Transactions on Transport Sciences | Peer-Reviewed Open Access Journal
DOI: 10.5507/tots.2019.005
ToTS Volume 10, Issue 2: pg33–pg41
Palacky University in Olomouc

Beliefs and expectations of driving learners about autonomous driving

Ana Martí-Belda, Patricia Bosó, Ignacio Lijarcio
University Research Institute on Traffic and Road Safety (INTRAS), University of Valencia,46016, Spain

ABSTRACT: *Autonomous driving is a topic that generates great interest and social debate in the field of transport and road safety. Professionals working on vehicle technologies, telecommunications engineers, and vehicle manufacturers say it is an imminent reality and that autonomous vehicles will be available in the near future. But there are still many issues to be resolved and many challenges to overcome. However, the opinion of end users has not been explored very much so far. This study aims to investigate the beliefs and expectations of 138 Spanish driving students about autonomous driving, through an online questionnaire designed "ad hoc". Descriptive statistics and frequencies were determined for appropriate demographic variables such as gender, age range, and study level, or employment status. An independent-samples t-test was conducted to compare how the students would feel if they used an autonomous vehicle, preference for using the autonomous vehicle in different situations, advantages and disadvantages of autonomous driving, and some concerns about autonomous driving by gender. Results showed that 77.5% of driving learners thought of an autonomous vehicle as a vehicle with a system that is able travel alone, but that the driver can drive manually at will; 39.9% thought that vehicles that do not need a driver are a very useful system; and 35, 5% believed that such cars would be available between 2017 and 2020, although 79% did not consider buying an autonomous vehicle. In the event of an accident, 50% of the students believed that the driver and the vehicle manufacturer should share the responsibility. Regarding preferences, 73.2% preferred to drive themselves rather than ride in an autonomous vehicle because driving is a pleasure for 51.4%, and they would only use it in case of alcohol, drug, or medicine consumption, or when fatigued, stressed, or in a monotonous driving situation. Public policies and manufacturers should take these results into consideration.*

KEYWORDS: *Autonomous driving; beliefs, feelings, expectations, concerns*

1. INTRODUCTION

Even though the number of accidents in Europe is decreasing (EC, 2016), the rate of progress has recently slowed down. Moreover, according to WHO (2015), the total number of road traffic deaths worldwide has plateaued at 1.25 million per year, with the highest road traffic fatality rates in low-income countries. Thus, these figures justify the need to put effort into increasing road safety. In the last decade, vehicle safety systems such as ADAS (Advanced Driving Assistance Systems) have evolved to reduce the numbers of deaths and injuries in urban areas and roads. According to European statistics, from 2001 to 2015, mortality was reduced to 28,900 deaths, largely due to innovations the automotive sector has added in terms of safety. It is important to note that the solution to this problem is as complex as its origins, and, therefore, we must use a multifactorial approach. However, large investments are currently being made in technology and infrastructures.

Vehicle safety systems have been experiencing a constant evolution and connectivity, and they make up one of the industrial sectors with the most innovation and incorporation of new technologies. Developing autonomous driving systems that are able to assist humans in everyday tasks and reduce fatalities caused by traffic accidents is one of the great challenges of modern computer science (Geiger, Lenz, & Urtasun, 2012). On the one hand, autonomous driving represents an attractive innovation for future mobility (Dixit, Chand & Nair, 2016; Fleetwood, 2017). ADAS' primary function is to facilitate drivers' task performance by providing real-time advice, instructions, and warnings that are expected to have a positive effect on traffic safety. On the other hand, there are also some potential problems. The predicted effects are not always as great as expected, and some concerns have been raised that drivers adapt

to these new systems in unexpected ways that can compromise safety (Brookhuis., De Waard, & Janssen, 2001). This is partly due to indirect behavioural changes in drivers, the so-called behavioural adaptation (Martens, & Jenssen, 2012; Dotzauer, De Waard, Caljouw, Pöhler, & Brouwer, 2015).

Automated vehicle technology is expected to offer several benefits, such as reducing vehicle crashes by eliminating driving error, increasing mobility of the young, elderly, and disabled, decreasing traffic congestion, or reducing pollution (Anderson et al., 2014). These expected benefits have fostered an increase in reports and studies on autonomous driving in recent years. All of this knowledge has culminated in the appearance of the first experiences with autonomous vehicles on our roads, with different levels of automation and different definitions of the technological capabilities and human involvement.

The National Highway Traffic Safety Administration (NHTSA) has defined five levels of vehicle automation based on the proportion of driver vs. vehicle control. In its highest form, the vehicle performs all the safety-critical driving functions and monitors roadway conditions for an entire trip, disengaging the driver from all duties (Trimble, Bishop, Morgan & Blanco, 2014).

One of the most widely accepted classifications of automation levels is the one proposed by SAE (On-Road Automated Vehicle Standards Committee, 2014), which starts with the manual driving mode (level 0) and moves up to driver assistance (level 1), partial automation (level 2), conditional automation (level 3, high automation (level 4), and, finally, to the fully automated driving mode (level 5).

According to the German Federal Highway Research Institute (BASt) (Gasser et al. 2012), the highest defined degree of automation is called "Full Automation": The fully automated vehicle drives by itself without human supervision. If system performance declines, the vehicle is autonomously "restored to the system state of minimal risk." From a technical point of view, "the greatest challenge lies in the complete absence of a human supervisor who knows the system limits, recognizes system faults and, where needed, switches the vehicle into a safe state" (Maurer et al., 2016).

The Spanish Traffic Directorate (DGT), like government agencies in other countries, is thinking about the mobile revolution and has a new project called "DGT 3.0", designed to promote connectivity between vehicles, roads, drivers, and the administration. The objectives of this ambitious project include the promotion of autonomous driving and autonomous vehicles, as well as new legislation for this new road scenario. This interest is justified by the figures. According to the DGT (2016), since the year 2000, the number of traffic accidents has declined by only 12%, compared to a very significant 71% reduction in the number of deaths. This improvement is attributed to the investment in passive safety, and the administration is now focusing on support for the ADAS. Knowing that distractions are responsible for most accidents due to the human factor, administrations usually decide to invest in technological issues, ignoring other ways to address this problem.

Therefore, it is important to consider that the social dimension of these changes can be at least as significant as the technological one. Autonomous driving not only poses a challenge in terms of further technological development, but also in terms of how the new technical possibilities are received. a basic question in ADAS implementation, beyond the debates about the advantages and disadvantages, is acceptance. Inadequate technological advancements may lead to serious consequences, especially in terms of loss of human life. This form of disruptive technology will need to be widely accepted by the community in order to facilitate the regulatory and behavioural adjustments required to achieve rapid adoption (Pettigrew, Talati & Norman, 2018).

Many experts (mostly those related to manufacturing vehicles) think autonomous driving will be the next big disruptive innovation in the coming years (Rosenzweig & Bartl, 2015). This statement is too ambitious and does not take into account the multifactorial origin of accidents. However, even assuming the advantages of investing in vehicle technology, many aspects still have to be studied regarding the interaction between technology and the user. Designers, for instance, should review and reassess the interaction between car and driver, and they should observe this phenomenon of 'control delegation' from the perspective of the human driver (Koo, Kwac, Ju, Steinert, Leifer & Nass, 2015).

However, when there is a breakthrough in technology, future users may not be prepared for its introduction. Different studies have documented public opinion about automated driving technology (Payre, Cestac & Delhome, 2014; Kyriakidis, Happee & Winter, 2015; Howard & Dai, 2014).

Most users accept technological systems that can help to make driving safer or more comfortable,

and they consider automated driving to be a useful advancement (Somer, 2013). a broad international study carried out in 2014 (Kyriakidis, Happee & de Winter, 2015) showed that, when future users are surveyed about user acceptability, concerns, and willingness to buy, acceptance is quite diverse. Results showed that respondents, on average, found manual driving to be the most enjoyable mode of driving. Respondents were found to be concerned about software hacking/misuse, as well as legal issues and safety. Similarly, Fraedrich and Lenz (2016) found general openness and a high degree of acceptance of autonomous vehicles, but only when the definition of an autonomous vehicle was not specified. When respondents were asked about specific use cases of autonomous driving, however, their assessments turn out to be far more negative. They felt "exposed" to more potential risks and dangers that may arise in an autonomous vehicle than they can "control" because they will no longer be able to control the vehicle themselves at all. In fact, 44 % of respondents indicated that they knew nothing about the subject, which clearly shows that awareness has not penetrated all corners of society. In a recent study, Pettigrew, Talati & Norman (2018) found that only about half of Australians (45% to 54%) believe that Automated Vehicles (AVs) would decrease traffic crashes, polluting emissions, stress, and road injuries, and enhance the safety of vulnerable users. This unsafe view of AVs has increased among the public, linked to -among others- ethical concerns about responsibility in case of an accident (Hevelke & Nida-Rümelin, 2015). Moreover, further concerns are related to perceptions of machine performance and its limits, communication problems between autonomous vehicles and human drivers, sustainability dimensions, national and international legislative developments, etc. (Maurer, Gerdes, JLenz, & Winner, 2016); therefore, many challenges still have to be addressed.

It seems that autonomous driving will be accepted if it is safer than "human driving" and if the vehicle user can override the autonomous functions as a last line of control (Rupp & King, 2010). Therefore, if we want drivers to shift to AVs, it is important to know to what extent individuals are prepared to accept the introduction and feasibility of this new vehicle, as well as the level and type of knowledge and skills future drivers must demonstrate, possible improvements in road safety, responsibility in case of an accident, etc. Some studies dealing with the topic of automated driving acceptance find a general openness to autonomous driving, but there is still a lot to discover. Another emerging question would be whether there are differences in specific "user" groups, comparing the introduction of AVs to the introduction of any major technology. It might be logical to consider that AVs would have greater acceptance among groups that are more open to the use of other technologies, such as young drivers.

The present study aims to explore beliefs and expectations about autonomous driving, in terms of usefulness, feasibility, perceived problems, use intention, responsibility in case of an accident, and perception of the training required, in a sample of Spanish driving learners who are currently obtaining their B driving licence. Knowledge about the beliefs and expectations of this population group is relevant because they represent future drivers who will probably have to face the different levels of autonomous driving in the near future.

2. METHODOLOGY

In order to design the survey, a focus group was previously held with representatives from different areas involved in the AVs: legislators, driving school teachers, psychologists, and engineers. As a result, a 13-question on-line survey was carried out to find out future drivers' beliefs and expectations. In this study, a subsample of driving learners responded to the survey. At the time of the study, the driving learners had just received basic information about AVs and the terminology included in the survey. A statement of informed consent was signed and accepted by participants as a requirement for their voluntary participation in the survey. Data were collected between October 31 and November 13, 2017.

The main topics addressed were:

- Beliefs about utility, viability in the future, responsibility, reasons for use.
- Expectations about periods of implementation, expected benefits, usage.
- Feelings and concerns about different possible implementations of self-driving.

The sample included 138 respondents who obtaining their licence B in a Spanish driving school at the time. Seventy-two respondents were men (52.2%), and 66 were women (47.8%). Their ages ranged between 17 and 24 years old (Table1).

Table 1: Age distribution of the sample

Age range	N	%
17-24	87	63
25-34	22	15,9
35-44	22	15,9
45-54	6	4,3
55-65	1	0,7

Descriptive statistics and frequencies were determined for relevant demographic variables such as gender or age range. In addition to demographic variables, the questionnaire registered variables on beliefs and expectations about autonomous driving. Means and standard deviations were also calculated for each variable.

An independent-samples t-test was conducted to compare how the students would feel if they used an autonomous vehicle, preference for using the autonomous vehicle in different situations, advantages and disadvantages of autonomous driving, and some concerns about autonomous driving by gender. Analyses were conducted with the SPSS v24.

3. RESULTS

At the beginning of the questionnaire, respondents were asked what they understood about autonomous driving. As Table 2 shows, most of the driving school students think an autonomous vehicle has a system that allows it to travel alone, where the driver cannot take the steering wheel and drive manually at any time.

Table 2: General knowledge about autonomous driving

How would you define an autonomous vehicle?	%	N
A vehicle whose system allows it to travel alone, and where the driver cannot take the wheel and drive manually at any time.	22.5	31
A vehicle whose system allows it to travel alone, and where the driver can take the steering wheel and drive manually at any time.	77.5	107

Regarding the perceived utility of the autonomous vehicle, four out of ten students surveyed think that vehicles that do not need a driver are a very useful system (39.9%), followed by those who believe that it is neither useless nor very useful (21.7%) and those who state that it is very useful (17.4%). At the opposite extreme, 20% of the students say that it is of little use (10.9%) or useless (10.1%) (Table 3)

On the other hand, with regard to their beliefs about the utility of autonomous driving, we wanted to know student's opinions about the viability of these new vehicle systems. As the table shows, the percentages obtained follow a pattern similar to the previous question. Specifically, 36.2% of the students think it is a quite feasible vehicle modality, followed by those who are at an intermediate point without a completely defined opinion (23.2%). At the extremes, however, we can highlight a large percentage of students who consider it little or not at all feasible (18.1% and 6.5%, respectively) or, on the contrary, very feasible (15.9%).

With regard to the question: When do you think there will be completely autonomous vehicles circulating on our roads? Only 3.6% of respondents believe that it will never become a reality, and so it can be said that the majority of students view this type of system as feasible, but in the medium to long term. Specifically, only 8% believe these vehicles will be available between 2017 and 2020, with percentages much higher between 2021 and 2025 (34.8%), from 2026 to 2030 (35.5%), and from 2031 on (18.1%).

When asked about the kinds of vehicles they expect to find in urban areas and roads in the future, 34.8% of respondents think there will be a large number of autonomous vehicles among a minority of conventional vehicles. Moreover, 23.9% think autonomous and conventional vehicles will coexist equally, and 23.2% think they will coexist. Only about one in ten respondents are at the extremes, stating that we will only find conventional vehicles (9.4%) or, on the contrary, only autonomous vehicles (8.7%).

However, despite the fact that a large part of the students surveyed believe that autonomous cars will be a reality and that they will coexist with conventional vehicles, 79% have not thought about buying a vehicle with this system, compared to 21% that do.

In case of accident, 50% of the students believe that the driver and the vehicle manufacturer would be responsible, equally, for the accident. However, 32.6% believe that the responsibility would be exclusive to the manufacturer of the vehicle, and only 17.4% believe that the responsibility would be exclusively the driver of the vehicle.

Finally, respondents were asked about their driving preferences. As Table 3 shows, the majority of the

respondents (73.2%) preferred to drive themselves rather than riding in an autonomous car (26.8%). When asked about their reasons for driving themselves, 51.4% stated that they prefer a conventional car for pleasure ("I enjoy and like to drive"), followed by 36.2% who would not choose the autonomous vehicle because he or she would feel safer driving himself. Few respondents stated that they would prefer manual driving due to a lack of confidence in technology or because they do not feel able to control this type of technological system (8.7% and 3.6%, respectively).

Table 3: Driving students' answers to questions about their beliefs and expectations with regard to autonomous driving

Do you consider it useful to have an autonomous vehicle in which a driver is not necessary?	%	N
Useless	10.1	14
Not very useful	10.9	15
Neither useless nor very useful	21.7	30
Quite useful	39.9	55
Very useful	17.4	24
Do you think that autonomous vehicles are feasible?	%	N
Not feasible	6.5	9
Not very feasible	18.1	25
Neither not feasible nor very feasible	23.2	32
Quite feasible	36.2	50
Very feasible	15.9	22
When do you think there will be completely autonomous vehicles circulating on our roads?	%	N
Between 2017-2020	8	11
Between 2021-2025	34.8	48
Between 2026-2030	35.5	49
From year 2031 onwards	18.1	25
Never	3.6	5
In the future, what kind of vehicle do you expect to find in urban areas and roads?	%	N
Only conventional vehicles	9.4	13
Some autonomous vehicles among a majority of conventional vehicles	23.2	32
Same number of autonomous and conventional vehicles	23.9	33
A large number of autonomous vehicles among a minority of conventional vehicles	34.8	48
Only autonomous vehicles	8.7	12
Only conventional vehicles	9.4	13
Have you thought about buying an autonomous vehicle?	%	N
Yes	21	29
No	79	109
In your opinion if an accident occurred while using an autonomous vehicle, who do you think would be responsible?	%	N
Vehicle manufacturer	32.6	45
Driver	17.4	24
Both	50	69
If you were given the choice between driving a car yourself or an autonomous vehicle without a driver, what would you choose?	%	N
Driving myself	73.2	101
Let me take an autonomous vehicle	26.8	37
Why would you prefer to drive yourself and not an autonomous vehicle?	%	N
I enjoy and like to drive	51.4	71
I would feel safer driving myself	36.2	50
Because of lack of confidence in technology	8.7	12
I do not feel I have enough capacity to control the technology	3.6	5

Driving learners were also asked about their feelings about situations for use, advantages, disadvantages, and concerns related to autonomous driving (see Table 4). Respondents were asked some questions with different response options that could be rated on a five-point scale according to their level of agreement, from 1 ("not at all") to 5 ("very"). Regarding the emotions aroused by the autonomous vehicle, the students were asked how they would feel if they used autonomous technology. Insecurity (M=2.75, SD=1.30) and distrust (M=2.75, SD=1.29) were the emotions with the highest rates, and stress (M=2.43, SD=1.32) was the least.

Regarding the preferred situations for using an autonomous car, respondents showed a greater preference for the use of this type of vehicle in cases where they had consumed alcohol, drugs, or mediation (M=4.02, SD=1.39), in situations of fatigue (M=3.67, SD=1.40), if driving was boring or monot-

onous (*M*=3.44, *SD*=1.46), if the driver had to perform some task while driving (reading, mobile, etc.) (*M*=3.39, *SD*=1.59), or in a stressful traffic situation (*M*=3.3, *SD*=1.59) and on long journeys (*M*=3.26, *SD*=1.52). On the other hand, the situations where the preference for the use of an autonomous vehicle was lower were those that involved driving on urban roads (*M*=2.68, *SD*=1.51), driving with children (*M*=2.55, *SD*=1.47), on short journeys (*M*=2.5, *SD*=1.44), or on daily journeys (*M*=2.44, *SD*=1.37).

Regarding advantages and disadvantages of autonomous vehicles, most respondents agreed that they would be very expensive to buy and maintain (*M*=3.63, *SD*=1.32), followed by "It will reduce fuel consumption" (*M*=3.43, *SD*=1.24), "It will improve traffic flow" (*M*=3.36, *SD*=1.20), and "The driver will stop being alert to traffic" (*M*=3.35, *SD*=1.31). The statement with the least agreement was "Driverless driving will not succeed in the future" (*M*=2.43, *SD*=1.18).

Finally, students were asked to assess their degree of concern in relation to several statements about the autonomous vehicle. Slightly higher average scores were shown by the students on questions related to legal issues (*M*=3.64, *SD*=1.23) and low driver control (*M*=3.62, *SD*=1.25). On the other hand, the lowest scores were found for concern about the lack of knowledge and complexity of the technology of this type of vehicle (*M*=3.2, *SD*=1.35).

Table 4: Feelings, situations for usage, advantages, disadvantages, and concerns about autonomous driving

How would you feel if you used an autonomous vehicle?	M	SD
Unsafe	2.75	1.30
Suspicious	2.75	1.29
Stressed	2.43	1.32
Fearfully	2.5	1.30
How much would you like to use an autonomous vehicle in the following situations?	**M**	**SD**
Alcohol, medicines, drugs	4.02	1.39
Tiredness situation	3.67	1.40
Boring and monotonous driving	3.44	1.46
Doing another task	3.39	1.59
Stressful traffic situation	3.3	1.59
Long journeys	3.26	1.52
Driving on an intercity road	2.92	1.47
Without children	2.79	1.47
Driving on urban roads	2.68	1.51
With children	2.55	1.47
Short journeys	2.5	1.44
Daily journeys	2.44	1.37
Advantages and disadvantages of the autonomous vehicle.	**M**	**SD**
It will be very expensive to buy and maintain	3.63	1.32
It will reduce fuel consumption	3.43	1.24
It will improve traffic flow	3.36	1.20
Driver will stop being alert to traffic	3.35	1.31
The driver may use his time for other activities	3.27	1.34
It will reduce accident rates	3.2	1.23
It will act better than I would in a complicated traffic situation	2.87	1.26
It will be very difficult to maintain such a complex technology	2.79	1.29
Driverless driving will not succeed in the future	2.43	1.18
Indicate your degree of concern with the following statements about autonomous driving	**M**	**SD**
Regarding legal issues, who is responsible in case of an accident?	3.64	1.23
Low driver control, leaving decisions in the hands of the system	3.62	1.25
Privacy issues, such as sharing the driver's data	3.51	1.27
Risk of hacking vehicle control	3.49	1.28
Lack of knowledge and complexity of the technology of these vehicles	3.2	1.35

Note: the scale ranged from 1 (not at all) to 5 (very)

4. CONCLUSIONS

The fascination with automotive autonomy seems to be spreading to many governments and, of course, manufacturers. But even though advances in vehicle automation provide new opportunities to meet society's future mobility demands, safety issues and the multifactorial nature of accidents have to be taken into account. There is evidence of safety improvements provided by vehicles with low degrees of automation. However, the safety forecast of highly or

fully automated vehicles depends on assumptions because, so far, there have been no serial applications of these characteristics (Maurer, Gerdes, JLenz, & Winner, 2016).

The perspectives of road users and potential future users receive little attention, even though it is constantly stressed that a user- and usage-oriented view can make an essential contribution to acceptance (Arras & Cerqui, 2005). In the present study, we investigated the beliefs and expectations of a group of driving learners about autonomous driving in terms of usefulness, feasibility, perceived problems, use intention, responsibility in case of an accident, and the perception of the training required.

Our results showed that, on average, driving learners think the autonomous vehicle has a system that allows the car to travel alone, where the driver is not able to take the steering wheel and drive manually at any time. This suggests that drivers still do not contemplate fully automated vehicles when talking about autonomous driving. However, young drivers do not seem to be sceptical about its future implementation, given that four out of ten students surveyed thought that vehicles that do not need a driver would be a very useful system, and a similar proportion think it is a feasible mode of transportation.

Moreover, 35.5% of the students believe that autonomous vehicles will be available between 2026 and 2030, which agrees with findings presented by Underwood (2014), De Winter et al. (2015), and Kyriakidis et al. (2015), but it is a short period compared to Begg's study, where 20% of the respondents believed that the Level-4 automated vehicles would be commonplace on UK roads by 2040, and 30% expressed the belief that this would never be the case (Begg, 2014). Cyganski, Fraedrich, and Lenz (2015) claimed that autonomous driving would also improve productivity and driving comfort, variables that are not explored in this study but support the use of this type of vehicle. Following the vision and future perspective on the existence of autonomous vehicles and their presence in daily life, learners were asked what kind of vehicles they expected to meet in cities and roads in the future. Most of them believed that, in the future, there would be a large number of autonomous vehicles among a minority of conventional vehicles. However, 79% have not thought about buying one.

An additional question raised by the results of this study is the responsibility in case of an accident. Fifty percent of students believe that both the driver and vehicle manufacturer share the responsibility. This belief raises concerns about the level of consumer awareness about vehicle failures and all the legal, technical, and economic risks that must be considered in case of an accident. Autonomous vehicles will presumably only attain widespread success when their overall benefits of society exceed the associated damage, and traffic safety and responsibility in case of accidents are extremely important matters that still have to be solved.

Regarding usage expectations, respondents mostly prefer to drive themselves rather than ride in an autonomous vehicle. The main reasons for this preference are pleasure (52.4%) and because they feel safer driving themselves (36.2%). Other studies have concluded that people who enjoy cars and driving (those who identify themselves as driving alone on most trips, as well as those who value a car for its image or luxury) were more likely to desire greater control over the car, and those who cite safety or control as a major factor were much less likely to want to buy a self-driving car (Ivers et al., 2009). In the field of emotions, the results obtained indicate that the sensations generated by driving an autonomous vehicle are relatively neutral because there were no ratings higher than 2.75 out of 5. In any case, insecurity and disruption were the feelings expressed most. These results show that, despite the optimism that manufacturers are trying to convey, there is a basic reticence that cannot easily be overcome.

Regarding their behavioural intentions, students were asked in what situations they would prefer to use an autonomous vehicle. Respondents indicated that they would mainly prefer to use one if they had consumed alcohol, medicine, or drugs, followed by situations of fatigue, monotonous driving, doing other tasks, and stressful traffic. These results match the main reasons for fines and loss of driving licence points in Spain (Martí-Belda, 2016), and they highlight the importance of the debate about legal responsibility in case of an accident because they may think they are no longer responsible for the car or the driving. Payre, Cestac and Delhomme (2014) obtained similar results: two out of five interviewees declared that they would be tempted to use fully automated driving if they were over the legal alcohol limit, and two out of five declared that they would use it after taking medication with side-effects. Although safety and other benefits of autonomous driving are still only assumptions, it is true that the autonomous vehicle offers the ability to overcome the risk of crashes derived from traffic violations and operational er-

rors, usually related to perceptual, decision-making, and psychomotor aspects (Ivers et al., 2009). This may be the most important strength in convincing public opinion.

Regarding disadvantages of autonomous driving, most respondents agreed that these vehicles would be very expensive to buy and maintain, and that drivers would stop being alert to traffic. As advantages, most people agreed that they would reduce fuel consumption and improve traffic flow. Finally, people were found to be very concerned about legal issues, leaving decisions in others' hands, privacy issues, the risk of hacking, and lack of knowledge. These results are consistent with those found in Pettigrew, Talati & Norman (2018), suggesting that more positive attitudes toward AVs will be engendered by informing the public about the ways this transport innovation will improve the lives of individuals and enhance societal welfare. Results suggest that the public may be interested in information related to the individual and societal health benefits of autonomous vehicles, which in turn may increase overall support for this innovation.

These findings have looked at driving learners' point of view, future intentions, and subjective understanding of autonomous driving. The results would benefit from further investigation with bigger samples, comparing different "user groups", such as experienced drivers, to find out whether acceptance is different between those who already drive and those who are learning to do so, and comparing different age groups. Common method bias of self-reported questionnaires also has to be taken into account in this study, and it could affect the results in many aspects, such as respondents' understanding, social desirability, lack of sincerity, or acquiescence bias (Raazavi, 2001). Knowledge about autonomous driving was not properly assessed, which could have influenced their responses. Likewise, responses might have been based on others' opinions (it is a topic frequently discussed in the mass media), rather than on their own point of view.

It is worrisome that a new technology such as the autonomous vehicle, which is aimed at people, is being developed with multimillion-dollar technological investments, but few studies have been carried out on how it will be received, perceived, and accepted by societies and individual end-users.

The acceptance and use of autonomous vehicles will be determined by the level of confidence, security, and safety the user perceives. Technology and connectivity are not the only values to take into account in the successful introduction of autonomous vehicles. Thus, the new challenges are not only the technological solutions, but also the user's understanding of this technology and the role users will play in this new mobility model, especially in a traffic risk situation. Society might be prepared to accept and consume technological solutions for mobility, but it is still not completely ready to accept that a machine can kill a human being. In addition, there is no certainty that technology is the best solution to reduce traffic accidents, because, in this new paradigm, other risks will appear that have yet to be explored. For instance, it is important to consider that a range of other road users, such as pedestrians, children, old people or cyclists, will share the environment. Automated vehicles will interact with all humans around them, and more studies are needed to discuss possible dramatic scenarios resulting from their interaction (Maurer, Gerdes, Lenz & Winner, 2016).

This study helps us to better understand how future drivers deal with the unspecific information they have about autonomous driving, but it is hard to predict whether autonomous driving will produce a fundamental transformation in the auto mobility system. This study emphasizes the idea that optimism about this system (mainly expressed by the economic powers) should be approached from a more realistic perspective because there are still a lot of doubts about the benefits of autonomous driving. Future studies are needed to better understand drivers' perceptions of AVs. More in-depth assessments and complementary quality data are needed, in addition to controlling the biases found in this study due to the small sample size or self-report methodology.

Acknowledgment: This work has been carried out within the frame work of Facthum.lab research group from the INTRAS (University of Valencia). We also would like to thank the National Confederation of Driving Schools in Spain (CNAE) for sponsoring and supporting the study.

REFERENCES

Anderson, J. M., Nidhi, K., Stanley, K. D., Sorensen, P., Samaras, C., & Oluwatola, O. A. (2014). *Autonomous vehicle technology: a guide for policymakers*. Rand Corporation.

Arras KO, Cerqui D (2005). Do we want to share our lives and bodies with robots? a 2000 people survey (No. LSA-REPORT-2005-002).

Brookhuis, K. A., De Waard, D., & Janssen, W. H. (2001). Behavioural impacts of advanced driver assistance systems–an overview. *European Journal of Transport and Infrastructure Research*, *1*(3), 245-253.

Cyganski, R., Fraedrich, E., & Lenz, B. (2015). Travel-time valuation for automated driving: a use-case-driven study. In *Proceedings of the 94th Annual Meeting of the TRB*.

De Winter, J. C. F., Happee, R., Martens, M. H., & Stanton, N. A. (2014). Effects of adaptive cruise control and highly automated driving on workload and situation awareness: a review of the empirical evidence. *Transportation Research Part F: Traffic Psychology and Behaviour, 27,* 196–217. Retrieved from http://dx.doi.org/10.1016/j.trf.2014.06.016.

DGT (2016). *Informe y análisis sobre la influencia de los ADAS en la seguridad vial y su aplicación para la clasificación de vehículos [Report and analysis on the influence of the ADAS on road safety and its application for the classification of vehicles].* Retrieved from http://revista.dgt.es/images/INFORME-SISTEMAS-DE-AYUDA-A-LA-CONDUCCION-copia.pdf

Dotzauer, M., De Waard, D., Caljouw, S. R., Pöhler, G., & Brouwer, W. H. (2015). Behavioral adaptation of young and older drivers to an intersection crossing advisory system. *Accident Analysis & Prevention*, *74*, 24-32.

European Commission (2016). *2015 road safety statistics: What is behind the figures?* (MEMO No. 16/864). Brüssel. Retrieved from http://europa.eu/rapid/press-release_MEMO-16-864_en.htm.

Gasser, T. M., Arzt, C., Ayoubi, M., Bartels, A., Bürkle, L., Eier, J., & Lotz, C. (2012). Rechtsfolgen zunehmender fahrzeugautomatisierung. *Berichte der Bundesanstalt für Straßenwesen. Unterreihe Fahrzeugtechnik*, (83).

Geiger, A., Lenz, P., & Urtasun, R. (2012, June). Are we ready for autonomous driving? the kitti vision benchmark suite. In *Computer Vision and Pattern Recognition (CVPR), 2012 IEEE Conference on* (pp. 3354-3361). IEEE.

Hevelke, A., & Nida-Rümelin, J. (2015). Responsibility for Crashes of Autonomous Vehicles: An Ethical Analysis. *Science and Engineering Ethics, 21(3),* 619–630. doi: 10.1007/s11948-014-9565-

Howard, D., & Dai, D. (2014). Public perceptions of self-driving cars: The case of Berkeley, California. In *Transportation Research Board 93rd Annual Meeting* (Vol. 14, No. 4502).

Ivers, R., Senserrick, T., Boufous, S., Stevenson, M., Chen, H.-Y., Woodward, M., & Norton, R. (2009). Novice Drivers' Risky Driving Behavior, Risk Perception, and Crash Risk: Findings from the DRIVE Study. American Journal of Public Health, 99(9), 1638-1644. doi: 10.2105/AJPH.2008.150367

Koo, J., Kwac, J., Ju, W., Steinert, M., Leifer, L., & Nass, C. (2015). Why did my car just do that? Explaining semi-autonomous driving actions to improve driver understanding, trust, and performance. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, *9*(4), 269-275.

KPMG. *Self-Driving Cars: Are We Ready?*. Yearly Analysis, KPMG, 2013.

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.

Martens, M. H., & Jenssen, G. D. (2012). Behavioral adaptation and acceptance. In *Handbook of Intelligent Vehicles* (pp. 117-138). Springer, London.

Marti-Belda, A. (2016). Legal questioning of the traffic offender. *Presentation at the 2016 Congress of forensic and legal psychology*, Madrid.

Maurer, M., Gerdes, J. C., Lenz, B., & Winner, H. (2016). Autonomous driving. *Berlin, Germany: Springer Berlin Heidelberg*, *10*, 978-3.

Payre, W., Cestac, J., & Delhomme, P. (2014). Intention to use a fully automated car: Attitudes and a priori acceptability. *Transportation research part F: traffic psychology and behaviour, 27*, 252-263.

Pettigrew, S., Fritschi, L., & Norman, R. (2018). The Potential Implications of Autonomous Vehicles in and around the Workplace. *International Journal of Environmental Research and Public Health, 15(9),* doi: 669 10.3390/ijerph1509187

Pettigrew, S., Talati, Z., & Norman, R. (2018). The health benefits of autonomous vehicles: public awareness and receptivity in Australia. *Australian and New Zealand journal of public health*, *42*(5), 480-483.

Raazavi, T. (2001). *Self-report measures: An overview of concerns and limitations of questionnaire use in occupational stress research*. Discussion Papers in Accounting and Management Science. Southampton: University of Southampton.

Rosenzweig, J., & Bartl, M. (2015). a review and analysis of literature on autonomous driving. *E-Journal Making-of Innovation*. Retrieved from http://www.michaelbartl.com/co-creation/wp-content/uploads/Lit-Review-AD_MoI.pdf

Rupp, J. D., & King, A. G. (2010). *Autonomous driving-A practical roadmap* (No. 2010-01-2335). SAE Technical Paper.

Sommer, K. (2013). Continental Mobility Study 2011. *Continental AG*. Retrieved from https://www.continental-corporation.com/resource/blob/7380/6cddc571cd3d3b5cacd279fe0d1a00c1/mobistud-2013-dl-data.pdf.

Taxonomy, S. A. E. (2014). *Definitions for terms related to on-road motor vehicle automated driving systems*. Technical report, SAE International. Retrieved from http://standards.sae.org/j3016_201401>.

Trimble TE, Bishop R, Morgan JF, Blanco M (2014). *Human factors evaluation of level 2 and level 3 automated driving concepts: Past research, state of automation technology, and emerging system concepts.* (Report No. DOT HS 812 043). Washington, DC: National Highway Traffic Safety Administration.

Underwood, S. E. (1992). Delphi forecast and analysis of intelligent vehicle-highway systems through 1991: Delphi II. *IVHS technical report; 92-17*.

Underwood, S. E. (2014). Automated vehicles forecast vehicle symposium opinion survey. In *automated vehicles symposium* (pp. 15-17).

WHO (2016). *Global status report on road safety 2015*. Ginevra: World Health Organization. Retrieved from http://www.who.int/violence_injury_prevention/road_safety_status/2015/en/