Journal of Risk Research

ISSN: 1366-9877 (Print) 1466-4461 (Online) Journal homepage: https://www.tandfonline.com/loi/rjrr20

What drives support for self-driving car technology in the United States?

Graham Dixon, P. Sol Hart, Christopher Clarke, Nicole H. O'Donnell & Jay Hmielowski

To cite this article: Graham Dixon, P. Sol Hart, Christopher Clarke, Nicole H. O'Donnell & Jay Hmielowski (2020) What drives support for self-driving car technology in the United States?, Journal of Risk Research, 23:3, 275-287, DOI: 10.1080/13669877.2018.1517384

To link to this article: https://doi.org/10.1080/13669877.2018.1517384

Published online: 05 Oct 2018.

JOURNAL OF RISK RESEARCH
2020, VOL. 23, NO. 3, 275–287
https://doi.org/10.1080/13669877.2018.1517384

Routledge
Taylor & Francis Group

Check for updates

What drives support for self-driving car technology in the United States?

Graham Dixon[a], P. Sol Hart[b], Christopher Clarke[c], Nicole H. O'Donnell[d] and Jay Hmielowski[e]

[a]School of Communication, The Ohio State University, Columbus, OH, USA; [b]Department of Communication Studies, University of Michigan, Ann Arbor, MI, USA; [c]Department of Communication, George Mason University, Fairfax, VA, USA; [d]Richard T. Robertson School of Media and Culture, Virginia Commonwealth University, Richmond, VA, USA; [e]Edward R. Murrow College of Communication, Washington State University, Pullman, WA, USA

ABSTRACT

Recent advances in automotive technology have made fully automated self-driving cars technologically feasible. Despite offering many benefits such as increased safety, improved fuel efficiency, and greater disability access, public support for self-driving cars remains low. While previous studies find that demographic factors such as age and sex influence self-driving car support, limited research has examined variables that are well known to predict public attitudes toward emerging technology. Using self-report data from a quota sample of American adults ($N = 1008$), we find that age and sex are not significantly associated with support for self-driving car policies when controlling for these other variables. Instead, significant predictors of support included trust in automotive institutions and regulatory bodies, recognition of self-driving car benefits, positive affect toward self-driving cars, and a greater perception that human-driven cars are riskier than self-driving cars. Importantly, we also find that individualism is negatively associated with support. That is, people who value personal autonomy and limited government regulation may perceive policies encouraging self-driving car use as threatening to their worldviews. Altogether, our results suggest strategies for encouraging greater public support of self-driving vehicles while also forecasting potential barriers as this technology emerges as a fixture in transportation policy.

ARTICLE HISTORY
Received 27 April 2018
Accepted 18 August 2018

KEYWORDS
Self-driving cars; technology acceptance; risk perception

Introduction

Technological advancements in vehicles such as seat belts, airbags, and antilock brakes have led to significant improvements in driver safety (Bengler et al. 2014; Obeng 2008). Despite these protective features, roughly 35,000 motor vehicle deaths occur each year in the U.S., with drivers (rather than the vehicles) being assigned the critical reason behind accidents 94% of the time (IIHS 2015; NHTSA 2015). Worldwide, 1.25 million people die each year in motor vehicle accidents (WHO 2015). Risky driving behaviors, such as texting or cell phone use, have increasingly played a role in motor vehicle accidents (Klauer et al. 2014). In response, car companies are exploring self-driving car technology, which allows vehicles to navigate entirely without direct human

CONTACT Graham Dixon dixon.716@osu.edu Ohio State University, 3016 Derby Hall, 154 N. Oval Mall, Columbus, OH 43210, USA

control (Howard and Danielle Dai 2014). While completely self-driving cars are not yet commercially available, research projects 20–40% of vehicle sales will be of the self-driving variety by 2030 (Litman 2017). Indeed, major auto manufacturers have announced their intention to offer self-driving cars by 2020, making the technology a reality in the not-too-distant future (Driverless Future, n.d.).

Many analysts believe self-driving cars will offer important societal benefits.[1] Recent analysis, for instance, estimates that wide-scale adoption of the technology will not only improve traffic flow and open up greater transportation access to the disabled community, but will also provide environmental benefits through greater fuel efficiency and lower vehicle emissions (Sun et al. 2016). Others have pointed to the potential breakthrough that self-driving cars could provide for public health. In 2015, the 35,000 fatalities from vehicle crashes in the U.S. (11.3 deaths per 100,000) (IIHS 2015) represented a greater overall mortality rate than firearm-related deaths (11.1 per 100,000) (CDC 2015) or terrorism (18 recorded fatalities in the U.S. in 2014) (National Consortium for the Study of Terrorism and Responses to Terrorism 2015). By ceding human control over to computer automation, research estimates that self-driving cars can reduce vehicle fatalities by 90%, resulting in 300,000 lives saved per decade in the U.S and an estimated savings of $190 billion in health care costs per year (Bertoncello and Wee 2015; Crew 2015). In fact, research by Google's self-driving car project (Waymo) shows its self-driving cars report the lowest at-fault accident rate for any driver class on the road – a rate 10 times lower than the safest driving demographic (60–69-year-olds), and 40 times lower than new drivers (Crow 2017). However, the overall accident rate among Google's self-driving car fleet is higher than that of experienced drivers, but these accidents are caused by human-driven cars whose drivers are more likely to break traffic laws and crash into self-driving cars (typically causing minor damage) (Crow 2017). In this sense, self-driving cars could result in one of the most significant public health breakthroughs of the twenty-first century, but only if there is wide-scale adoption.

Despite these benefits, many people remain skeptical of self-driving cars. Public opinion polls, for instance, consistently find low support among the American public for self-driving vehicles (Abraham et al. 2017; Schoettle and Sivak 2014; Schoettle and Sivak 2016). In a recent study, only 15.5% of the American public prefer completely self-driving cars, while 38.7% prefer partially-self driving; a plurality, 45.8% prefer cars that have no self-driving capability at all (Schoettle and Sivak 2016). Research also finds that people are skeptical that self-driving cars will perform better than human-driven cars, are concerned about the risks posed by self-driving cars (Kohl et al. 2017; Kyriakidis, Happee, and de Winter 2015; Schoettle and Sivak 2014; Schoettle and Sivak 2016) and harbor distrust toward auto manufacturers (Kohl et al. 2017). Reflecting these sentiments, research has even found that Twitter users tweet the risks of self-driving cars three times more than the benefits, often citing concerns of safety and threats of hacking (Kohl et al. 2017). As a result, these negative views toward self-driving cars could present a barrier to the wide-scale adoption of the technology.

Identifying the factors associated with public skepticism toward self-driving cars is necessary for encouraging a greater acceptance. Indeed, more favorable views of a technology often associates with technology adoption (Park and Chen 2007). Studies on self-driving cars are limited, finding age and sex as potential factors influencing support (Abraham et al. 2017; Clark 2016; Hohenberger, Spörrle, and Welpe 2016; Kyriakidis et al. 2015; Payre, Cestac, and Delhomme 2014; Schoettle and Sivak 2016). However, predictors of support likely go beyond these demographic variables and also include a variety of risk-related factors that are well-known to predict public attitudes toward emerging technologies, such as risk perception, perceived control, trust, and cultural worldviews. Our study represents one of the first to explore these factors together, and we believe that this work has important risk communication implications as self-driving car technology emerges as a fixture in transportation policy.

Predictors of support for self-driving cars: previous research and future directions

Age and sex

While limited, previous studies have examined the relationship of demographic variables and views on self-driving cars, finding age and biological sex to have predictive value. For example, recent work has identified age as a potential predictor in support for self-driving cars. Consistent across several studies, younger people are more likely to support them and show less concern (Abraham et al. 2017; Clark 2016; Schoettle and Sivak 2016). One reason for this disparity is that older individuals might be more hesitant toward self-driving cars due to concerns with usability surrounding the technology (Clark 2016). Furthermore, younger drivers tend to perceive fewer driving risks than older drivers (Jonah and Dawsom 1987).

Biological sex has also been examined as a predictor in support for self-driving cars. While one study has observed no differences among men and women in their preference for vehicle automation (Schoettle and Sivak 2016), a larger number of studies report consistent differences. In Hohenberger et al. (2016), women were more likely to associate self-driving cars with negative emotions, whereas men associated them with positive emotions, which partially explained their willingness to use the technology. Similar research has found that women associate higher levels of worry toward self-driving cars, whereas men show greater willingness to purchase (Kyriakidis et al. 2015) and use them (Payre et al. 2014). These findings might reflect on the 'white male effect,' which is the tendency of males (particularly white males) to be less concerned with risks than females and minorities (Flynn, Slovic, and Mertz 1994). However, recent research suggests this wide generalization is not fully supported by the evidence, which further reflects the uncertainty that the emergent findings on sex-based differences of self-driving cars are broad and generalizable (Nelson 2015). Furthermore, the predictive power of these demographic variables might be less powerful when accounting for variables well known to predict public attitudes toward emerging technologies, such as worldviews, affect, risk perception, trust, and perceived control.

Worldviews

Described as 'general social, cultural, and political attitudes toward the world' that help explain 'how individuals and groups interpret the world in different, yet patterned ways,' worldviews could act as foundational concept that drives support for self-driving cars (Douglas and Wildavsky 1983, Leiserowitz 2006, 49). Two distinct worldview continua have been developed. The first ranges from communitarian to individualism (i.e. group). Individualists value personal autonomy and limited government regulation, whereas communitarians place greater value in collective control. The second continuum ranges from hierarchy to egalitarianism (i.e. grid) (Kahan 2012). Egalitarians place value on social justice and a fair distribution of resources across social groups, whereas hierarchists place value on rules, order, and authority.

Kahan's work on cultural cognition thesis suggests that where individuals fall along these worldview continua influences the types of health, environmental, and other risks they recognize (2012). To use climate change risk perception as an example, individualists tend to see less risk because, for them, addressing climate change would sanctify government intrusion into free markets and harm personal autonomy – principles that these individuals greatly value (Kahan 2012). Conversely, for egalitarians wary of perceived inequitable distribution of harm (Boudet et al. 2014), climate change is seen as more of a risk because it harms people with less resources to effectively respond to it (i.e. racial/ethnic minorities, people in poor countries, etc.).

Drawing on this previous work, worldviews may play a role in people's support for self-driving cars, although research has yet to examine this premise. For example, people display a strong preference for manually operated cars (Kohl et al. 2017) – a preference that may be especially strong for individuals scoring on the individualism end of the communitarian-individualist worldview continuum. This may be due to manually-operated cars holding symbolic value of freedom and independence to those who score high on the individualism scale (Boeglin 2015). As a result, individualists may view self-driving cars less favorably amid concern over restrictions that self-driving cars would have on one's freedom to manually drive as well as the potential for additional government control/regulations over self-driving cars. Thus, people holding stronger individualistic views might be less supportive of self-driving cars.

On the other hand, self-driving cars may be viewed positively by those scoring high on the egalitarianism end of the hierarchy-egalitarian continuum. Many benefits of self-driving cars involve egalitarian themes, such as greater access for social groups like those with disabilities that would otherwise prevent them from operating a motor vehicle, as well as improved energy efficiency that in turn reduces harm posed to vulnerable populations. Egalitarians might then be more supportive of the technology.

Affect, trust, and risk/benefits

In addition to worldviews, we also examine the role of affect, institutional trust, and perceived risk/benefits in how people form support for self-driving cars. First, defined as a positive or negative feeling state and quality (goodness or badness) associated with a stimulus (Finucane, Alhakami, Slovic, and Johnson 2000), affect has been featured prominently in risk research. Indeed, our risk perceptions are heavily influenced of how we feel about a particular risk issue (Finucane et al. 2000), which can lead us to engage in actions that diverge from our cognitive assessments of the risks (Loewenstein et al. 2001). Research on issues like nanotechnology, gene technology, electric cars, and nuclear power finds that affect is influential in predicting support for the technology and intentions of use (Lee, Scheufele and Lewenstein 2005; Moons and De Pelsmacker 2012; Siegrist 2000; Slovic 1999). Limited research on self-driving car perceptions points to a similar relationship. For example, one study documented that the more positive feelings a person has toward self-driving cars, the higher their willingness to use them (Hohenberger et al. 2016). Thus, positive affect toward self-driving cars might associate with greater support for the technology.

Like affect, trust could also play a role in people's support for self-driving cars. Reflecting people's considerations for expertise, competence, and shared values, trust often plays a role in shaping peoples' views of emerging technology (Boudet et al. 2014; Lee et al. 2005; Anderson et al. 2012; Ho, Scheufele, and Corley, 2011; Siegrist et al. 2007). In particular, trust can impact support for emerging technology by influencing perceived risks and benefits (Siegrist 2000). This relationship may also extend to self-driving cars. For example, one study has found a negative association between trust in the reliability and dependability of autonomous vehicles and risk perceptions of self-driving cars (Choi and Ji 2015). However, examination of trust also extends to the organizational bodies responsible for the creation and maintenance of the technology, such as the auto manufacturers, the companies behind self-driving car software, and government regulatory agencies. In this regard, trust is not just placed on the technology itself, but on the organizational bodies responsible for its construction and regulation of risks. To extend this work a bit further, we explore how institutional trust – that is, trust in automotive industries, companies producing self-driving car technology, and government agencies charged with regulating the automotive industry – associates with support for self-driving cars. Drawing on previous findings, we believe that institutional trust will positively associate with support for self-driving cars.

Additionally, the perception of risk and benefits serve as important factors in how people support and accept emerging technology. Defined as 'things, forces, or circumstances that pose danger to people or to what they value' (Stern & Fineberg, 1996, 215), research on self-driving cars shows that there is generally greater perceived risk and low support compared with human-driven cars (Abraham et al. 2017; Schoettle and Sivak 2014; Schoettle and Sivak 2016). Numerous studies report that perceived risks and benefits influence support of technology (Brossard, Scheufele, Kim and Lewenstein 2009; Ho et al. 2011; Scheufele and Lewenstein 2005). Conversely, a greater perception of benefits tends to result in opposite effects, increasing support for a technology (Ho et al. 2011; Scheufele and Lewenstein 2005). Therefore, we reason that greater perceived benefits will associate with greater support, and a perception that self-driving cars are riskier than human-driven cars will associate with lower support.

Perceived control

Support for self-driving cars might also be influenced on whether people perceive they have control over the technology. The perception of personal control refers to the extent to which people believe they personally influence or manage the cause of an event, situation, or risk (McAuley, Duncan, and Russell 1992). In risk research, greater perceived control over an event or risk tends to attenuate risk perception (Klein and Kunda, 1994; Nordgren, Van der Pligt, and Van Harreveld 2007; Weinstein 1984). That is, people tend to be more accepting of risks that are deemed controllable than those that are not, which explains in part why some individuals fear traveling by air rather than car, despite the likelihood of death or injury traveling by air being much lower (Maas 2013). Support for self-driving cars might be influenced, in part, by the feeling of having personal control over the technology. Indeed, Weyer, Fink, and Adelt (2015) found that while individuals have confidence in autonomous vehicle technology, they would also like to have some control over vehicle maneuvering if needed. Perhaps then a greater perception of personal control when operating a self-driving car will be associated with greater support for self-driving car technology.

In addition, a greater perception of external control – that is, a perception that the self-driving car has operational control– might also associate with higher support. While people may perceive a greater risk regarding (and be less supportive of) a technology if they think they lack control over it (Klein and Kunda 1994), the perception that the car has control, such as control over avoiding hazardous situations, may also heighten support for self-driving cars. Thus, a perception of external control might be a positive predictor when it's a perception that the car can actively manage to avoid hazardous situations.

Present study

In expanding previous studies on self-driving cars, we explore how the aforementioned variables associate with support for the technology. Doing so can provide a more complete picture of how the American public shape their views of this emerging technology.

Method

We conducted an online survey from April 20–28, 2017 of a U.S. general population panel recruited by Qualtrics using quota sampling ($N = 1008$). Washington State University Institutional Review Board determined our study as exempt upon initial review. Although Qualtrics does not obtain a fully representative random sample of American respondents, it is heterogeneous, offers similar levels of response quality, and tends to mirror the general population in terms demographics such as age, race, and gender (Ansolabehere and Schaffner 2014). Thus, while the topline results should not be taken as representative of the U.S. population, we believe our Qualtrics sample provides an adequate representation of the American adult population (Table 1). Furthermore, as the public shifts from using landlines to cell phones, collecting data using random digit dialing to reach a probability sample has become

Table 1. Demographic and worldview descriptive statistics.

Variable	Measure	Descriptive statistics
Age	What is your age?	$M = 44.36$, $SD = 16.39$
Sex	0 = female; 1 = male	52.4% female
Race	1 = American Indian or Alaska Native 2 = Black or African American 3 = White 4 = Asian 5 = Native American or other Pacific Islander 6 = Other 1 = Hispanic or Latino; 0 = not Hispanic or Latino	.6% – American Indian or Alaska Native 14.3% – Black or African American 76% – White 5.3% – Asian .2% – Native American or other Pacific Islander 3.7% – Other 16.9% – Hispanic or Latino
Income level	1 = less than \$24,999 2 = \$25,000 to \$49,999 3 = \$50,000 to \$99,999 4 = \$100,000 to \$149,999 5 = \$150,000 or more	$M = 2.38$, $SD = 1.06$
Political ideology	1 = very conservative 2 = conservative 3 = slightly conservative 4 = moderate 5 = slightly liberal 6 = liberal 7 = very liberal	$M = 3.92$, $SD = 1.67$
Car ownership	1 = yes, 0 = no	82.5% – yes
Traffic severity	How serious a problem is traffic congestion where you live? 1 = not at all serious 2 = slightly serious 3 = moderately serious 4 = very serious 5 = extremely serious	$M = 2.63$, $SD = 1.22$
Egalitarianism	1. We have gone too far in pushing equal rights in this country (reverse coded). 2. Our society would be better off if the distribution of wealth was more equal. 3. We need to dramatically reduce inequalities between the rich and the poor, whites and people of color, and men and women. 4. Discrimination against minorities is still a very serious problem in our society. 5. It seems like blacks, women, homosexuals and other groups don't want equal rights, they want special rights just for them (reverse coded). 6. Society as a whole has become too soft and feminine (reverse coded).	Using six point Likert type scale (1 = strongly disagree; 6 = strongly agree) $M = 4.1$, $SD = 1.14$ Cronbach's alpha = .82
Individualism	1. The government interferes far too much in our everyday lives. 2. Sometimes the government needs to make laws that keep people from hurting themselves (reverse coded). 3. It's not the government's business to try to protect people from themselves. 4. The government should stop telling people how to live their lives. 5. The government should do more to advance society's goals, even if that means limiting the freedom and choices of individuals (reverse coded). 6. Government should put limits on the choices individuals can make so they don't get in the way of what's good for society (reverse coded).	Using six point Likert type scale (1 = strongly disagree; 6 = strongly agree) $M = 3.8$, $SD = .9$ Cronbach's alpha = .7

Table 2. Self-driving car measures and descriptive statistics.

Variable	Measure	Descriptive statistics
Self-driving car familiarity	How familiar are you with self-driving cars? 1 = not familiar at all 2 = slightly familiar 3 = moderately familiar 4 = very familiar 5 = extremely familiar	$M = 2.65$, $SD = 1.14$
Institutional trust	1. I trust the automotive industry to minimize potential risks of self-driving cars to humans. 2. I trust companies that manufacture self-driving car technology to minimize potential risks to humans. 3. I trust government agencies regulating the automotive industry to minimize potential risks of self-driving cars to humans.	Using six point Likert type scale (1 = strongly disagree; 6 = strongly agree) $M = 3.8$, $SD = 1.35$ Cronbach's alpha = .93
Personal control	If you are operating a self-driving car, avoiding hazardous situations is something … (9-point bipolar scale) 1. You cannot manage … … … you can manage 2. You cannot control … … … you can control 3. Over which you have no power … … ..over which you have power	$M = 5.31$, $SD = 2.48$ Cronbach's alpha = .95
External control	If you are operating a self-driving car, avoiding hazardous situations is something … (9-point bipolar scale) 1. The car cannot manage … … … the car can manage 2. The car cannot control … … … the car can control 3. Over which the car has no power … … ..over which the car has power	$M = 5.51$, $SD = 2.27$ Cronbach's alpha = .96
Perceived benefits	1. In terms of my own life, self-driving cars would offer many benefits. 2. In terms of society, self-driving cars would offer no benefits at all (reverse coded) 3. In terms of transportation, self-driving cars would offer many benefits.	Using six point Likert type scale (1 = strongly disagree; 6 = strongly agree) $M = 3.78$, $SD = 1.21$ Cronbach's alpha = .78
Perceived risks	In the case of self-driving cars versus human-driven cars, which do you believe is a more serious threat to human safety? 1 = Human-driven cars definitely a more serious threat 2 = Human-driven cars probably a more serious threat 3 = Same threat 4 = Self-driving cars probably a more serious threat 5 = Self-driving cars definitely a more serious threat In the case of self-driving cars versus human-driven cars, which do you believe poses a greater risk to human safety? 1 = Human-driven cars definitely a greater risk 2 = Human-driven cars probably a greater risk 3 = Same risk 4 = Self-driving cars probably a greater risk 5 = Self-driving cars definitely a greater risk In the case of self-driving cars versus human-driven cars, which do you believe has a higher likelihood of creating unsafe situations? 1 = Human-driven cars definitely a higher likelihood 2 = Human-driven cars probably a higher likelihood 3 = Same likelihood 4 = Self-driving cars probably a higher likelihood 5 = Self-driving cars definitely a higher likelihood	$M = 3.03$, $SD = 1.12$ Cronbach's alpha = .92
Affect	When I think about self-driving cars, I feel … 1 = very bad 2 = bad 3 = somewhat bad 4 = neutral 5 = somewhat good 6 = good 7 = very good	$M = 4.28$, $SD = 1.6$
Policy Support	To what extent do you support/oppose the following actions? (1 = strongly oppose to 6 = strongly support). 1. The sale of self-driving cars in the United States 2. The increased use of self-driving cars in the United States. 3. Automakers manufacturing more self-driving cars than human-driven cars. 4. Self-driving cars eventually replacing human-driven cars. 5. Legislation that allows more self-driving cars on the road.	$M = 3.53$, $SD = 1.41$ Cronbach's alpha = .95

more constrained (Ansolabehere and Schaffner 2014). As a result, quota samples have become more popular in recent years.

Survey design

We first asked demographic questions including age, sex, race, income, traffic severity, and car ownership (political ideology was asked at end of the survey). Respondents were then presented with a short statement defining self-driving cars as cars that 'are capable of sensing the surrounding environment and navigating without human input,' after which they answered questions pertaining to familiarity with self-driving cars, policy support, as well as our variables of interest (i.e. worldviews, institutional trust, affect, perceived risks and benefits, and perceived control).

In the interest of space, Tables 1 and 2 provide a full list of our survey measures, including descriptive statistics and results of reliability analyses where necessary. Several variable measures used previously validated scales. For example, worldviews were measured using Kahan, Jenkins-Smith, and Braman's short-form cultural cognition measure that involves two, six-item subscales: individualism and egalitarianism (2011). Perceived control measures were adapted from the revised causal dimension scale (McAuley et al. 1992).

Analysis strategy

We performed a hierarchical regression analysis using SPSS. We implemented hierarchical regression models that examined our groups of variables in specific blocks. In all regression models, variance inflation factors for explanatory variables were below 3.

Results

First, we find that when examining demographic variables, age and sex associate with support for self-driving cars. Specifically, age negatively associates with support, while males have greater support than females (see Table 3, model 1). However, these significant associations disappear when controlling for socio-psychological variables proposed in this study.

Controlling for cultural cognition worldviews and variables common in risk perception research (institutional trust, perceived benefits, affect, risk perception), age and sex are no longer significantly associated with support for self-driving cars (see Table 3, model 4). Individualism, egalitarianism, and risk perception negatively associate with support, while institutional trust, perceived benefits, and positive affect associate with greater support. Including variables on people's perception of control (perceived control and external control) did little in changing these associations. However, we note that perceived external control had a small, but significant, positive association with support (see Table 3, model 5).

Discussion

Like any emerging technology, public support of self-driving cars will likely play an important role in facilitating or impeding their adoption. Our study highlights psychological and risk-related factors that influence people's support for these cars. More broadly, it represents one of the first to explore these factors together, and we believe that this work has important risk communication implications as self-driving car technology becomes a more prominent fixture in transportation policy.

Unlike in previous studies, we find that demographic variables, such as age and sex, are not predictive of one's support when controlling for psychological and risk-related factors. Instead, variables used often in risk perception research – affect, institutional trust, risk perception, perceived benefits – are considerably more influential. These findings correspond with research on

Table 3. Regression model with policy support as the dependent variable ($N = 1008$).

	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	2.741***	2.17***	2.87***	1.3***	1.23***
Block 1: Demographics					
Age	−.01***	−.01*	−.01*	−.001	−.001
Sex (1 = male)	.37***	.25**	.25**	.03	.03
Race (1 = non-white)	−.002	−.05	−.1	−.06	−.05
Income level	.15***	.12**	.1*	−.02	−.02
Political ideology	.06*	.05*	.01	.01	.014
Car ownership (1 = yes)	−.04	−.11	−.07	−.02	−.03
Traffic severity	.2***	.13***	.12**	.01	.02
Block 2: Familiarity					
Self-driving car familiarity		.3***	.28***	.02	.01
R^2 Change		.04***			
F Change		F(1, 999) = 48.52***			
Block 3: Cultural cognition					
Egalitarianism			.07	−.05*	−.05*
Individualism			−.19***	−.09**	−.09**
R^2 Change			.02***		
F Change			F(2, 997) = 10.5***		
Block 4: Risk perception					
Institutional trust				.11***	.09***
Perceived benefits				.32***	.31***
Affect				.4***	.39***
Perceived risk				−.21***	−.2***
R^2 Change				.61***	
F Change				F(4, 993) = 7 00.1***	
Block 5: Perceived control					
Personal control					.01
External control					.03*
R^2 Change					.002*
F Change					F(2,991) = 4.3*
Overall R^2 and F test	.11, F(7, 1000) = 17.94***	.15, F(8, 999) = 22.5***	.17, F(10, 997) = 20.4***	.78, F(14, 993) = 255.6***	.79, F(16, 991) = 225.7***

Unstandardized coefficients reported. Race coded as non-white =1. Affect is positive coded high. Political ideology is liberal coded high. Perception of self-driving cars as riskier coded high for risk comparison variable.
*$p < .05$.
**$p < .01$.
***$p < .00$.

public support for other emerging technologies, such as nanotechnology, indicating that institutional trust, perceived benefits/risks, and affect are instrumental factors in shaping support (Brossard et al. 2009; Ho et al. 2011; Scheufele and Lewenstein 2005).

Additionally, we found that individualism was negatively associated with support, suggesting that values related to personal autonomy and limited government regulation might inhibit people's support for self-driving cars. This finding could be due to individualists perceiving aspects of self-driving cars as threatening to their worldview, such as the perceived loss of personal driving freedom, additional government intrusion into the car industry via regulations, or privacy concerns stemming from GPS location software used by the vehicles. Indeed, similar concerns on government regulation affect people's responses to other risk topics, including climate change (Kahan et al. 2014). As a result, individualism could be a strong catalyst in mobilizing opposition to self-driving car technology as it becomes more visible as a public policy issue. For example, commentators and scholars have speculated to this possibility if cars become stripped of their symbolic values of freedom and independence and instead replaced with full automation (Boeglin 2015). The result could be 'resistance from diverse groups like automobile enthusiasts, rebellious teenagers, and those distrustful of big government' (Boeglin, 2015 8), which in turn could foment organized opposition. Our empirical findings lend credence to this view, suggesting that resistance to self-driving cars might be just as much an outcome of perceived threats to individualism as it is an outcome of perceived threats to personal safety. Thus, policymakers interested in mobilizing public support for this technology should consider not only the health risks people may perceive but also the perceived threats to individualistic worldviews posed by the technology. Doing so can also allow scholars to explore innovative ways of addressing concerns around skepticism of self-driving cars.

One way to address individualists is through message targeting. Targeting involves adapting messages to reflect common characteristics, such as worldviews, of a target subgroup (Schmid et al. 2008). This approach has been useful for communicating climate change to skeptical audiences, such as political conservatives (Bain, Hornsey, Bongiorno, and Jeffries 2012; Campbell and Kay 2014; Dixon, Hmielowski, and Ma 2017; Feinberg and Willer 2013). For self-driving cars, one could emphasize the benefits that individualists value, such as (1) greater freedom to perform activities while in the car, (2) reducing the need for traffic enforcement personnel, and (3) higher speed limits, which signal greater freedom to travel at faster speeds with more limited government regulation. Doing so might allow the technology to better resonate with these individuals, increase institutional trust, and subsequently reduce opposition. Future research can explore these ideas further using experiment-based message testing.

In addition to individualism, egalitarianism negatively associated with support, which might indicate the technology is perceived as threatening to egalitarian values. Indeed, we expected that egalitarians would have greater support due to the benefits of self-driving cars being of relevance to egalitarians. These egalitarian benefits could include greater transportation access for disadvantaged individuals and greater energy efficiency. However, these characteristics of self-driving cars might not yet be visible in public and news media discourse. As self-driving car benefits are more widely reported, future research can explore whether egalitarianism becomes a positive predictor of support.

Perceived control provided mixed results. While we found that the greater perception of external control – that is, perceiving that the self-driving itself has control of avoid hazardous situations – associated with support, personal control did not. For personal control, it could be that our measure was too specific since it asked participants about their perceived control regarding avoiding hazardous situations. People may react differently to a more general measure of perceived control, such as perceived control over the vehicle in general, rather than for a specific circumstance like an accident. We also recognize the limitations in our study design, particularly with our self-report data. Furthermore, our results do not demonstrate causal relationships, which can only be determined through careful and controlled experimental manipulation.

Finally, although not a key variable in our study, our results show that familiarity with self-driving cars has no significant association with support when controlling for all other variables. This finding corresponds with other research showing that beliefs about science or risk topics are not necessarily due to a lack of knowledge or familiarity on the subject (Simis et al. 2016). Improving support among resistant audiences will likely not be successful if the goal is simply to familiarize people with the technology. Instead, our findings point to the importance of developing messages that address the predictors of self-driving car support. This can include: (1) cultivating greater trust in institutions involved in self-driving cars, (2) using positive affective messaging that relays the benefits of self-driving cars, or (3) employing targeted messaging reflecting the values shared by individualists. Experimental research can explore the effectiveness of whether messages framed to reflect these variables can actually impact support in a causal manner. Doing so will not only strengthen the internal validity of the findings we report in this paper but can shed light on the best approaches for engaging the public on self-driving cars.

Conclusion

Vehicle automation has the potential to transform the transportation sector but can only do so through wide-scale adoption. Overall, our study identifies potential barriers to adoption and potential message design strategies to address these barriers. While variables often used in risk research – affect, control, institutional trust, risk perception, perceived benefits – strongly associate with self-driving car support, our findings also point to the importance of cultural worldviews. Specifically, people who value personal autonomy and limited government regulation may view self-driving cars as threatening to their worldviews, and those with these strongly held views may be less willing to support the technology. Thus, improving support for self-driving cars may require more than educating audiences of the risks and benefits, and instead establishing greater trust and understanding of how the technology impacts deeply held worldviews.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes

1. SAE International differentiates six levels of vehicle automation. The first group of vehicles, Levels 0–2, span from zero automation to partial automation, in which a human driver is in control of monitoring the driving environment (Fleetwood 2017). The partially-automated vehicle, Level 2, has the capacity to execute steering and acceleration/deceleration, with functions such as adaptive cruise control. The second group of vehicles, Levels 3–5, include conditional, high, and full automation capabilities. The discussion of automated vehicles in the present study is focused on those with full automation, in which all aspects of driving are performed by the vehicle in all possible environments (SAE n.d.).

References

Abraham, H., C. Lee, S. Brady, C. Fitzgerald, B. Mehler, B. Reimer, Joseph, and F. Coughlin. 2017. "Autonomous Vehicles, Trust, And Driving Alternatives: A Survey of Consumer Preferences." In Transportation research board 96th annual meeting, Washington, DC, 8–12.

Anderson, A. A., D. A. Scheufele, D. Brossard, and E. A. Corley. 2012. "The Role of Media and Deference to Scientific Authority in Cultivating Trust in Sources of Information about Emerging Technologies." *International Journal of Public Opinion Research* 24 (2): 225–237.

Ansolabehere, S., and B. F. Schaffner. 2014. "Does Survey Mode Still Matter? Findings from a 2010 Multi-Mode Comparison." *Political Analysis* 22 (03): 285–303.

Bain, P. G., M. J. Hornsey, R. Bongiorno, and C. Jeffries. 2012. "Promoting Pro Environmental Action in Climate Change Deniers." *Nature Climate Change* 2 (8): 603.

Bengler, K., K. Dietmayer, B. Farber, M. Maurer, C. Stiller, and H. Winner. 2014. "Three Decades of Driver Assistance Systems: Review and Future Perspectives." *IEEE Intelligent Transportation Systems Magazine* 6 (4):6–22.

Bertoncello, M., and D. Wee. 2015. *Ten Ways Autonomous Driving Could Redefine the Automotive World. McKinsey & Company*. http://www.mckinsey.com/industries/automotive-and-assembly/our-insights/ten-ways autonomous-driving-could-redefine-the-automotive-world

Boeglin, J. 2015. "The Costs of Self-Driving Cars: reconciling Freedom and Privacy with Tort Liability in Autonomous Vehicle Regulation." *Yale JL & Tech* 17: 171.

Boudet, H., C. Clarke, D. Bugden, E. Maibach, C. Roser-Renouf, and A. Leiserowitz. 2014. "'Fracking' Controversy and Communication: Using National Survey Data to Understand Public Perceptions of Hydraulic Fracturing." *Energy Policy* 65: 57–67.

Brossard, D., D. A. Scheufele, E. Kim, and B. V. Lewenstein. 2009. "Religiosity as a Perceptual Filter: Examining Processes of Opinion Formation about Nanotechnology." *Public Understanding of Science* 18 (5): 546–58.

Campbell, T. H., and A. C. Kay. 2014. "Solution Aversion: On the Relation between Ideology and Motivated Disbelief." *Journal of Personality and Social Psychology* 107 (5): 809

CDC. Firearm Mortality by State: 2015. *CDC National Center for Health Statistics* 2015. https://www.cdc.gov/nchs/pressroom/sosmap/firearm_mortality/firearm.htm.

Choi, J. K., and Y. G. Ji. 2015. "Investigating the Importance of Trust on Adopting an Autonomous Vehicle." *International Journal of Human-Computer Interaction* 31 (10): 692–702.
Clark, H. E. 2016. Limited Self-Driving Vehicle Automation: Age Differences in the Takeover of Vehicle Control, Engagement in Non-driving-related Activities and Opinions of the Technology.
Crew, B. 2015. "Driverless Cars Could Reduce Traffic Fatalities by up to 90%, says report." *Science Alert*. https://www.sciencealert.com/driverless-cars-could-reduce traffic-fatalities-by-up-to-90-says-report.
Crow, A. 2017. *How Safe Are Self-Driving Cars*? *Rocky Mountain Institute*. https://www.rmi.org/news/safe-self-driving-cars/.
Dixon, G., J. Hmielowski, and Y. Ma. 2017. "Improving Climate Change Acceptance among US Conservatives through Value-Based Message Targeting." *Science Communication* 39 (4): 520–534.
Douglas, M., and A. Wildavsky. 1983. *Risk and Culture: An Essay on the Selection of Technological and Environmental Dangers*. Berkeley: University of California Press.
Forecasts. Driverless car market watch (n.d.). http://www.driverless-future.com/?page_id =384
Feinberg, M., and R. Willer. 2013. "The Moral Roots of Environmental Attitudes." *Psychological Science* 24 (1): 56–62.
Finucane, M. L., A. Alhakami, P. Slovic, and S. M. Johnson. 2000. "The Affect Heuristic in Judgments of Risks and Benefits." *Journal of Behavioral Decision Making* 13 (1): 1.
Fleetwood, J. 2017. "Public Health, Ethics, and Autonomous Vehicles." *American Journal of Public Health* 107 (4): 532–537.
Flynn, J., P. Slovic, and C. K. Mertz. 1994. "Gender, Race, and Perception of Environmental Health Risks." *Risk Analysis: An Official Publication of the Society for Risk Analysis* 14 (6): 1101–1108.
Ho, S. S., D. A. Scheufele, and E. A. Corley. 2011. "Value Predispositions, Mass Media, and Attitudes toward Nanotechnology: The Interplay of Public and Experts." *Science Communication* 33 (2): 167–200.
Hohenberger, C., M. Spörrle, and I. M. Welpe. 2016. "How and Why Do Men and Women Differ in Their Willingness to Use Automated Cars? the Influence of Emotions across Different Age Groups." *Transportation Research Part A: Policy and Practice* 94: 374–85.
Howard, D., and P. Danielle Dai. 2014. "Perceptions of Self-Driving Cars: The Case of Berkeley, California." In Transportation *research board 93rd annual meeting*. vol. 14 (4502).
Insurance Institute for Highway Safety. General statistics. United States. Insurance Institute for Highway Safety Highway Loss Data Institute. 2015. http://www.iihs.org/iihs/topics/t/general-statistics/fatalityfacts/state-by-state-overview.
Jonah, B. A., and N. E. Dawson. 1987. "Youth and Risk: Age Differences in Risky Driving, Risk Perception, and Risk Utility." *Alcohol, Drugs & Driving*. 3 (3–4): 13–29
Kahan, D. M. 2012. "Cultural Cognition as a Conception of the Cultural Theory of Risk." In *Handbook of Risk Theory*, 725–759. Netherlands: Springer.
Kahan, D. M., H. Jenkins-Smith, and D. Braman. 2011. "Cultural Cognition of Scientific Consensus." *Journal of Risk Research* 14 (2): 147–74.
Kahan, D. M., M. Wittlin, E. Peters, P. Slovic, L. L. Ouellette, D. Braman, and N. M. Gregory. 2014. "The Tragedy of the Risk-Perception Commons: culture Conflict, Rationality Conflict, and Climate Change." http://scholarship.law.gwu.edu/cgi/viewcontent.cgi?article =1270&context=faculty_publcations.
Klauer, S. G., F. Guo, B. G. Simons-Morton, M. C. Ouimet, S. E. Lee, and T. A. Dingus. 2014. "Distracted Driving and Risk of Road Crashes among Novice and Experienced Drivers." *The New England Journal of Medicine* 370 (1): 54–9. [PMC][10.1056/NEJMsa1204142] [24382065].
Klein, W. M., and Z. Kunda. 1994. "Exaggerated Self-Assessments and the Preference for Controllable Risks." *Organizational Behavior and Human Decision Processes* 59 (3): 410–427.
Kohl, C., D. Mostafa, M. Böhm, and H. Krcmar. 2017. *Disruption of Individual Mobility Ahead? A Longitudinal Study of Risk and Benefit Perceptions of Self-Driving Cars on Twitter*. http://aisel.aisnet.org/wi2017/track12/paper/11/
Kyriakidis, M., R. Happee, and J. C. F. de Winter. 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.
Lee, C.-J., D. A. Scheufele, and B. V. Lewenstein. 2005. "Public Attitudes toward Emerging Technologies: Examining the Interactive Effects of Cognitions and Affect on Public Attitudes toward Nanotechnology." *Science Communication* 27 (2): 240–267.
Leiserowitz, A. 2006. "Climate Change Risk Perception and Policy Preferences: The Role of Affect, Imagery, and Values." *Climatic Change* 77 (1–2): 45–72.
Litman, T. 2017. *Autonomous Vehicle Implementation Predictions*. Victoria Transport Policy Institute
Loewenstein, G. F., E. U. Weber, C. K. Hsee, and N. Welch. 2001. "Risk as Feelings." *Psychological Bulletin* 127 (2): 267
Maas, H. 2013. "The Odds Are 11 Million to 1 That You'll Die in a Plane Crash." *The Week*. http://theweek.com/articles/462449/odds-are-11-million-1-that-youll-die plane-crash
McAuley, E., T. E. Duncan, and D. W. Russell. 1992. "Measuring Causal Attributions: The Revised Causal Dimension Scale (CDSII)." *Personality and Social Psychology Bulletin* 18 (5): 566–73.

Moons, I., and P. De Pelsmacker. 2012. "Emotions as Determinants of Electric Car Usage Intention." *Journal of Marketing Management* 28 (3–4): 195–237.
2015. "For the Study of Terrorism and Responses to Terrorism." *American Deaths in Terrorist Attacks*. http://www.start.umd.edu/pubs/START_AmericanTerrorismDeaths_FactSheet_Oct2015 pdf
Nelson, J. A. 2015. "Are Women Really More Risk-Averse than Men? A Re-Analysis of the Literature Using Expanded Methods." *Journal of Economic Surveys* 29 (3): 566–585.
Nordgren, L. F., J. Van der Pligt, and F. Van Harreveld. 2007. "Unpacking Perceived Control in Risk Perception: The Mediating Role of Anticipated Regret." *Journal of Behavioral Decision Making* 20 (5): 533–544.
Obeng, K. 2008. "Injury Severity, Vehicle Safety Features, and Intersection Crashes." *Traffic Injury Prevention* 9 (3): 268–276.
Park, Y., and J. V. Chen. 2007. "Acceptance and Adoption of the Innovative Use of Smartphone." *Industrial Management & Data Systems* 107 (9): 1349–1365.
Payre, W., J. Cestac, and P. Delhomme. 2014. "Intention to Use a Fully Automated Car: Attitudes and a Priori Acceptability." *Transportation Research Part F: Traffic Psychology and Behaviour* 27: 252–263.
SAE . Taxonomy and definitions for terms related to on-road motor vehicle automated driving systems. *SAE On-Road Automated Vehicle Standards Committee* (n.d.). http://www.sae.org/misc/pdfs/automated_driving.pdf.
Scheufele, D. A., and B. V. Lewenstein. 2005. "The Public and Nanotechnology: How Citizens Make Sense of Emerging Technologies." *Journal of Nanoparticle Research* 7 (6): 659–667.
Schmid, K. L., S. E. Rivers, E. L. Amy, and P. Salovey. 2008. "Targeting or Tailoring? Maximizing Resources to Create Effective Health Communications." *Marketing Health Services* 28 (1): 32.
Schoettle, B., and M. Sivak. 2016. *Motorists' Preferences for Different Levels of Vehicle Automation*. Ann Arbor: University of Michigan Transportation Research Institute (2016). Report No. SWT-2016–8.
Schoettle, B., and M. Sivak. 2014. *A Survey of Public Opinion About Autonomous and Self-Driving Vehicles in the U.S., the U.K., and Australia*. Ann Arbor: University of Michigan Transportation Research Institute Report No.:UMTRI-2014021.
Siegrist M. 2000. "The influence of trust and perceptions of risks and benefits on the acceptance of gene technology." Risk Analysis 20(2):195–204.
Siegrist, M., C. Keller, H. Kastenholz, S. Frey, and A. Wiek. 2007. "Laypeople's and Experts' Perception of Nanotechnology hazards." *Risk Analysis: An Official Publication of the Society for Risk Analysis* 27 (1): 59–69.
Simis, M. J., H. Madden, M. A. Cacciatore, and S. K. Yeo. 2016. "The Lure of Rationality: Why Does the Deficit Model Persist in Science Communication?" *Public Understanding of Science (Bristol, England)* 25 (4): 400–414.
Slovic P. 1999. "Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield." Risk Analysis 19(4):689–701.
(Eds.) 1996. *Understanding risk: Informing decisions in a Democratic Society*. Washington, DC: National Academy Press.
Sun, Y., D. Olaru, B. Smith, S. Greaves, and A. Collins. 2016. "Road to Autonomous Vehicles in Australia: A Comparative Literature Review." *Australasian Transport Research Forum* 16–18.
Critical reasons for crashes investigated in the national motor vehicle crash causation survey (2015). https://crash-stats.nhtsa.dot.gov/Api/Public/ViewPublication/812115.
Weinstein, N. D. 1984. "Why It Won't Happen to Me: Perceptions of Risk Factors and Susceptibility." *Health Psychology* 3 (5): 431.
Weyer, J., R. D. Fink, and F. Adelt. 2015. "Human–Machine Cooperation in Smart Cars. An Empirical Investigation of the Loss-of-Control Thesis." *Safety Science* 72: 199–208.
2015. *Global Status Report on Road Safety*. http://www.who.int/violence_injury_prevention/road_safety_status/2015/en/.