THE PULSE OF AUTONOMOUS DRIVING

An international user typology and an emotional landscape of autonomous driving

Overview of the study's results

FOREWORD BY DR. LUCIANO FLORIDI

The Future of Autonomous Driving may be Variety

Mobility is an essential part of life in many societies. Every day, all over the world, cars play key functions (e.g., in transport or leisure) and social roles (e.g., as statements or status symbols). They are part of our history and culture. Any transformation of mobility affects the very essence of contemporary societies. And it is hard to imagine a more profound transformation of mobility than autonomous driving. So, understanding attitudes towards its benefits and shortcomings means being able to address societal welfare and individual wellbeing more successfully. Hence, this study is more than just a welcome addition to our knowledge of the phenomenon; it is a necessary step for any policy- and law-making decision, as well R&D and business strategy, that intends to be proactive and informed in delivering a better world.

The survey contains a wealth of information and insights about people's attitudes to autonomous driving in China, France, Germany, Italy, Japan, South Korea, Spain, United Kingdom, and United States. For example, structuring the responses into 5 typologies of drivers is helpful to understand overall attitudes. Here, I would like to outline two interesting points emerging from the study and draw a general conclusion.

Consider the tension between technological *novelty* and *change*. The majority of those surveyed expressed *interest* (82 %) and *curiosity* (62 %) about autonomous driving. However, a majority also raised *concerns* about loss of control (70 %), technically unavoidable residual risks (66 %), and the lack of a legal framework (65 %). This is not as odd as it seems. Appreciating a novelty requires only an open mind but involves no actual risks or costs. Embracing a change implies a commitment that raises concerns about risks and costs (only 28 % of people are willing to pay more for autonomous vehicles). Autonomous driving is both a realistic novelty and an unprecedented change. To translate high levels of interest and curiosity into low levels of concerns one needs to provide better technology, more safety, and robust ethical and legal frameworks. Thus, high expectations about these latter variables are understandable.

Consider next that only a minority (8 %) "feel able to explain the subject". This may seem worryingly low and even cast doubts on the value of the survey. It is not, and it should not.

FOREWORD BY DR. LUCIANO FLORIDI

Take cars with automatic transmission. In 2018, only 3.7 % of the vehicles sold by CarMax (the largest used-car retailer in the United States) had manual transmission. Cars with automatic transmission are by far the default option in the United States. Yet, arguably only a very small percentage of customers may "feel able to explain" the difference between Constantly Variable Transmission, Dual Clutch Transmission, and Simple Automatic Transmission. Attitudes are usually based on beliefs and experience rather than scientific knowledge. It would be a mistake to conclude that people's attitudes about something they cannot explain are insignificant or unreliable. What matters is that 90 % of the people surveyed "have heard of the technology" and 30 % "know it well".

A general conclusion that emerges from the survey may be summarised by a single word: *variety*. The question about the future of autonomous driving is not *when* or even *where*, but *how* it will take place. It will be a matter of what options, choices, and degrees of autonomous driving are offered to customers. Their needs, preferences, attitudes, and circumstances differ. They are best addressed by a flexible variety of alternatives. In bad sci-fi movies, there are only new cars and a handful of models. Reality is greasy and sticky, like a real engine. Public policies and business strategies about autonomous driving will need to make *variety* a feature, not a bug. Hopefully also ensuring that autonomous vehicles will be environmentally more sustainable than the ones we drive today.

Dr. Luciano Floridi, Oxford Internet Institute, Professor of Philosophy and Ethics of Information and Director of the Digital Ethics Lab, University of Oxford, and member of the scientific network of the initiative *&Audi*

EXECUTIVE SUMMARY

What do people think about autonomous driving?

Autonomous driving has the potential to improve mobility substantially. More than 95 percent of accidents today are caused by humans.[1] Autonomous driving can make traffic on our roads safer and more convenient. Set against this are some relevant challenges – from the legal framework to individuals' trust in the technology. Alongside rational arguments, emotions also shape the societal debate about autonomously driving cars. Audi's initiative *&Audi* aims to contribute to the introduction of autonomous driving in the interests of individuals and of society. To achieve this, it is essential to understand what moves people. With the representative online study, The Pulse of Autonomous Driving, the initiative *&Audi* has examined the question of how rational arguments, emotions, values and lifestyles shape people's attitudes to autonomous driving. A total of 21,000 people were interviewed from nine countries: China, France, Germany, Italy, Japan, South Korea, Spain, the United Kingdom and the United States. The result is a trio consisting of the emotional landscape, the human readiness index and the user typology.

1 National Highway Traffic Safety Administration. Traffic Safety Facts. Retrieved August 2, 2019, from https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812115

What are the core findings of the study?

» The **emotional landscape** shows great interest in and high curiosity about autonomous driving across all countries. More than half of the respondents want to try out the technology. The greatest expected benefit is easier access to mobility for people who cannot or do not want to drive a car. Nevertheless, there also is concern about loss of control. And the level of knowledge about autonomous driving appears to be low.

» The **human readiness index (HRI)** provides insights into how attitudes to autonomous driving are related to sociodemographics: the younger the respondents and the higher their level of education and income, the more positive their attitude to autonomous driving. The Chinese and South Koreans regard autonomous driving very positively, while Europeans, Japanese and Americans are more reserved.

» The **user typology** looks at attitudes to autonomous driving in the context of people's lives. Five user types for autonomous driving emerged, ranging from rejection to enthusiasm: the suspicious driver, the safety-oriented reluctant, the open-minded co-pilot, the status-oriented trendsetter and the tech-savvy passenger. These user types shows differences more clearly than an examination of only socio-demographic characteristics.

EXECUTIVE SUMMARY

What can we learn from the study?

Increase knowledge

The results make it clear that there is room for knowledge about autonomous driving. There is potential to enhance know-how about technical aspects, the social benefits of the technology and its limits. The aim is to establish appropriate expectations of the opportunities and limitations of the technology in society.

Appeal to needs

The user typology reveals differences in attitudes to autonomous driving depending on the context of people's lives. Varying needs should be met with specific offers of autonomous driving. These offers can range from specific information to experience of technology in diverse use cases.

Cooperative approach

Certified safety, a legal framework, reliable technologies: the study points to measures that would enhance confidence in autonomous driving. Here it is evident that interdisciplinary cooperation between business, science, politics and other societal stakeholders is necessary in responding to people's hopes and demands.

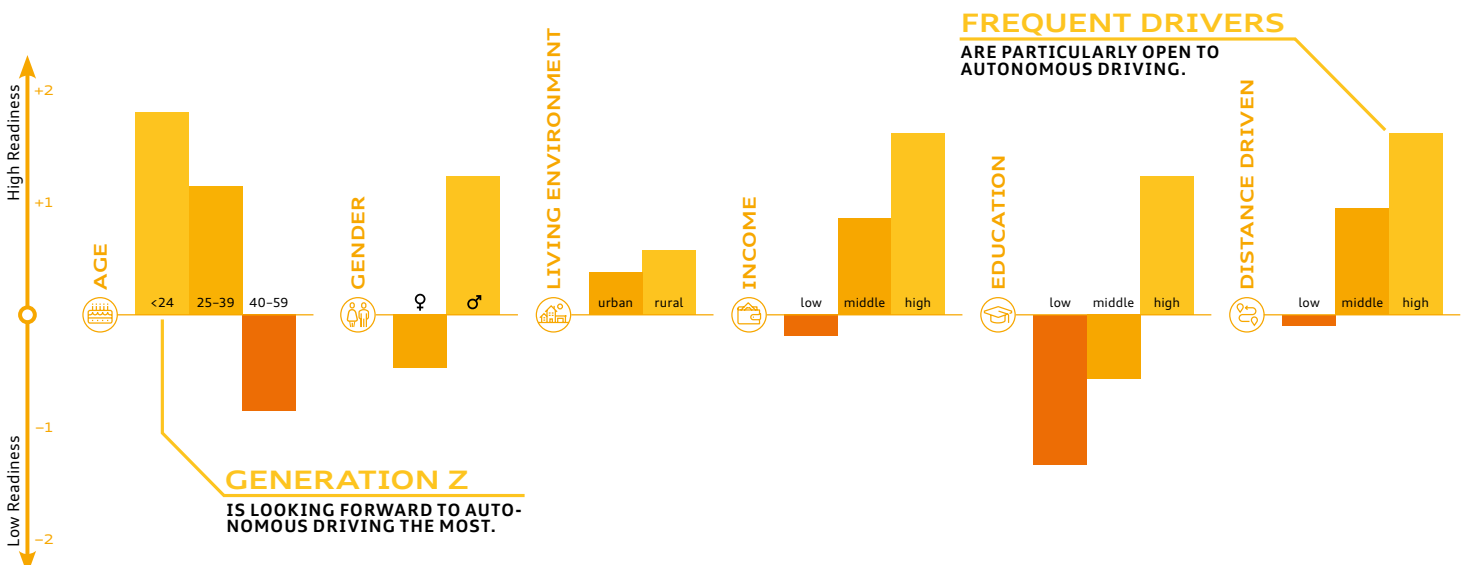
Thomas Müller,
Head of Automated
Driving at Audi

»Automated and autonomous driving has the potential to improve our mobility substantially. It can make traffic safer and mobility more convenient, as well as giving access to individual mobility for more people. Our aim is to introduce the technology for the benefit of the individual and society. On the way there, alongside technical development, it is of decisive importance to convince people. The study The Pulse of Autonomous Driving *provides us with differentiated insights about where people stand in relation to autonomous driving and how we can establish suitable expectations about the new technology in society.«*

HUMAN READINESS INDEX

Are people ready for autonomously driving cars?

The human readiness index (HRI) provides insights into how attitudes to autonomous driving are related to sociodemographics. In addition to interest, knowledge and emotions, it also includes the readiness of respondents to use the technology and generates from this a numerical indicator on a scale between –10 and +10. The results show that, across borders, Generation Z is especially open to autonomous driving (+1.9). The same applies to men (+1.3), well-educated persons (+1.3) and those with higher income (+1.7). Frequent drivers also tend to regard the technology more positively than those who drive little. By contrast, hardly any difference is apparent between people that live in cities (+0.4) and in the countryside (+0.6).



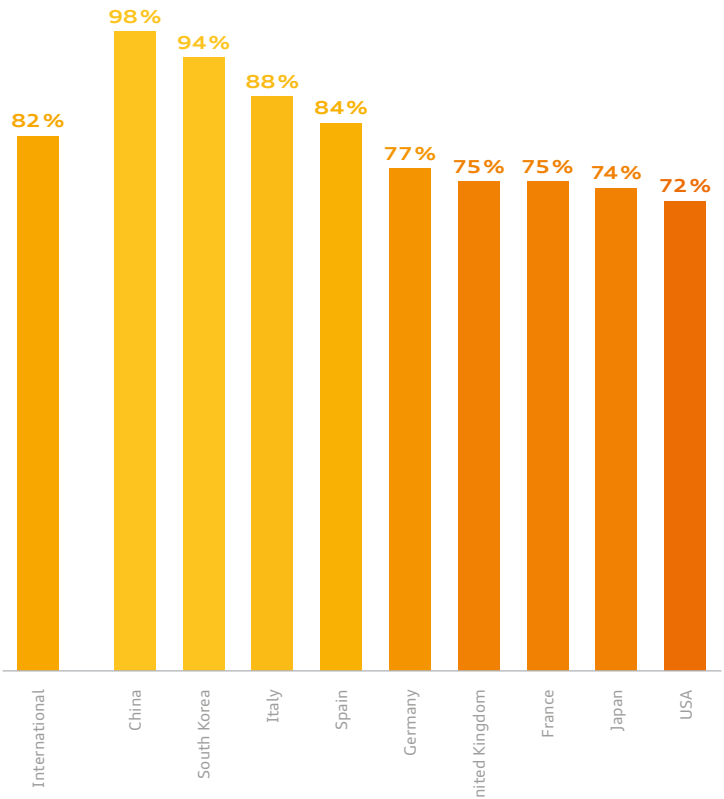
Great interest in autonomous driving

Internationally, 82 percent of respondents displayed interest in autonomous driving. Chinese and South Koreans are especially interested (98 percent and 94 percent). Europeans are a little more reserved: in Italy 88 percent of respondents showed interest in the technology, in Germany 77 percent. Among Americans, 72 percent are interested in self-driving cars.

People's feelings are also relevant for their attitudes to autonomous driving. 62 percent of respondents are curious and almost half (49 percent) regard autonomous driving with optimism.

Younger people are especially open to autonomous driving. Three out of four respondents from Generation Z (73 percent) are curious about the technology. Among baby boomers aged between 40 and 60, this applies to more than one in two (59 percent). And those who are already sharing today will use autonomous driving tomorrow: 70 percent of car-sharing users and 81 percent of ride-sharing users are strongly interested in autonomous driving.

Interest in autonomous driving



Mobility for all

Respondents see potential for society and the individual in the new technology. They expect the greatest benefit from easier access to mobility for older persons, children, people with handicaps, and persons who have no driver's license (76 percent). Almost three quarters of respondents (72 percent) hope for greater convenience, because in an autonomously driving car they will have their hands and heads free to do other things than driving. Moreover, a majority (59 percent) believe that autonomous driving will make road traffic safer.

But how can the time in an autonomously driving car be used best? Interest is highest in enjoying the view (80 percent), reading, listening to music or watching movies (all 74 percent), followed by talking to other passengers (71 percent).

Perceived benefits of autonomous driving, international

Fear of loss of control

In autonomous driving, humans hand over control to the machine. In consequence, in addition to the potential advantages, reservations and risks play a key part in the societal debate. 41 percent of respondents report that they are suspicious, and somewhat more than one third (38 percent) are anxious.

The most frequent reservations relate to a possible loss of control (70 percent), technically unavoidable residual risks (66 percent), and the lack of a legal framework (65 percent). The fact that the car assesses situations independently also leads to reservations on the part of a majority of respondents (63 percent).

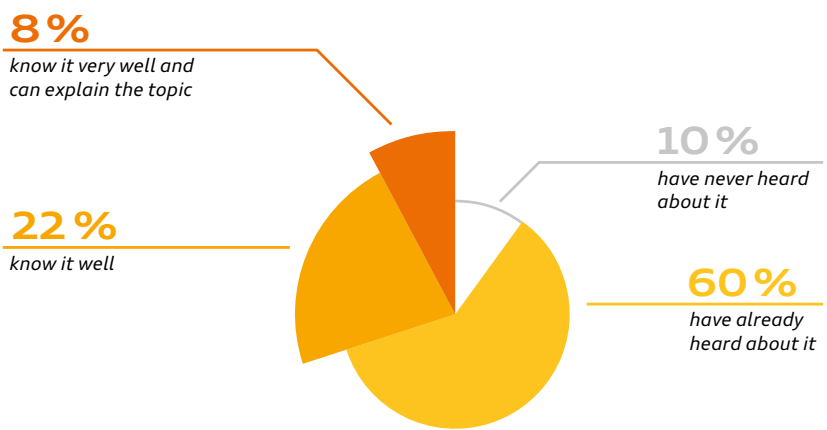
Reports about accidents with automated cars, by contrast, make little impression: more than half of the people surveyed (55 percent) have heard of such accidents. Among almost two thirds (61 percent) of those respondents, reports of accidents have not led to a change in their attitude to autonomous driving.

Critical aspects of autonomous driving, international

Room to improve knowledge

Autonomous driving is a top theme across borders: 90 percent of respondents have heard about the technology. 22 percent say that they know a lot about autonomous driving. But only 8 percent feel able to explain the subject. Car enthusiasts, Generation Z, higher earners and well-educated persons seem to be best informed. There is also a discrepancy between knowledge, on the one hand, and a wide spread interest in (82 percent) and curiosity about (62 percent) autonomous driving, on the other hand. This suggests the conclusion that autonomous driving is a known unknown for many respondents.

Knowledge of autonomous driving, international



High level of interest in a test drive

Practice is better than theory – according to this motto, more than half of the respondents (53 percent) would like to test autonomous driving. China leads the field: eight out of ten Chinese would get aboard a self-driving car, while the figure in Germany is one in three. A high level of willingness to use is also evident among frequent drivers (55 percent) and regular users of driver assistance systems (64 percent).

53 %

of respondents would like to test autonomous driving.

It makes a difference here whether other people already have experience with the technology. A majority of respondents (52 percent) would test autonomous driving if others have already tried it out. There were also differences according to use scenarios: about one third of respondents would relinquish control of the car for autonomous parking (35 percent) and in a traffic jam on a highway (34 percent). In the scenario of driving on a country road, only about one in five (22 percent) would be willing to give up control.

35 %

would use autonomous parking.

34 %

would use autonomous driving in a highway traffic jam.

28 %

would use autonomous driving on a highway.

25 %

would use autonomous driving in a city center.

22 %

would use autonomous driving on a country road.

EMOTIONAL LANDSCAPE

A look at the world

GERMANY | HRI –0.7

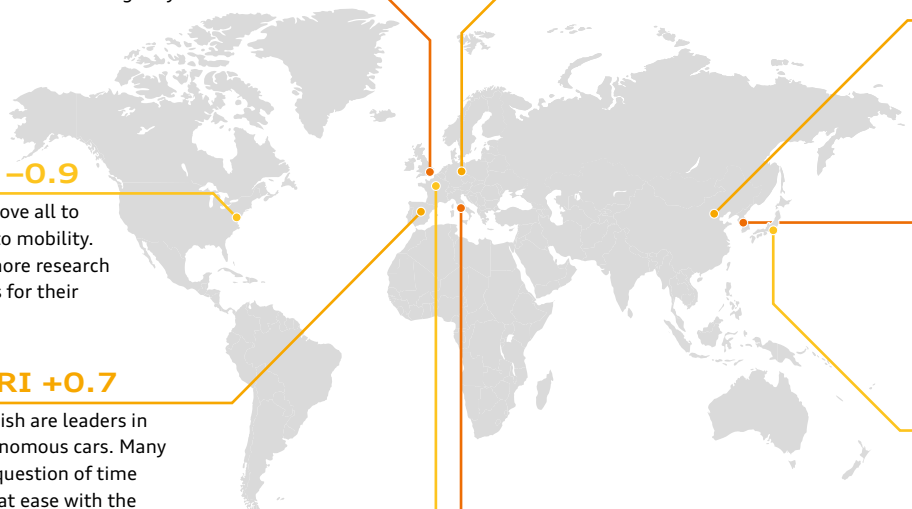
The Germans are comparatively reserved. In an international comparison, they are neither especially euphoric nor especially critical.

UNITED KINGDOM | HRI –0.9

Among the British, ethical considerations play a major role. In autonomous driving they let others take the lead.

CHINA | HRI +5.1

The Chinese regard autonomous cars euphorically. Amongst critical aspects, they focus on loss of control and data security.



USA | HRI –0.9

Americans hope above all to gain easier access to mobility. They also call for more research and tests as a basis for their trust.

SOUTH KOREA | HRI +1.2

For South Koreans, autonomous driving means above all greater safety. As soon as access to the technology is possible, criticism will subside, according to a widely held view.

SPAIN | HRI +0.7

In Europe the Spanish are leaders in acceptance of autonomous cars. Many believe it is only a question of time before people feel at ease with the technology.

JAPAN | HRI –0.9

The Japanese are comparatively cautious. For them, the technology must first prove to be safe through extensive tests.

FRANCE | HRI –0.7

The attitude in France tends to be reserved. Many French, more than in other nations, say that their trust cannot be increased at present.

ITALY | HRI +0.7

Italians expect, among other things, easier access to mobility. Proof of the safety of the technology, for example an independent seal of inspection, could increase their trust.

USER TYPOLOGY

Five user types: autonomous driving in the context of people's lives

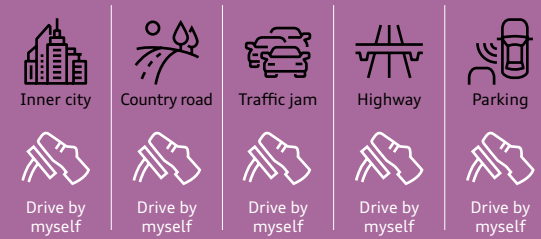
Across national borders, variations in attitudes to autonomous driving can be identified. To understand these better, it is important to examine them in the context of the different worlds in which people live. For this purpose, the 21,000 respondents were grouped into five user types. The most informative criteria for acceptance proved to be interest, emotions, willingness to use, willingness to pay, and the perceived benefit of self-driving cars. Furthermore, personal factors such as sociodemographic characteristics, values, lifestyle and current mobility patterns of the respondents were considered.

The suspicious driver

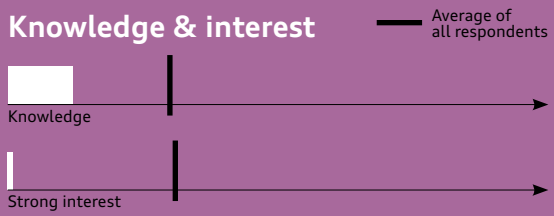
Interest in autonomous driving? Not in the case of the suspicious driver. People of this type prefer to take the wheel themselves. As fans of safety, they are fundamentally critical of the unknown – and this also applies to new technologies. They prefer the status quo. Suspicious drivers have no emotional attachment to the car. For them, a car is an item for handling everyday tasks. They do not need the latest technology for this. They will not turn their attention to self-driving cars until a large majority of people are already driving autonomously on the roads. 14 percent of global respondents fall into this category. This type is most often encountered in Germany (26 percent), the USA (23 percent) and France (21 percent). The human readiness index of the suspicious driver is –8.4.

»I simply don't trust the technology – autonomous vehicles only work in theory.«

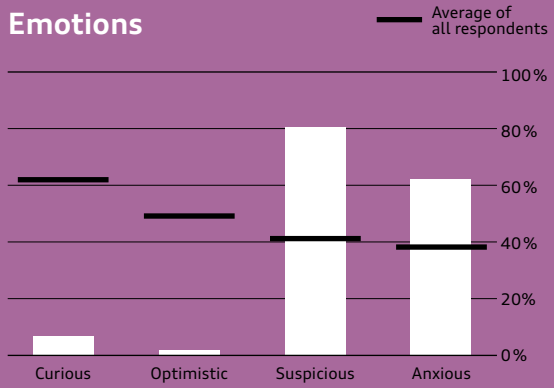
Scenarios for use



Knowledge & interest

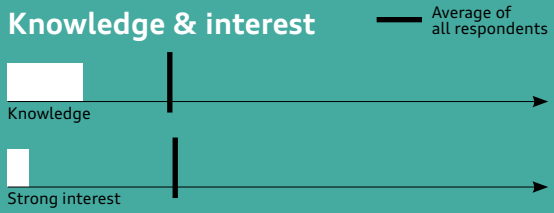


Emotions



Scenarios for use

Knowledge & interest



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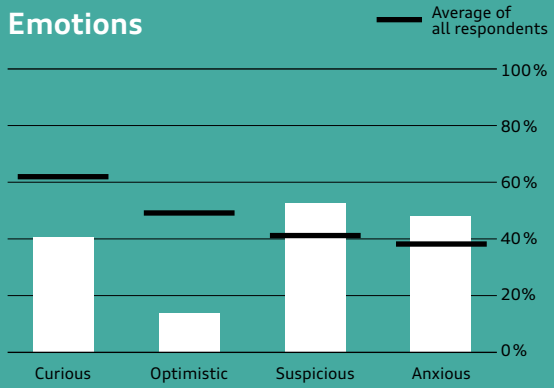


The safety-orientated reluctant

Safety-oriented reluctants tend to be reserved about autonomous driving. They have low interest in autonomous driving and do not know much about it. Nevertheless, they do have some curiosity: for example, safety-oriented reluctants can imagine the autonomous car taking control in congestion on a highway, so long as they can intervene at any time – or when parking. This makes it clear that safety is the key point for them, and they are less in search of adventure. This type, at 24 percent of respondents, is the second-largest group in the typology. The safety-oriented reluctant is found most often in Japan (31 percent), France (30 percent) and the United Kingdom (28 percent). Their human readiness index is –2.8.

»Autonomous cars should first be tested for years before they are approved.«

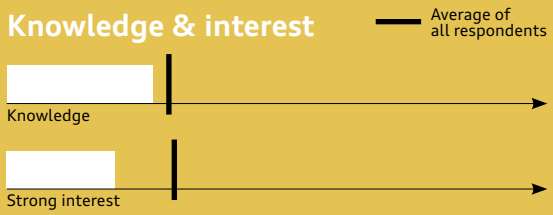
The open-minded co-pilot

Open-minded co-pilots basically regard autonomous driving in a positive light. However, they do not see things in black and white. They expect greater safety and more convenience from autonomously driving cars, but wish to be able to intervene at all times. Most of all, they would like to have their own car for autonomous driving. Here it is important to them that self-driving cars have previously been tested in real situations on public roads, ideally in a variety of different weather and road conditions. 30 percent of respondents are in the open-minded co-pilot category, making this the largest user group, especially well represented in South Korea (37 percent), Japan (35 percent), Italy (33 percent) and Spain (32 percent). The human readiness index of the open-minded co-pilot is +1.3.

»Although the technology is still being developed, I would like to try out self-driving cars. Nevertheless, I definitely want to be able to intervene at all times.«

Scenarios for use

Knowledge & interest



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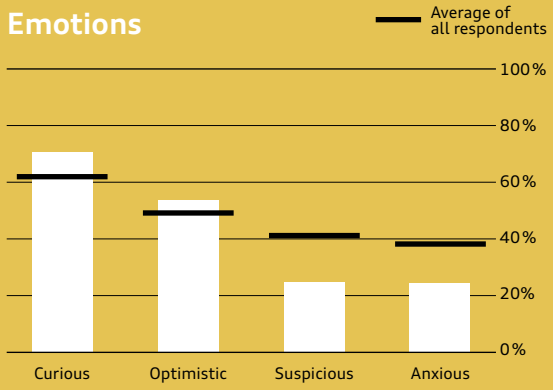
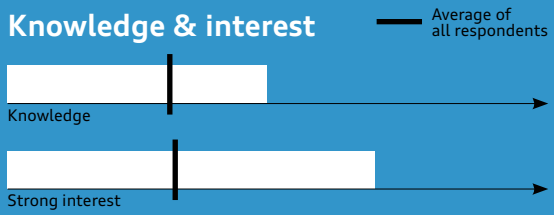


Scenarios for use

Knowledge & interest



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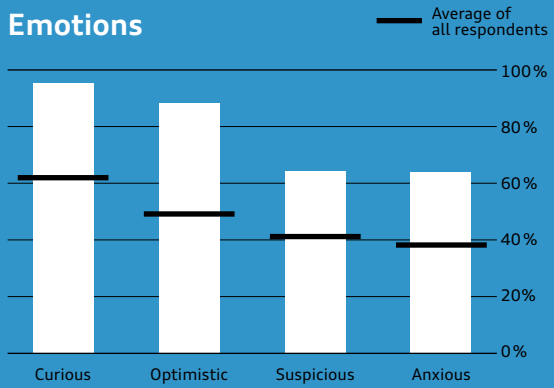


The status-oriented trendsetter

Life can always get even better: in search of excitement and adventure, new technologies are just the thing for trendsetters. They are correspondingly open to the idea of trying out autonomous driving. More than others, status-oriented trendsetters believe that it will improve their image. Nevertheless, they take a thoughtful look at the technology: they regard safety aspects more critically than many others. They would also like to find out more about the systems and the algorithms behind them. Ultimately, the trendsetter is convinced that the technology will win out if reputable manufacturers take care of developing it. In total 16 percent of respondents are status-oriented trendsetters. This type of person is found most frequently in South Korea (28 percent) and the USA (22 percent). The human readiness index of the status-oriented trendsetter is +3.3.

»I have great curiosity about the new technology, especially when vehicles have higher levels of automation.«

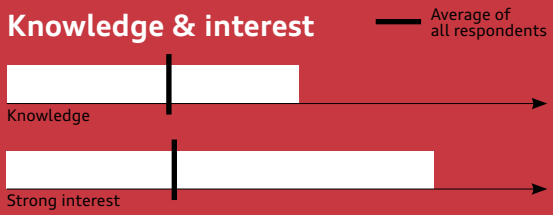
The tech-savvy passenger

Tech-savvy passengers would ideally like to get aboard self-driving cars today. For them it is only a question of time before autonomous driving becomes reality. Openness and flexibility play a key role in their lives. They are the only user type for whom the loss of control is not the principal concern. Their reservations are more about issues such as the lack of a legal framework. As technology fans they are not afraid of being merely a passenger. They believe in positive effects such as easier access to mobility, greater convenience and above all greater safety on the road. Tech-savvy passengers are highly aware of environmental issues, and also use bicycles and public transport systems alongside cars. In total, 16 percent of respondents are tech-savvy passengers. They are found most often in China (46 percent). The human readiness index of the tech-savvy passenger is +8.4.

»Autonomous driving is the future, which cannot arrive soon enough!«

Scenarios for use

Knowledge & interest



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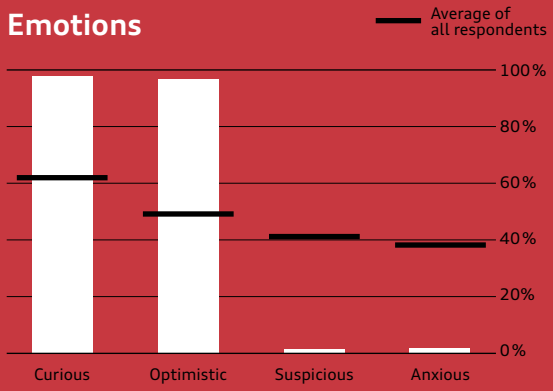

INITIATIVE *&AUDI*

Artificial intelligence will fundamentally change our lives, our mobility and our world of work. The mission of the initiative *&Audi* is to contribute to the responsible use of new technological possibilities. For this purpose, since 2015 Audi has brought together international opinion leaders and movers in the field of AI from business, science and public life. This interdisciplinary network discusses how AI can be applied for the benefit of the individual and society, thus raising awareness that our future can and should be actively shaped in the age of AI.

The initiative *&Audi* focuses on two topics in which artificial intelligence plays a key role and where Audi can contribute its expertise to the dialogue: autonomous driving and the future of the world of work.

Publisher
AUDI AG
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Press kit
www.audi-mediacenter.com/en/pulse-of-autonomous-driving

For more information, see: www.audi.com/pulse-of-autonomous-driving

Editorial office and layout
VORN Strategy Consulting, Berlin
365 Sherpas, Berlin

Illustration
Fritz Classen, Hamburg

Photo credits
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The study was conducted in cooperation with the Ipsos market research institute.

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