willingness to adopt, overall perceptions and safety beliefs) of driverless vehicles between those aged 13-15 and those aged 25+ years, the recruitment method was found to have a greater influence on the results than age group (as can be seen in Table 4-2).

5 DISCUSSION

Overall, the two age groups were quite aware of although had no to little exposure to driverless vehicles. Participants reported being unlikely to transition to using driverless vehicles, although consider driverless vehicles will be safer than human-driven vehicles.

When considering the interpretation of the statistically significant findings from the regression analyses with respect to differences in age groups, the primary analysis of interest:

- The majority of participants (regardless of age) had heard about driverless vehicles, and most reported not having ridden in a driverless vehicle (with a similar result also found in a study by Lee et al. (2019)). It is anticipated this lack of direct experience or exposure to driverless vehicles may be related to the technology being in its infancy and constrained mainly to research, Given the anticipated greater exposure to media and experiences, it seems reasonable, those aged 25 years and older may be more likely to report a higher level of awareness and exposure to driverless vehicles compared to those aged 13 – 15 years.
- The similarity of views between age groups on willingness to adopt, overall perceptions and safety beliefs about driverless vehicles may indicate respondents share the same views and concerns about driverless vehicles regardless of age, and thus there may not be a difference in uptake rates of driverless vehicles and services across age groups. However, this study did not explore reasons for these perceptions, which may differ between age groups.

When considering the interpretation of the statistically significant findings from the regression analyses with respect to differences in recruitment method:

- Those participants recruited through Instagram were more likely to report (i) a higher level of awareness, (ii) lower willingness to adopt, and (iii) more negative overall perceptions of driverless vehicles compared to those recruited via a MR firm.
- These finding are despite the MR participants completing the survey approximately a year later (thus, it might be expected they would have greater exposure to media about driverless vehicles (higher awareness), and their responses may be influenced by these media). This unanticipated finding is difficult to interpret, particularly without information about factors that may contribute to this difference.

6 CONCLUSIONS

6.1 DIFFERENCES IN PERCEPTIONS BETWEEN AGE GROUPS

The primary objective of this study is to investigate if there are differences in perceptions towards driverless vehicles for 13 – 15 year old participants compared to those aged 25 years and older. In general, the two age groups were quite aware of although had no to little exposure to driverless vehicles. The majority of participants reported being unlikely to transition to using driverless vehicles, although most consider driverless vehicles will be safer than human-driven vehicles. An ordered logistic regression analysis of the pooled data indicates: 1) while 25+ year old participants are more aware (1.3 times) and exposed (1.7 times) to driverless vehicles when compared to the 13 – 15 year age group, there were 2) no statistical differences observed between the two age groups on their willingness to adopt, overall perceptions and beliefs about the safety of driverless vehicles. Ledger & Chevalier (2019) found similar results from the analysis of the first wave of the ADVI youth survey.

The findings related to overall low willingness to adopt, driverless vehicle technology, may be related to the technology being considered futuristic or hypothetical. Given the developmental stage of the technology, it may take longer for people to develop concrete perceptions about the technology (across age groups) and these perceptions may be influenced by experience with the technology, as well as exposure to media about the technology. This speculation is corroborated by Lee et al. (2019) which mentions *"Consumers are seeking assurance that self-driving features will be at least as safe as they [human drivers] are. Under these conditions, willingness to use vehicle automation increased from less than half to almost a 2/3 majority. These results suggest that consumers are hesitant about the performance of self-driving features*

6.2 DIFFERENCES IN PERCEPTIONS BETWEEN SURVEY WAVES

Additionally, this analysis found the two survey waves to present different responses to the five survey questions. One of the reasons for this could be that the two waves were spaced a year apart, thus the difference could be a consequence of a temporal change in individual perception. However, the existence of a temporal aspect could not be validated based on the available data. Another reason for this difference could be the recruitment method adopted in each wave. While the first wave involved participants recruited through Instagram, wave 2 had around 90% of MR panel participants (with the remaining 10% recruited through Instagram). Instagram participants were found to have a greater awareness, yet a stronger negative sentiment towards willingness to adopt and overall perceptions of driverless vehicles than the participants recruited by the MR firm. This finding is difficult to interpret, particularly without information about factors that may contribute to this difference.

6.3 LIMITATIONS

The limitations of this analysis are as follows: Firstly, the survey only five asked questions. While this provides some broad understanding of perceptions toward driverless vehicles, it does not provide an understanding of the reasons behind these perceptions or factors that may influence these perceptions. For example, the barriers to willingness to adopt were not asked during the survey.

Secondly, participants recruited via different methods (in wave#1 through Instagram and in wave#2 mostly via an MR panel) reported different sentiments to a few questions. For example, the results from Table 4-2 showed participants recruited via Instagram were more likely than those recruited via the MR firm to report: 1) a higher level of awareness (1.3 times), 2) a more negative response toward willingness to adopt (3 times), 3) a more negative response for overall perceptions (2.5 times) of driverless vehicles. While this aspect was accounted for during the ordered logistic regression (by using the recruitment method as an attribute; see results in Table 4-2), the underlying cause of this difference could not be determined from the existing survey.

While these limitations are not thought to adversely affect the results obtained in this study, it is suggested future surveys expand the questionnaire content to provide a wider and deeper understanding of factors that may influence responses to the questions being investigated.

6.4 SUMMARY

In summary, the results from the ADVI Youth Surveys (waves 1 and 2 combined) indicate the participants (across Australia and New Zealand), regardless of age, appear to maintain similar perceptions about driverless vehicles, and imply adoption rates may not be different among emerging drivers (13 – 15 years) compared to those aged 25+ years. Furthermore, the participants show a tendency to hold negative perceptions about driverless vehicles, despite believing driverless vehicles will be safer than human driven vehicles. These findings could have implications for vehicle manufacturers and government investigating the barriers to the adoption of driverless vehicle technology. For example, it is interesting to note while a majority of the participants reported having never ridden in a driverless vehicle, many expressed strong negative perceptions about them. Thus, future research could seek to investigate whether increases in education/awareness and experience with the emerging technology across age groups are useful in alleviating these negative perceptions towards driverless vehicles. It is also suggested future research investigate factors that may influence these perceptions.

REFERENCES

Cunningham, M. L., Regan, M. A., Horberry, T., Weeratunga, K., & Dixit, V. (2019). Public opinion about automated vehicles in Australia: Results from a large-scale national survey. *Transportation research part A: policy and practice*, *129*, 1-18.

Farron Research (2021). Farron Research. Retrieved from https://www.farronresearch.net.au/

Field, A. (2013). Discovering statistics using IBM SPSS statistics 5th edition. sage.

Hjorthol, R. (2016). Decreasing popularity of the car? Changes in driving licence and access to a car among young adults over a 25-year period in Norway. *Journal of Transport Geography*, *51*, 140-146.

Kyriakidis, M., Happee, R., & de Winter, J. C. (2015). Public opinion on automated driving: Results of an international questionnaire among 5000 respondents. *Transportation research part F: traffic psychology and behaviour*, *32*, 127-140.

Laerd Statistics (2018). Mann-Whitney U Test using SPSS Statistics. Retrieved from https://statistics.laerd.com/spss-tutorials/mann-whitney-u-test-using-spss-statistics.php#:~:text=The%20Mann%2DWhitney%20U%20test,continuous%2C%20but%20not%20normally%20distributed.&text=The%20Mann%2DWhitney%20U%20test%20is%20often%20considered%20the%20nonparametric,is%20not%20always%20the%20case.

Ledger, S., & Chevalier, A. (2020). ADVI Youth Survey Results.

Lee, C., Seppelt, B., Abraham, H., Reimer, B., Mehler, B., & Coughlin, J. F. (2019). Consumer comfort with vehicle automation: Changes over time. Proceedings of the Tenth International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design, Sante Fe, New Mexico, pp. 412-418.

Liu, P., Guo, Q., Ren, F., Wang, L., & Xu, Z. (2019). Willingness to pay for self-driving vehicles: influences of demographic and psychological factors. *Transportation Research Part C: Emerging Technologies*, *100*, 306-317.

National Highway Traffic Safety Administration 2013, Preliminary statement of policy concerning automated vehicles, National Highway Traffic Safety Administration, Washington, DC, USA.

NapoleanCat (2020a). Instagram Users in Australia November 2019. Retrieved from https://napoleoncat.com/stats/instagram-users-in-australia/2019/11

NapoleanCat (2020b). Instagram Users in New Zealand November 2019. Retrieved from https://napoleoncat.com/stats/instagram-users-in-new_zealand/2019/11

Nordhoff, S., De Winter, J., Kyriakidis, M., Van Arem, B., & Happee, R. (2018). Acceptance of driverless vehicles: Results from a large cross-national questionnaire study. *Journal of Advanced Transportation*, *2018*.

MRS Cognitive and Brain Sciences Unit (2020). Rules of thumb of magnitudes of effect sizes. Retrieved from http://imaging.mrc-cbu.cam.ac.uk/statswiki/FAQ/effectSize

Murray, Å. (2003). Decreasing number of young licence holders and reduced number of accidents: A description of trends in Sweden. *Accident Analysis & Prevention*, *35*(6), 841-850.

Raimond, T., & Milthorpe, F. (2010, September). Why are young people driving less? Trends in licence-holding and travel behaviour. In *Proceedings of Australasian Transport Research Forum* (Vol. 29).

UCLA (2011). FAQ: What are pseudo R-squareds?. Retrieved from https://stats.idre.ucla.edu/other/mult-pkg/faq/general/faq-what-are-pseudo-r-squareds/

Wikipedia (2021). Death of Elaine Herzberg. Retrieved from https://en.wikipedia.org/wiki/Death_of_Elaine_Herzberg

Williams, R. (2020). Ordered Logit Models – Basic and Intermediate Topics. Retrieved from https://www3.nd.edu/~rwilliam/stats3/Ologit01.pdf

APPENDIX

A.1 TABLED DESCRIPTIVE STATISTICS

Table A-1 summarises the responses to the five survey questions on driverless vehicles across the two waves.

Table A-1: Summary of responses to survey questions

Survey Question *[Label for analysis]*	**Wave#1 (n = 498)**		**Wave#2 (n = 322)**	
	13 – 15 years (n = 167)	**25+ years (n = 331)**	**13 – 15 years (n = 107)**	**25+ years (n = 215)**
Have you heard about driverless vehicles before? *[Awareness]*				
No	5.4% (9)	1.5% (5)	9.3% (10)	6.5% (14)
Yes, once	6.6% (11)	2.4% (8)	20.6% (22)	12.1% (26)
Yes, a few times	31.1% (52)	28.7% (95)	45.8% (49)	47.0% (101)
Yes, many times	56.9% (95)	67.4% (223)	24.3% (26)	34.4% (74)
Have you ever ridden in a car, mini-bus or shuttle that can drive itself? *[Exposure]*				
No	89.2% (149)	83.4% (276)	88.8% (95)	80.0% (172)
Yes, 1 or 2 times	6.0% (10)	13.0% (43)	9.3% (10)	14.0% (30)
Yes, 3+ times	4.8% (8)	3.6% (12)	1.9% (2)	6.0% (13)
If you had the choice to use a driverless road vehicle or human-driven road vehicles in the future, how likely would you be to use driverless vehicles? *[Willingness to adopt]*				
Very likely	10.2% (17)	13.0% (43)	11.2% (12)	15.3% (33)
Somewhat likely	18.0% (30)	13.3% (44)	34.6% (37)	42.8% (92)
Neither likely nor unlikely	14.4% (24)	23.6% (78)	27.1% (29)	17.2% (37)
Somewhat unlikely	16.2% (27)	6.9% (23)	17.8% (19)	13.5% (29)
Very unlikely	41.2% (69)	43.2% (143)	9.3% (10)	11.2% (24)
Overall, how do you feel about driverless road vehicles? *[Overall perceptions]*				
Very positive	30.5% (51)	35.6% (118)	6.5% (7)	9.3% (20)
Somewhat positive	12.0% (20)	10.9% (36)	20.6% (22)	15.8% (34)
Neither positive nor negative	13.8% (23)	23.9% (79)	19.6% (21)	17.7% (38)
Somewhat negative	22.2% (37)	12.1% (40)	38.3% (41)	41.4% (89)
Very negative	21.5% (36)	17.5% (58)	15.0% (16)	15.8% (34)
When released, how safe do you believe driverless road vehicles will be compared to a road vehicle driven by a human? *[Safety beliefs]*				
Much more safe	28.7% (48)	19.9% (66)	42.1% (45)	38.6% (83)

Somewhat safer	13.7% (23)	13.6% (45)	21.5% (23)	26.0% (56)
The same	16.8% (28)	23.9% (79)	7.5% (8)	8.4% (18)
Somewhat less safe	19.8% (33)	22.7% (75)	19.6% (21)	13.5% (29)
Much less safe	21.0% (35)	19.9% (66)	9.3% (10)	13.5% (29)

A.2 INFERENTIAL ANALYSIS RESULTS

SHAPIRO-WILK TEST OF NORMALITY

A Shapiro-Wilk test is undertaken to determine whether a variable of interest is normally distributed. As a few statistical tests are based on the premise the dependent variable follows a normal distribution, assessing this condition is important to validate the underlying assumption required for parametric testing (which involves fitting a distribution on the data and calibrating its parameters to generate the best fit). The null hypothesis, H_0, in a Shapiro-Wilk test is that the variable follows a normal distribution. If the statistical significance value, also referred to as the p-value, is greater than 0.05, the null hypothesis cannot be rejected at the 95% confidence limit. Conversely, a p-value of less than 0.05 implies the dependent variable follows a non-normal distribution.

MANN-WHITNEY U TEST

The Mann-Whitney U test is used to compare differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed (Laerd Statistics, 2018). This test compares the mean ranks across a binary independent variable and checks if the difference is statistically significant. While it is very similar to ANOVA, the key difference lies in the ordinal/categorical (as opposed to continuous) nature of the dependent variable. The H_0 for this test is the mean rank across the two independent groups is the same. The Z-score corresponding to this test helps in rejecting/not rejecting the H_0.

EFFECT SIZE USING ETA-SQUARED

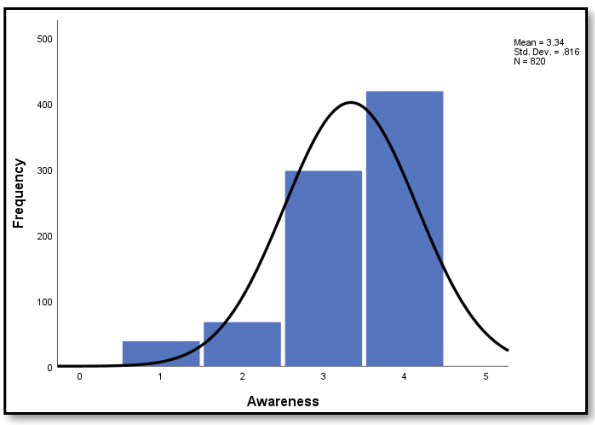
The Mann-Whitney test indicates whether the mean rank of a quantity is different between two groups. However, it does not indicate the extent or the magnitude of this difference. This magnitude, also known as the effect size, is determined using Eta-squared statistic. The formula for Eta-squared is given by Equation 1 where Z corresponds to the Z-score obtained from the Mann-Whitney test and N is the total number of observations.

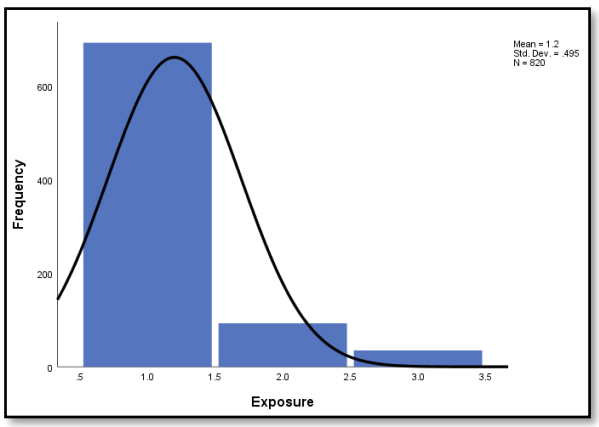
$$\eta^2 (= \frac{Z^2}{N-1}) \quad (1)$$

The magnitudes of the effect sizes can be interpreted as follows: 0.01 indicates a small effect size, 0.09 indicates medium, and 0.25 indicates a large effect size (MRC Cognition and Brain Sciences Unit, 2020).

RESULTS

Figure A-1 shows the histogram with a superimposed normal distribution plots for the five survey questions. The plots indicate that the histograms do not quite follow the normal distribution shape. Thus, a Shapiro-Wilk test of normality was undertaken to determine whether the histogram plots statistically follow a normal distribution.





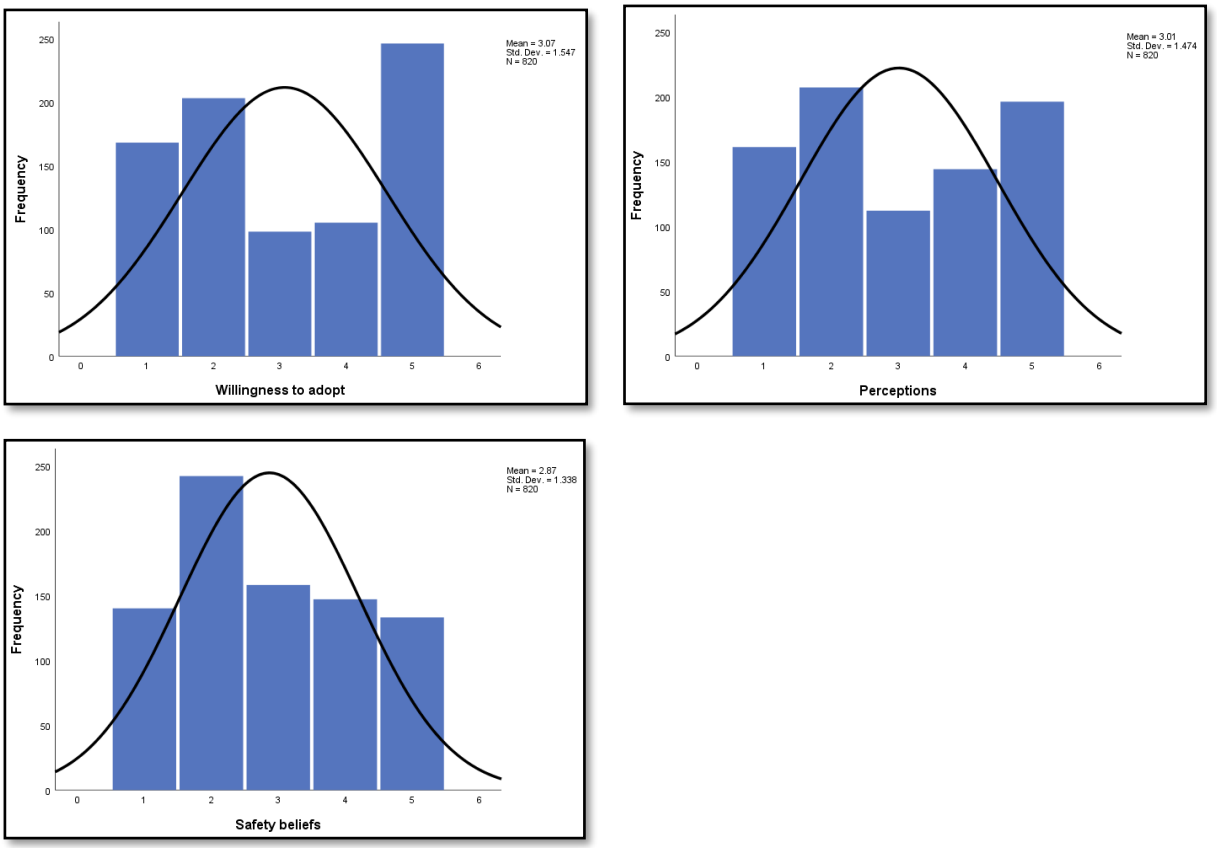


Figure A-1: Histogram plots for the survey questions

Table A-2 shows the results obtained from the Shapiro-Wilk test of normality. For each test, the p-value, reported under the 'Significance' column, is less than 0.05 which implies the null hypothesis that the variable follows a normal distribution can be rejected with 95% confidence. Hence, the variables are not normally distributed which indicates non-parametric tests such as the Mann-Whitney U test are a more accurate method to apply to the data.

Table A-2: Results from Shapiro-Wilk test of normality

Survey Question	Statistic	df	Significance
Awareness	0.748	820	0.000
Exposure	0.446	820	0.000
Willingness to adopt	0.844	820	0.000
Overall perceptions	0.868	820	0.000
Safety beliefs	0.893	820	0.000

The non-parametric Mann-Whitney U test is undertaken on each of the survey questions since the response is measured on an ordinal (Likert) scale. The covariates used in thiese tests include:

- age group (13-15 vs 25+ years), as this is our variable of interest
- gender (males vs females), as this has been found to be influential in previous surveys about community perceptions of automated vehicles
- recruitment method (Instagram vs MR), as there appears to be differences between these groups when we look at the data in Table A-2
- survey wave (1 vs 2), to cater for any differences related to time
- recruitment method within 13-15 and 25+ years separately, to investigate if the recruitment method had any impact within an age group.

The results from the tests, which assesses whether the null-hypothesis has been rejected/not rejected, have been summarised in Table A-3.

Table A-3: Results from Mann-Whitney tests

Survey Question	Factor					
	Age Group	**Recruitment Method**	**Survey Wave**	**13-15 (Method)**	**25+ (Method)**	**Gender**
Awareness	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected
Exposure	Rejected	Accepted	Accepted	Accepted	Accepted	Accepted
Willingness to adopt	Accepted	Rejected	Rejected	Rejected	Rejected	Accepted
Overall perceptions	Accepted	Rejected	Rejected	Rejected	Rejected	Accepted
Safety beliefs	Accepted	Accepted	Accepted	Accepted	Accepted	Accepted

H_0: The mean ranks of the two distributions are the same. If $p < 0.05$ then H_0 is rejected, else not rejected

An additional output from the Mann-Whitney U test is the Z-score which can be used to determine the Eta-squared as an estimate of the effect size. For example, the Z-score comparing awareness using recruitment method provides a Z-score of -9.759. Thus, the eta squared value, which can be computed using Equation 1 is 0.1162 ($(-9.759)^2/820 - 1$). The remaining Eta-squared values have been presented in Table A-4.

Table A-4: Eta-squared values to provide an estimate of the effect size

Survey Question	Factor					
	Age Group	**Recruitment Method**	**Survey Wave**	**13-15 (Method)**	**25+ (Method)**	**Gender**
Awareness	0.0148	0.1162	0.1143	0.1253	0.1125	0.0772
Exposure	0.0078	0	0	0	0	0
Willingness to adopt	0	0.0777	0.07	0.1190	0.0608	0
Overall perceptions	0	0.0621	0.0567	0.0867	0.0517	0
Safety beliefs	0	0	0	0	0	0

The cells with 0 signify a statistically insignificant effect size.

These can be interpreted using the rule of thumb that values around 0.01 indicating small effect sizes, 0.09 indicating medium effect sizes, and 0.25 indicating large effect sizes (MRC Cognition and Brain Sciences Unit, 2020). Based on this rule, the age group, which is the variable of interest, is found to have no effect on exposure, willingness to adopt, overall perceptions and safety beliefs. Furthermore, a medium effect size for awareness based on recruitment method (Instagram vs MR), survey wave (first vs second), recruitment method within 13-15 and 25+ years can be seen. Excluding the results for awareness, the majority of effect sizes are found to be statistically insignificant with 95% confidence. For example, responses to the ordinal question on safety beliefs is insignificant across the factors.

A.3 ORDERED LOGISTIC REGRESSION

MATHEMATICAL FORMULATION

Assume that Y_i represents the ordinal response for an individual i that is observed by an analyst. This observation is a manifestation of a latent variable Y_i^*, which is continuous and measures the perception of individual i. The relationship between Y_i (measured on a 3-point Likert scale) and Y_i^* can be expressed through Equation 2.

$$\begin{aligned} Y_i &= 1 \quad \forall\, Y_i^* \leq \tau_1 \\ Y_i &= 2 \quad \forall\, \tau_1 < Y_i^* \leq \tau_2 \\ Y_i &= 3 \quad \forall\, Y_i^* > \tau_2 \end{aligned} \tag{2}$$

In this equation, τ corresponds to the threshold-values which divides the domain of Y_i^* into observable responses represented by Y_i. As a general rule of thumb, there exist J-1 threshold values for a Likert scale variable comprising J anchors.

Y_i^* can be expressed in terms of observed attributes using Equation 3. In this equation, $\boldsymbol{X_{ik}}$ represents a $K \times 1$ vector of observed attributes/attitudes of an individual. Corresponds to a $1 \times K$ vector of the parameters for the attributes. ε_i corresponds to the unobserved error which is assumed to follow an EV-1 distribution to form the logit kernel.

$$Y_i^* = \boldsymbol{\beta_k}.\boldsymbol{X_{ik}} + \varepsilon_i \tag{3}$$

The probabilities for observing the outcome Y_i, in this case for a 3-point Likert scale is given in Equation 4. Equation 5 gives the likelihood function which corresponds to the product of all probabilities across individuals $i : i \in [1, N]$ where N is the total number of individuals in the dataset. Equation 6 is obtained by taking natural logarithm of Equation 5, and is maximised using the maximum likelihood estimation technique. The maximum likelihood estimation provides the set of parameter values which maximises the log-likelihood function shown in Equation 6. Readers can refer to a detailed explanation of ordered logit model in Williams (2020).

$$\begin{aligned} P(Y_i = 1) &= \frac{1}{1 + \exp\left(\boldsymbol{\beta_k}.\boldsymbol{X_{ik}} - \tau_1\right)} \\ P(Y_i = 2) &= \frac{1}{1 + \exp\left(\boldsymbol{\beta_k}.\boldsymbol{X_{ik}} - \tau_2\right)} - \frac{1}{1 + \exp\left(\boldsymbol{\beta_k}.\boldsymbol{X_{ik}} - \tau_1\right)} \\ P(Y_i = 3) &= 1 - \frac{1}{1 + \exp\left(\boldsymbol{\beta_k}.\boldsymbol{X_{ik}} - \tau_2\right)} \end{aligned} \tag{4}$$

$$L = \prod_{i=1}^{N} P_i \tag{5}$$

$$l = \ln(L) = \sum_{i=1}^{N} \ln(P_i) \tag{6}$$

Similar expressions can be obtained for C-point Likert scale variables (e.g. 5-point, 7-point, etc.).

RESULTS

For Awareness

Table A-5 shows the results from the ordered logistic regression (obtained from SPSS) with awareness as the dependent variable. As discussed in the mathematical formulation above, the values τ_1 to τ_3 correspond to the threshold-values which divide the underlying latent variable into observed Likert scale ratings. Since the options to the question on awareness comprises a 4-point Likert scale rating, three threshold points have been estimated.

Table A-5: Ordered logistic regression results with awareness as dependent variable

Parameter Estimate	Log-odds (a)	Odds (e^a)
Thresholds		
τ_1	-4.049 ***	-
τ_2	-2.880 ***	-
τ_3	-0.685 ***	-
Attributes		
Twnetyfiveplus	0.472 ***	1.6 ***
MRSource	-1.387 ***	0.249 ***
Female	-1.036 ***	0.354 ***
Model goodness-of-fit		
Cox & Snell	0.181	

*** - Significant at 99%; ** - Significant at 95%; * - Significant at 90%

The main findings from this table are:

- Compared to those aged 13-15 years, The odds of participants aged 25+ years reporting higher awareness of driverless vehicles are 1.6 ($\exp(0.472)$), or a ratio of 4:3, in comparison with 13-15 years age group participants, keeping other explanatory variables unchanged (e.g. MRSource and gender). In other words, participants aged 25+ years are more likely to report having heard about driverless vehicles than the 13-15 year old participants.
- Compared to wave#1 participants, the odds of the wave#2 participants reporting a higher level of awareness are 0.249 ($\exp(-1.387)$), or a ratio of 3:4, keeping other explanatory variables unchanged. In other words, Instagram participants reported greater awareness about driverless vehicles.
- Compared to males, the odds of the female participants to report a higher level of awareness are 0.354 ($\exp(-1.036)$), or 1:3, keeping other explanatory variables unchanged.
- The goodness-of-fit of this model is expressed in terms of Cox & Snell R-squared value (UCLA, 2011) and is found to be 0.181 which indicates a decent model fit to the data.

The results of Ordered Logistic Regression for the other four questions are presented below.

For Exposure

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	12.051	11	.360
Deviance	13.905	11	.238

Link function: Logit.

Pseudo R-Square

Cox and Snell	.013
Nagelkerke	.019
McFadden	.012

Link function: Logit.

Parameter Estimates

							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Threshold	[q0002 = 1]	1.991	.223	80.043	1	.000	1.555	2.427
	[q0002 = 2]	3.424	.266	165.561	1	.000	2.903	3.946
Location	Twentyfiveplus	.540	.223	5.854	1	.016	.103	.978
	Female	-.352	.200	3.087	1	.079	-.745	.041
	MRSource	.171	.199	.734	1	.392	-.220	.561

Link function: Logit.

For Willingness to Adopt

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	146.760	25	.000
Deviance	152.039	25	.000

Link function: Logit.

Pseudo R-Square

Cox and Snell	.075
Nagelkerke	.078
McFadden	.025

Link function: Logit.

Parameter Estimates

							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Threshold	[q0003 = 1]	-1.882	.152	152.321	1	.000	-2.180	-1.583
	[q0003 = 2]	-.675	.138	23.912	1	.000	-.946	-.405
	[q0003 = 3]	-.155	.136	1.299	1	.254	-.422	.112
	[q0003 = 4]	.456	.137	11.032	1	.001	.187	.725
Location	Twentyfiveplus	.053	.133	.159	1	.690	-.208	.314
	Female	-.142	.127	1.258	1	.262	-.391	.106
	MRSource	-1.010	.133	57.258	1	.000	-1.271	-.748

Link function: Logit.

For Overall Perceptions

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	149.107	25	.000
Deviance	150.438	25	.000

Link function: Logit.

Pseudo R-Square

Cox and Snell	.059
Nagelkerke	.062
McFadden	.019

Link function: Logit.

Parameter Estimates

							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Threshold	[q0004 = 1]	-1.867	.152	151.640	1	.000	-2.164	-1.570
	[q0004 = 2]	-.636	.137	21.517	1	.000	-.905	-.367
	[q0004 = 3]	-.049	.135	.133	1	.716	-.314	.216
	[q0004 = 4]	.822	.139	34.970	1	.000	.550	1.095
Location	Twentyfiveplus	.017	.132	.017	1	.897	-.242	.276
	Female	-.078	.126	.384	1	.535	-.325	.169
	MRSource	-.897	.132	45.970	1	.000	-1.156	-.638

Link function: Logit.

For Safety Beliefs

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	92.880	25	.000
Deviance	97.710	25	.000

Link function: Logit.

Pseudo R-Square

Cox and Snell	.008
Nagelkerke	.008
McFadden	.002

Link function: Logit.

Parameter Estimates

							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Threshold	[q0005 = 1]	-1.616	.149	118.320	1	.000	-1.907	-1.325
	[q0005 = 2]	-.168	.135	1.545	1	.214	-.433	.097
	[q0005 = 3]	.630	.137	21.242	1	.000	.362	.898
	[q0005 = 4]	1.622	.149	118.565	1	.000	1.330	1.914
Location	Twentyfiveplus	.184	.132	1.949	1	.163	-.074	.443
	Female	-.185	.126	2.151	1	.143	-.431	.062
	MRSource	-.168	.129	1.683	1	.195	-.422	.086

Link function: Logit.

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