

CONSUMER COMFORT WITH VEHICLE AUTOMATION: CHANGES OVER TIME

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Summary: Higher levels of vehicle automation are forecast as a potential mobility solution for many, but understanding consumer comfort and acceptance of self-driving technologies remains an open question. Results from a series of surveys over three years showed a slight increase in the percentage of people comfortable with full self-driving automation in 2018, following a drop from 2016 to 2017. The recovery in comfort with higher levels of automation was most pronounced among younger adults between ages 25 and 44. However, the percentage of people only comfortable with no automation or features that activate only in certain situations such as in an emergency also increased in the past year, indicating a polarizing trend. Results from the survey also showed that acceptance of self-driving vehicles is conditional on people's ability to drive as well as having assurance regarding the safety of the technology. Responses also point to a possible misunderstanding among the public regarding the definition and availability of full self-driving technology, indicating a need for improved messaging and consumer education.

INTRODUCTION

Automated vehicle technology is widely forecast to transform how we live and move. It is often characterized a technological solution that can increase efficiency and mobility for drivers and non-drivers alike, while alleviating conditions of distracted driving, impaired driving, and other common causes of crashes and adverse interactions prevalent today. The importance of this issue is highlighted in NHTSA's (2015) estimate that 94% of crashes are attributable to driver error. However, even with the growing penetration of advanced driver assistance systems (ADAS), fatalities in the United States have increased since 2015, showing a reversal of a long standing historical decline. While the reality is that a highly automated transportation system that removes driver error offers significant promise of increased safety will unfold, it is an open question as to how fast society will see the benefit from advances such technology offers.

Research has reported a recent decline in consumer interest and trust in automated technologies (Abraham et al., 2017; Westenberg et al., 2018). Drivers have expressed concerns over the security of on-board data, technology complexity, and outcomes for if and when automated vehicle technology performs differently than expected (Westenberg et al., 2018). A 2016 study from the Texas A&M Transportation Institute found that consumers were in a wait-and-see position in terms of accepting and using self-driving vehicles (Zmud et al., 2016). More recently, in a 2018 survey from JD Power and Miller Canfield, ratings showed a year over year decline in trust in fully automated self-driving vehicles (Westenberg et al., 2018). These patterns suggest an apparent disconnect between trust in lower levels of automation technology on the road today vs. the vehicle taking full driving control.

The current study aims to extend upon these findings through a survey of consumer perceptions and opinions of self-driving technologies summarized over multiple years. This study follows previous research conducted in 2016 and 2017. In these past years, surveys were conducted to explore consumers' perceptions and willingness to accept varying levels of automation (Abraham et al., 2017; Abraham et al., 2018). Both surveys found that many drivers are comfortable with the idea of driver assistance features, but far fewer are comfortable with fully self-driving vehicles. Comfort with self-driving vehicles was significantly lower in 2017 than 2016. There appeared to be age differences in comfort with self-driving vehicles that narrowed between the 2016 and 2017 surveys. Younger adults were significantly more likely than older adults to be comfortable with self-driving vehicles in both years. However, significantly fewer younger adults were comfortable with self-driving vehicles in 2017 than in 2016.

Since the 2017 survey was deployed, the public has been confronted with frequent headlines regarding self-driving. Given the various advances and setbacks in automation over the past year, the survey was re-deployed to gain deeper insight into the following questions:

1. Has consumer acceptance of self-driving cars changed over the past two years?
2. Have age differences in acceptance of self-driving cars shifted over the past two years?
3. Does willingness to use a self-driving car vary under different scenarios?

METHODS

The survey instrument included questions on demographics, vehicle ownership, comfort with automation, and willingness to use a self-driving vehicle under different conditions. Many of the questions were repeated from the previous surveys for comparison. The survey was constructed in Qualtrics and administered online.

As in previous years, participants were recruited using online posts and through an email to a large automotive manufacturer's consumer panel. The survey was open between March 28th – April 27th, 2018, which was roughly the timeframe of previous deployments. Participants were told that the survey would take less than 15 minutes, and were offered the opportunity for one of ten \$50 Amazon gift cards upon completing the survey.

In total, 4116 individuals completed the survey. Responses were excluded from analysis if the respondent resided outside of the US, did not own a vehicle with a production year of later than 1980, or if they were incomplete. Of the 4116 completed surveys, 611 were removed based on these criteria, leaving 3505 responses for analysis.

The age and gender distribution in the analysis sample is summarized in Figure 1 along with that of the previous two years. Similar to previous years, the sample was weighted toward older adults and male participants. The sample was skewed toward individuals with high income and level of education. Participants with graduate or professional degrees made up 41.0% of the sample, while 10.6% had some graduate education and 26.5% had a bachelor's degree. Participants with total annual household income of \$200,000 or more constituted 14.0% of the sample, while 11.4% reported having an annual household income between \$150,000 to \$199,999 and 19.3% between \$100,000 and \$149,999.

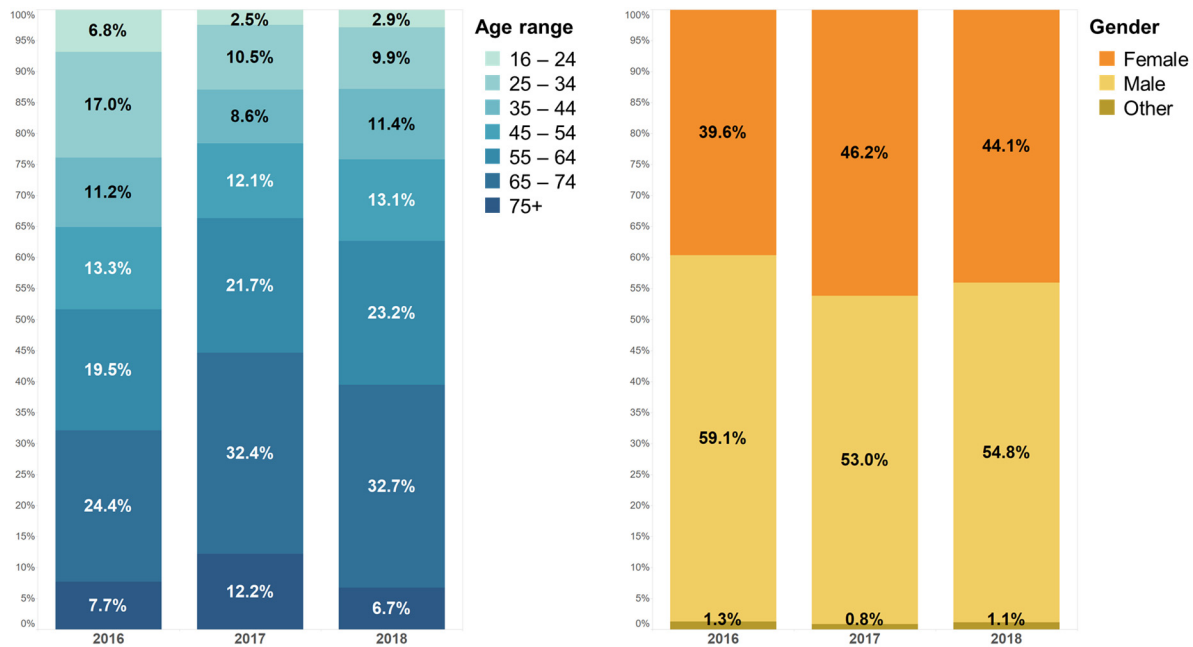


Figure 1. Sample characteristics across the three survey years.

RESULTS

Automation preferences

Consumer preferences and level of comfort regarding various levels of automation were assessed using the question “*What is the maximum level of automation you would be comfortable with?*” Participants were asked to choose from five options that differed in the degree of automation: 1) No automation; 2) features that are usually inactive, but activate only in certain events such as a collision (“emergency only”); 3) features that actively help the driver while the driver remains in control (“driver assist”); 4) features that relieve the driver of all control for periods of time (“partial self-driving”); and 5) features that completely relieve the driver of all control for the entire drive (“full self-driving”). This question was also asked in 2016 and 2017, and was used to identify any changes in consumer acceptance of vehicle automation.

As illustrated in Figure 2, the majority of participants in 2018 reported they would be comfortable with automation levels in which the driver remains in control (“no automation”: 5.8% + “emergency only”: 14.3% + “driver assist”: 51.2% = 71.3%), and a little less than a third of the sample indicated comfort with features that placed the vehicle in control (“partial self-driving”: 11.8% + “full self-driving”: 16.9% = 28.7%). Acceptance of full vehicle automation nominally increased in 2018, following a drop that was observed between 2016 and 2017. A slightly higher percentage of people said they would be comfortable with partial or full automation in 2018 (11.8% + 16.9 = 28.7%) as compared to 2017 (14.1% + 13.1% = 27.2%). Interestingly, however, there was also an increase in the percentage of people who preferred either “no automation” or “emergency only” forms of automation in 2018 (5.8% + 14.3% = 20.1%) as compared to 2017 (2.2% + 11.2% = 13.2%). These results suggest an overall polarizing trend in acceptance of vehicle automation in the past year: consumers have either become accepting of more advanced forms of automation or have shifted towards less

automation. This trend is supported with the concomitant lower percentage of people most comfortable with “driver assist” forms of automation (59.4% in 2017; 51.2% in 2018).

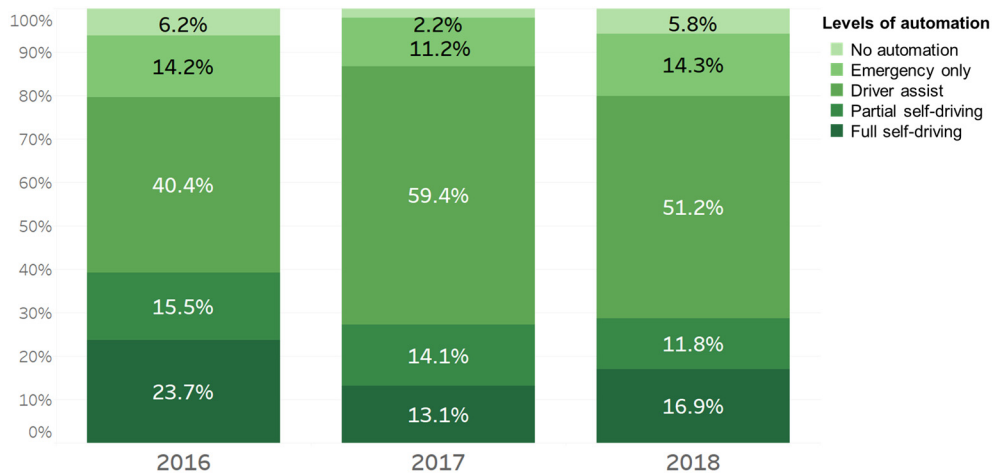


Figure 2. Consumer acceptance of vehicle automation over 3 years of surveys.

It should be noted that the sample characteristics differ across the three years. As shown in Figure 1, the 2018 sample included more younger adults than 2017, but was generally older compared to 2016. All three included more men than women. To account for possible age and gender effects, comparison between data from three years was repeated with the samples adjusted and balanced to the US Census age and gender distribution. The adjusted samples also revealed the same trend, further confirming a recovery in consumer acceptance of full vehicle automation in 2018 after a drop in 2017, along with a decline in comfort between 2017 and 2018 with “driver assist” forms of automation. Table 1 summarizes how consumers of different ages answered the question on comfort with varied levels of automation across the three years; darker shaded cells indicate higher frequencies, and lighter shaded cells indicate lower frequencies.

Table 1. Age differences in maximum level of automation consumers are comfortable with

		16-24	25-34	35-44	45-54	55-64	65-74	75+
2016	No automation	12%	8%	10%	6%	5%	4%	3%
	Emergency only	18%	11%	16%	16%	15%	12%	17%
	Driver assist	27%	25%	21%	41%	44%	56%	52%
	Partial self-driving	16%	15%	19%	13%	17%	14%	15%
	Full self-driving	26%	40%	34%	23%	19%	14%	13%
2017	No automation	0%	3%	4%	3%	2%	2%	1%
	Emergency only	24%	15%	11%	13%	10%	10%	10%
	Driver assist	46%	43%	49%	55%	63%	65%	69%
	Partial self-driving	16%	19%	15%	14%	13%	14%	11%
	Full self-driving	14%	20%	21%	15%	12%	10%	10%
2018	No automation	8%	7%	5%	8%	6%	5%	5%
	Emergency only	16%	12%	14%	18%	14%	13%	17%
	Driver assist	45%	36%	42%	43%	54%	59%	61%
	Partial self-driving	12%	12%	10%	13%	11%	12%	11%
	Full self-driving	19%	33%	29%	18%	14%	11%	7%

In 2018, more people chose full self-driving as the maximum level of automation they are comfortable with compared to 2017, except for the oldest group (75+). However, even after the moderation in the past year, acceptance of full automation fell short compared to 2016 in all age groups. Participants between 25 and 44 were more likely than other generations to accept full self-driving vehicles, while older adults indicated they would be comfortable with features that assist the driver, but not with the vehicle taking control of driving. While the majority of older respondents (55+) chose “driver assist” forms of automation as the maximum level that they are comfortable with across all three years, with the exception of those between 55-64 in year 2016, many younger participants between ages 25 and 44 indicated that they would be comfortable with “full self-driving”. A chi-square test further revealed that the age differences in frequencies of choosing the “driver assist” and “full self-driving” levels were statistically significant.

An ANOVA was carried out for a statistical comparison of the age differences. For the ANOVA, each of the five levels was assigned a number on a scale from 1 = “no automation” to 5 = “full self-driving”. As illustrated in Figure 2, age differences in overall comfort with automation was found to be significant for all three years. Age differences were observed in comparing responses from years 2017 and 2018. While acceptance rebounded among younger participants between ages 25 and 44 from year 2017 to 2018, it continued to drop for other age groups, with the biggest drop in the oldest group aged 75 years or older. This indicates that recent technology trends and related events may have different effects for people of different ages.

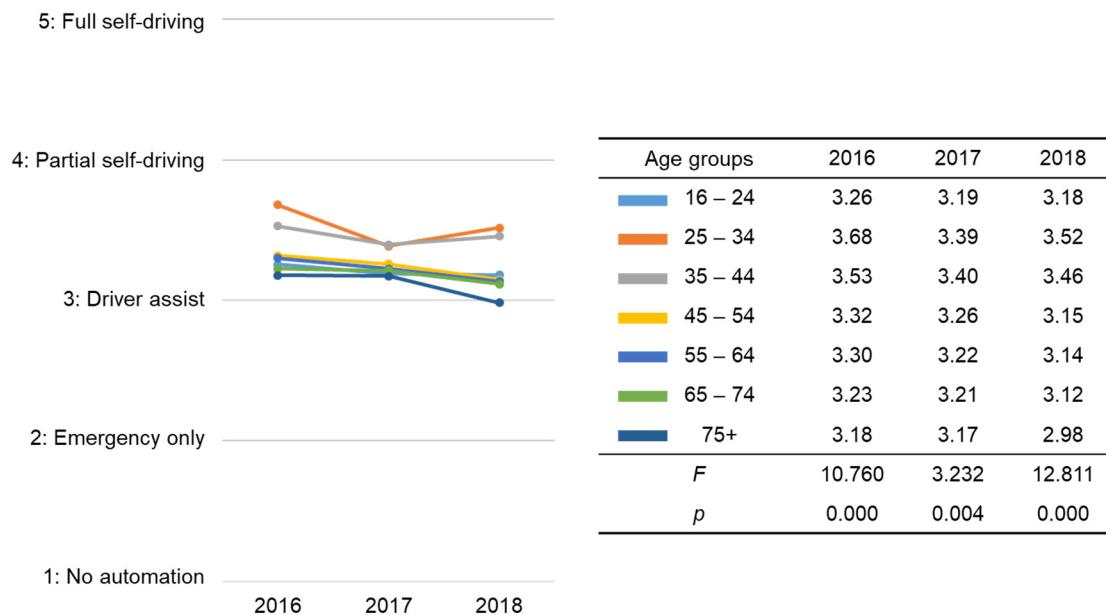


Figure 3. Age differences in acceptance of automation across three years: ANOVA results.

Willingness to use a self-driving vehicle

In the 2018 survey, participants were additionally asked questions regarding their willingness to use a self-driving vehicle under specific circumstances. The first question asked “*Would you be willing to use a self-driving vehicle?*” Two following questions asked about their willingness to use a self-driving vehicle under conditions in which they were no longer able to drive, or if the self-driving vehicle was as safe a driver as them. Results are summarized in Figure 4.

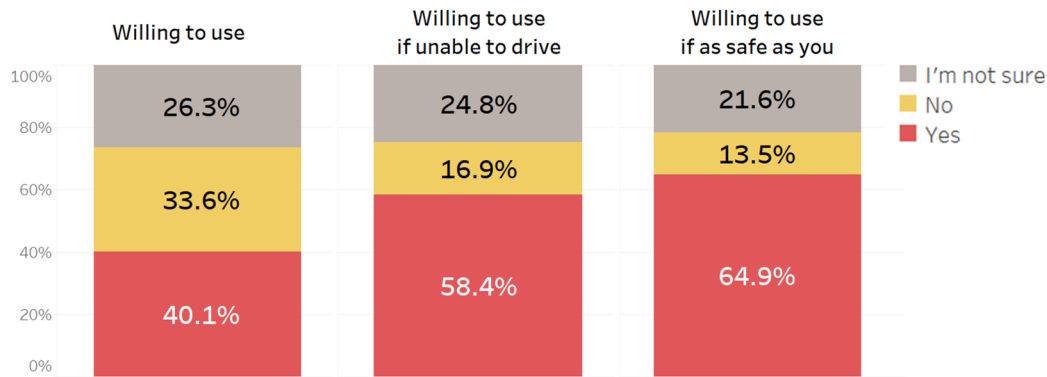


Figure 4. Willingness to use self-driving vehicle

Only about 4 in 10 participants initially indicated that they would be willing to use a self-driving car. The rest of the sample was divided between not willing (33.6%) and unsure (26.3%). When asked to consider a situation in which they were unable to drive, however, those willing to use a self-driving car made up the majority (58.4%), and fewer people indicated being unwilling to use (16.9%). Under the condition that a self-driving car would be as safe as they are, even more participants reported being willing to use (64.9%), and those still unwilling made up a smaller portion of the sample (13.5%). While consumers are seemingly uneasy about using a self-driving car, these results indicate that willingness to use may be dependent on their ability and/or access to drive manually, and that perceptions of relative safety may be a key factor in acceptance.

Consumers' knowledge of and exposure to automated driving

When asked a series of questions about knowledge of self-driving vehicles, to the question of if self-driving cars are available for purchase today, less than half (48.5%) answered “no”, which correctly reflects the current state of the art, while the rest of the sample either responded “yes” (22.7%) or were unsure (28.8%). When asked if they or someone they know had ever driven or taken a ride in a vehicle they would describe as self-driving, the majority responded “no” (86.7%) or were not sure (5.1%). A small percentage of those who responded “yes” to this question (8.2%) were asked to provide more detail in an open-ended format. Coding of these open responses showed that, as depicted in Figure 5, for those who responded “yes”, the self-driving vehicle was most often a consumer-level vehicle. Tesla was referenced in 35% of these responses, while 49% mentioned some other consumer vehicle. Only 14% of these responses talked about an experimental or test vehicle, which represents the current state of the art for self-driving vehicles. These results indicate that the broader public may have a limited knowledge of the current state of the technology, and also points to the possibility of consumers having inconsistent definitions of self-driving.

CONCLUSIONS

A series of surveys were conducted from 2016 to 2018 to better understand consumer acceptance of vehicle automation. Overall, for 2018, respondents indicated they were most comfortable with forms of automation in which they remained in control over those that placed the vehicle in control. A polarizing trend was observed in which the percentage of respondents comfortable with full self-driving automation increased, while the percentage of people only comfortable

with no automation or features that activate only emergency also increased. From 2017 to 2018, a recovery in comfort with higher levels of automation was observed for younger participants between ages 25-44, while overall acceptance continued to drop for other age groups.

In how consumers are currently assessing self-driving features, results on their willingness to use these features and perceptions of safety indicate there is an overall reluctance and distrust of higher-level technologies. Consumers are seeking assurance that self-driving features will be at least as safe as they are. Under these conditions, willingness to use vehicle automation increased from less than half to almost a 2/3 majority (from 40.1% to 64.9%). These results suggest that consumers are hesitant about the performance of self-driving features. Confusion over what and how current technologies differ from self-driving features appears to be a key contributor.

The hype over self-driving technology is clearly affecting our consumer psyche, impacting both perceptions of their safety and understanding of what self-driving technology is. Less than half of the 2018 sample correctly understood that a fully self-driving car was not available for purchase. This figure reflects a troubling consequence of over-hyped technology and the many promises that were made for a near self-driving future, as yet unrealized. Education campaigns are needed to help calibrate (and temper) consumer expectations of a self-driving future.

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