Cars and Contemporary Communication: How the Rise of Autonomous and Robotized Cars is Perceived and Felt in Europe

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European Perceptions of Autonomous and Robotized Cars

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This article explores users' attitudes, perceptions, views, and emotions toward car automation and robotization, two processes increasingly affecting society in different ways––namely, the rise of autonomous and robotized cars (and vehicles in general) and the increasing level of robotization of current cars. To address these questions, we investigated the feeling of trust and comfort toward driverless cars among Europeans using two Eurobarometer surveys. Making use of two representative samples of the European population, we aimed to explore citizens' attitudes and opinions about automation and digitization. The two surveys involved, respectively, 27,801 and 27,901 participants from all EU-28 countries. Furthermore, we investigated, in Northern Italy, the perception of robotization of cars and other technologies of everyday use, as well as the attitudes and opinions of children and preteens (n = 740), and adolescents (n = 801)—relevant social groups not covered in the Eurobarometer surveys.

Keywords: driverless cars, robotized cars, comfort toward driverless cars, imaginary and perception of car robotization, trust in driverless cars

Attitudes, perceptions, views, and emotions toward car automation and robotization are themes of growing interest in social science research, policy, and business reports (Abraham et al., 2016; Gleave et al., 2016; Kelley, 2016), although still underresearched. This article contributes to increasing knowledge in this area by investigating Europeans' emotions and perceptions toward autonomous vehicles as indicated in two Eurobarometer surveys and by describing the imaginary about car robotization in relevant social groups not covered in the Eurobarometer surveys (i.e., children, preteens, and adolescents in Northern Italy).

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The introduction of the Google car has attracted a lot of attention, whereas the process of the robotization of current cars, much more important in our opinion, has been largely passed over. Automation and robotization are two concepts with a clear overlap that may be erroneously considered synonymous. The Google car is a disruptive, top-down innovation that was designed from a machine perspective, whereas the robotization of current cars is a process that proceeds more in close relation with drivers' needs or desires. Furthermore, it is worth distinguishing between full automation, or "autonomation," and partial automation, or "heteromation" (Ekbia & Nardi, 2017). In the context of our study, the former concept can be traced back to the rise of fully autonomous driverless cars (and vehicles in general) such as the car developed by Google, whereas partial automation is the framework within which the robotization process of present cars takes place. The framework established by the SAE taxonomy of vehicle automation, which distinguishes between fully autonomous cars (SAE level 5) and partially autonomous cars (levels 3 and 4, in which cars can handle "all aspects of the dynamic driving task, with the expectation that the human driver will respond appropriately to a request to intervene"), in reality can be considered an example of the incremental robotization of current cars (SAE International, 2014). This process, which implies the sequential introduction of ever more sophisticated innovations and is pursued by OEMs (Original Equipment Manufacturers) like Mercedes and Ford, has been sustained by the European Commission. In its last report, "On the Road to Automated Mobility: An EU Strategy for Mobility of the Future" (2018), the European Commission abandoned the idea of autonomous vehicles and now prefers to discuss "connected and automated vehicles." This shift of terminology is indicative of the direction of the European debate.

By contrast, the achievement of a fully autonomous vehicle (SAE level 5) remains an often-declared objective, and there is much uncertainty regarding when this will be realized. Optimistic predictions depict fully autonomous vehicles available before 2020 (Javelosa, 2016), whereas other, more cautious, estimations set as realistic the target of 2030 (International Transport Forum, 2015) or even later (Litman, 2018).

Car robotization takes place within a large trend in which the entire society is invested and that includes three processes occurring in parallel. The first is the sharp increase in automation and robots in society, especially in the sphere of reproduction (Fortunati, Esposito, & Lugano, 2015). Second is the enrichment of robot types and shapes. By *robot*, today we refer not only to the classic types of robots, but also to intelligent agents or personal virtual assistants, elements of smart environments or ambient assistive living technologies, computational intelligent games/storytelling devices, embodied conversational avatars, and automatic healthcare and education services (Esposito, Fortunati, & Lugano, 2014, p. 626). Moreover, we also use *robot* to refer to new forms of robots, such as the robot-plants or drone swarms. Third is the gradual robotization of all machines, tools, and devices by embedding fundamental components of robotics, such as sensors, algorithms, and artificial intelligence and actuators (Fortunati, 2018). This is visible, among other areas, in the concurrent policy and business developments on the Internet of Things (IoT), Industry 4.0, and connected and automated driving.

In relation to driverless cars, grand narratives have inspired many fictional products. Furthermore, the driverless car is the subject of a large debate across mass media and social media. Self-driving cars, truck platooning, and various forms of connected and automated driving are widely promoted by policy reports, industry press releases, media stories, and online discussions. As such, although most people have not yet had direct experience with any type of autonomous vehicle, they are most likely to have an opinion about them. On the contrary, there is a limited awareness of and debate about robotization (Fortunati, 2018; Fortunati, Esposito, & Lugano, 2015), because this process, although no less important, attracts less attention. Indeed, aspects of robotization can be found in commercially available cars with low or no automation in driving at all. Namely, as Goggin (2012) points out,

> Computers became incorporated in cars for communication and signal processing within the vehicle's own internal systems. By the twenty-first century, these systems included hugely expanded onboard sensors, widespread use of software throughout vehicles, electronic control systems, as well as systems that gathered increasing amounts of data. (p. 311)

These systems implement what is generally classified as "driver assistance" (SAE level 1) and "partial automation" (SAE level 2), as well as the wide range of intelligent software agents and virtual assistants supporting or even replacing human decisions while driving (e.g., warnings when fatigue or drowsiness is identified, music choice, setting in-car temperature, taking/refusing a call). Consequently, the car has become an important node of the IoT: This evolution of cars goes hand in hand with their increasing robotization, given that cars have been subject to high levels of computerization and to the acquisition, as we mentioned, of fundamental components of robotics. This robotization process, often associated with interaction dynamics between the car, its driver, and passengers, at first sight may seem less disruptive than automated driving. A closer look, however, indicates that it could also play a strategic role in paving the way for automated driving and general acceptance of autonomous systems. In this sense, the use of virtual assistants like Siri, Cortana, or Alexa on mobile devices may provide useful indications about interaction expectations in autonomous cars (Fortunati, 2018).

In this article, to focus on the car as the object of our analysis, we have excluded other types of autonomous vehicles (e.g., buses, trucks, trains, metros), although they will be part of the future mobility ecosystem. Here we investigate both automation (driverless car) and robotization (car as robot); we use the term *driverless cars* to refer to cars that will achieve level 5 of vehicle automation, and we use the term *robotized cars* or *cars as robots* to refer to the incremental process of car robotization.

These developments unfold against a backdrop where cars have been a central node of social, communication, and technology developments. Today, cars have become a place of encounter and hybridization between increasingly automated mobility, media content, mediated and analog communication, and activities such as driving. In particular, the car has become a complex hub of communication flows—from the road infrastructure and signs to the car driver (e.g., traffic lights and road signs); from the car driver to pedestrians; from the car itself to the driver (e.g., satnav systems, geowebs); and from the passengers to the driver and from the driver toward them and through the car, toward other cars and the road infrastructure. On top of information exchanges supporting driving and wayfinding, in-car communication is also flowing across multiple channels: mobile phones, Internet, TV and radio, and so on (Goggin, 2012). In this context, interpersonal communication merges with mediated and media communication, as well as with car communication. Drivers assume many different communicative roles: They are conversation interlocutors, users of mobile media, and audiences. On their side, cars should be seen also as "talking technologies" (Bull, 2004).

Keeping in mind that cars have become a rich communication environment, the process of robotization poses the issue of whether people need, and can effectively manage, more technology and communication channels. The question is open given that we do not have a sufficient body of research to provide adequate answers, and our study, for various reasons, could not investigate it. But we can at least cite the survey collected by Abraham et al. (2016), in which most of the 2,954 respondents have reported being pleased with the technology available in their vehicle. The mean response for their satisfaction on an 11-point scale was 8.08, indicating that most respondents were fairly happy with the current technological integration.

Another issue is whether automation and robotization will mitigate driving and the possible negative effects of the current cognitive overload of communication and information. This will likely involve two parallel trends. Driverless cars might mitigate the overload of communication and information, although Bainbridge (1983) warns that greater automation may demand more, rather than less, attention and skills on the part of the human who remains in the loop. Robotization of current cars, instead, might worsen it. Without a doubt, the coexistence of communication complexity and driving is not yet fully understood and needs to be explored with a wave of empirical research through direct observation within cars (Haddington & Rauniomaa, 2011). Beckmann (2004) associates the extension of agency to intelligent systems with an epochal change. This shift radically affects the perspective of both drivers and passengers who, instead of having to trust other drivers, must trust autonomous driving software (Featherstone, 2004), the companies behind the software, and its regulatory framework. At a conceptual level, it is the overall notion of automobility, an important form of mobility (Featherstone, 2004), that assumes new meanings. The paradigm of connected and automated driving may be described as a "threat of Orwellian surveillance that is part of a potentially Faustian bargain for more efficiency, convenience, sustainability and security in transport" (Büscher, Coulton, Efstratiou, Gellersen, & Hemment, 2011, p.135). Paradoxically, human freedom autonomy may be limited by broader technological autonomy and control. At least, from the specific viewpoint of road safety, this shift could be regarded as beneficial, in the sense that the positive outcomes would be largely outpaced by its unintended consequences. Indeed, the only alternative to an autonomous machine designed to take over the execution of a task (e.g., driving a car) would be that the persons take care of the task themselves—when this is possible. This creates an opposition and a tension between the human being willing to remain fully in control of the situation and the machine meant to execute a task more efficiently than the person does. In this regard, it is worth recalling that, historically, automobility has been a relevant source of personal freedom (Hay & Packer, 2004; Urry, 2004).

This complex analysis needs to be integrated with an understanding of people's attitudes and opinions toward driverless cars, which comprises the argument of the next section.

Attitudes, Views, and Opinions Toward Driverless Cars

A crucial factor affecting the success of autonomous driving is represented by whether and how people will welcome autonomous cars. This is still a rather young area of research; most of the scholarly attention has been devoted to technological and economic aspects, with social ones remaining in the background. A recent review of literature on social and behavioral questions associated with autonomous vehicles (Cavoli, Phillips, Cohen, & Jones, 2017) found that 71% of the academic and "grey[1]" literature on the topic has been produced since the early 2000s, and it is largely associated with technical domains, particularly engineering (45%) and computer science (26%). In this respect, the contribution of social science literature is very limited (3%). The origin of the studies is also highly unbalanced, with countries with large ICT companies and car manufacturers producing most of the studies on self-driving cars: The top contributors are the United States (~2,750 contributions), followed by Germany (~500), China (~450), France (~400), and the United Kingdom (~350).

Promoters of the technology were perhaps too confident that a strong promotion of the envisaged benefits (e.g., safer roads, less traffic, greater time savings, cost reduction, contribution to environmental sustainability) would have been sufficient to convince people of the radical technological shift. Instead, this massive advertising contributed to creating high expectations without addressing a large variety of psychological and cultural barriers and concerns.

Attitudes, views, and opinions toward self-driving cars have not so far been systematically addressed, for a variety of reasons. For example, a survey carried out by the Pew Research Center and Smithsonian magazine in 2014 revealed that "Americans are split on the idea of riding in a driverless car: 48% say they would, while 50% say they would not" (Pew Research Center, 2014, p. 10). Another interesting study, carried out by Begg (2014) and involving 3,500 transport professionals of London, discovered that the more sophisticated the level of automation, the more skeptical these respondents are.

Although there is an increasing awareness of the importance of these issues, there is still an insufficient body of knowledge on attitudes and perceptions toward driverless cars and on the expected benefits and challenges associated with them. For instance, views and attitudes are often based on experts' opinions or collected from drivers only (Cavoli et al., 2017; König & Neumayr, 2017), thus offering only a partial and somewhat biased picture of the general views toward driverless cars. In the absence of direct experience, realistic scenarios and situations are not often presented when interviewing or surveying respondents. Additionally, such knowledge cannot be easily organized because studies often refer to self-driving cars generally, without reference to the level of automation (full or partial). This distinction has several implications that may affect, in one way or another, the results of a study. These limitations are not so easy to overcome, and for the moment, we are obliged to live with them.

The possibility of investigating public perception and views on self-driving cars based on direct experience still seems quite far away. Despite the optimistic predictions, there is high uncertainty regarding how rapidly this radical technological development will become mainstream. According to the results of an

[1] Consultancy or think tank reports.

online survey on public opinion of self-driving cars by Kyriakidis, Happee, and De Winter (2015), a large majority of the 5,000 respondents (70%) expected that the market share of these cars would not reach 50% before 2050. This estimation may not be as far from reality as it may seem; market actors still seem to focus mainly on the technological and business aspects, leaving in the background the question of whether customers really want specific features and services, and perhaps neglecting other important expectations or needs.

Although it is not possible to provide a general overview concerning views and attitudes toward self-driving cars, it is possible to highlight what we currently know concerning specific issues and situations. A possible barrier for self-driving cars concerns the act of driving, regarded as a pleasant and adventurous experience (Eyerman & Löfgren, 1995; Steg, 2005). Driving and traveling do not always follow the well-defined goal of going from A to B and with a specific purpose; rather, driving may be desired "for its own sake" (Mokhtarian & Salomon, 2001, p. 696). König and Neumayr (2017) found that people who do not own a car or who do not drive frequently were more open to and positive about self-driving cars as compared with frequent drivers. Accordingly, "people who enjoy driving are less likely to be interested in autonomous vehicles" (Cavoli et al., 2017, p. 39).

While a marked pleasure of driving may be limited to some drivers only, and certainly not in an urban context with frequent traffic jams, the issue of being in control affects a larger number of drivers. Some studies (König & Neumayr, 2017; Schoettle & Sivak, 2015) revealed that the idea of a fully autonomous car without driving controls is not appealing at all. Drawing a parallel with people not using public transport, Böhm, Jones, Land, and Paterson (2006) highlighted the difference between "moving" and "being moved," which is related to the shift of agency from human beings to intelligent systems (Beckmann, 2004). Whereas moving is an active modality characterized by being in control of the situation and making decisions, being moved is a passive modality that is likely to increase people's dependence on technology and its related service providers. Indeed, from the perspective of a fully autonomous car, there should be no difference between driving without passengers and transporting people or only goods.

Related to the issue of control is that of trust toward driverless cars. The delegation of control requires a prominent level of trust, and trust is developed over time both directly (personal experience) or indirectly (based on evidence and cases from others). In the case of driverless cars, it is trust toward software and its producers (Featherstone, 2004). At least in the beginning, it is expected that many users will be suspicious and distrust driverless cars. Even when there is an established trust toward the automotive producer, there still may be serious concerns about cybersecurity (i.e., the possibility that a malicious user will hack and control one's car or collect and steal personal data; Douma & Palodichuk, 2012). Even if that high-level trust is ensured with adequate cybersecurity measures, people may still be concerned for their personal privacy and not easily accept the "always-on" tracking of their vehicle and personal devices. Although acceptable to guarantee road safety (for example, the foreseen decrease in deaths due to traffic accidents), its general and broad application would likely be connected to the idea of a surveillance society (Büscher et al., 2011). In this respect, according to Derikx, de Reuver, and Kroesen (2016), users' privacy concerns may be counterbalanced by monetary benefits.

There is also some evidence for gender differences, with males having a more positive attitude toward self-driving cars than females (Cavoli et al., 2017; König & Neumayr, 2017; Kyriakidis et al., 2015; "Only 18 per cent of Britons," 2014; Regan et al., 2017; Schoettle & Sivak, 2014).

Generational differences have not been frequently addressed in surveys on self-driving cars. However, elderly and disabled people were judged as one of the social groups that could benefit the most from this new technology. Interestingly, respondents from this age group did not show much interest or motivation in using self-driving cars (Bansal, Kockelman, & Singh, 2016; König & Neumayr, 2017; Kyriakidis et al., 2015). Cavoli et al. (2017) traced a precise socioeconomic profile of the group most likely to be interested in autonomous vehicles: male, young, living in an urban area, and with a marked interest in technology. If these characteristics are mapped to a specific geographical area, California would be the place with the most market possibility for acceptance of autonomous driving. Regarding the variations in public perception based on geographical areas, Kyriakidis et al. (2015) also mentioned California as a likely "early adopter" area of autonomous vehicles and added that China and Germany seem to be more open to and positive toward this technology compared with, for instance, Japan. Hence, historical and cultural backgrounds seem to play a relevant role in shaping public opinion and perception toward self-driving cars.

In conclusion, from this review of the current literature, it emerges that, despite an increasing body of knowledge, we do not know much about perception, attitudes, and views toward self-driving cars. The literature that we presented demonstrates that issues such as the pleasure of driving, trust, control, privacy, and security play significant roles, and more systematic investigation is needed to derive solid conclusions. It also seems important to promote studies on specific social groups that have not been systematically targeted (e.g., children, adolescents, elderly) and to go beyond the methodological perspective of "drivers" versus "nondrivers." To the existing body of knowledge, this article aims to provide some new knowledge on perception, attitudes, and views toward self-driving cars. Let us note, however, that our study presents the same methodological limitations as the literature we reviewed so far. In particular, these studies do not present realistic scenarios and situations to respondents to somehow supply a direct experience of driverless cars. They also do not make reference to the level of automation. Despite these limitations, we are convinced that the findings we present here are interesting and relevant.

In line with these remarks, in the next section, we illustrate the aims, samples, and methods applied in our investigation of perception and emotions toward autonomous vehicles that emerged in two European Eurobarometer surveys and in the exploration of perception, attitudes, and imaginary about car robotization in two Italian surveys targeting children, preteens, and adolescents. Then we move on to illustrate and briefly discuss the key findings, and we finish with some concluding remarks.

Aim, Samples, and Methods

To investigate the public perception, social-emotional temperature, and imaginary in Europe about autonomous vehicles and robotization, we analyzed two Eurobarometer surveys: the "Special Eurobarometer 427 Autonomous Systems" (Eurobarometer, 2015) and the "Special Eurobarometer 460: Attitudes Toward the Impact of Digitalization and Automation on Daily Life" (Eurobarometer, 2017). These two surveys made use of a representative sample of the European population to investigate citizens' attitudes and opinions about automation and digitization (Abraham et al., 2016; Gleave et al., 2016; Kelley, 2016). The first involved 27,801 respondents—12,517 males (45%) and 15,284 females (55%)—interviewed face-to-face and in their mother tongue. The second involved 27,901 respondents: 13,456 males (48.2%) and 14,445 females (51.8%). Overall, all EU-28[2] countries participated in these two surveys.

The second survey has been replicated with a different sample. The questionnaires, although different, repeated some questions. Thus, the present study is based on repeated cross-national surveys. In the analysis, we use weighted data to correct some distortions of the internal structure of the sample. The profile of respondents of the two surveys has been illustrated very briefly earlier for the sake of space. It is worth noticing that, although microdata were released for the first survey, only the official report is available for the second. This obliged us to focus mainly on the first survey, in which, by means of two linear regression analyses, we explored socio-demographic variables, attitudes, and behaviors that influenced the feeling of comfort in the transportation of humans and goods in a driverless car. In particular, we focused on the following questions:

> Here are two situations related to autonomous or driverless cars on public roads:
>
> 1. Travel yourself in an autonomous or driverless car;
>
> 2. Transport goods in an autonomous or driverless commercial vehicle or lorry.
>
> For each, please tell me, using a scale from 1 to 10, how you would personally feel about it. On this scale, "1" means that you would feel "*totally uncomfortable*" and "10" means that you would feel "*totally comfortable*" with this situation.

The variables considered are gender, age (exact), education (low, medium, high, and still studying), size of the location of residence (small, medium, and large), attitude toward robots measured on a 4-point Likert scale, and use of robots at home and/or at work and/or elsewhere (with yes/no as response category). Other analyses reported here are based on descriptive statistics and illustrate the variation in the feeling of comfort toward driverless cars to transport human beings in the period from 2014 and 2017. The Eurobarometer surveys represent the scaffold of the data concerning social feelings toward autonomous cars in Europe and are treated as longitudinal studies in this concern. It is well known, however, that these surveys typically include respondents 15 years old and older. The qualitative and quantitative exploration of children, preteens, and adolescents, who will most likely be driving the evolution of these technologies, is not addressed. To fill in this gap, we conducted two surveys on the perception of robotization of cars and other smart devices of everyday use with a convenience sample of young people from Northeast Italy (children and preteens for the first survey, and adolescents and young adults for the second). These samples, although not statistically representative of the Italian population of children and adolescents, have been designed carefully for reflecting quite well the characteristics of northeastern Italian children and adolescents.

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[2] The data collection took place before the "Brexit" referendum of June 23, 2016.

Both surveys investigated the perception of the car as a robot and, in general, of automation processes of current technologies (all measured on a 4-point Likert scale). In addition, the first survey explored children's and preteens' imaginary (with free response), and the second investigated confidence in driverless cars (measured on a 5-point Likert scale), emotions toward robots, such as wonder, fear, and interest (with a dichotomous response yes/no), and the desire to have a robot at home (measured on a 4-point scale, where 0 = *not at all*, 1 = *a little*, 2 = *enough*, and 3 = *for sure*).

In the first survey, 704 questionnaires were collected in primary and secondary schools of Udine and Pordenone, two cities in the Friuli Venezia-Giulia region. This sample comprised 376 (53.4%) males and 328 (46.6%) females and consisted of 334 elementary school children and 370 secondary school preteens. The age range was 9–15 years, and the average age was 11.16 (*SD* 1.408). In Pordenone, two of four Comprehensive Institutes[3]—the "Central" Comprehensive Institute and the "Torre" Comprehensive Institute—were randomly selected. In the first Institute, all the primary schools were selected: Gabelli, Collodi, IV Novembre, and its secondary school, Centro Storico. In the second Institute, two primary schools were selected: Odorico da Pordenone and Narvesa, and one lower secondary school, Lozer. A simple questionnaire (organized in different sections) was distributed to the children. The questionnaire included a few personal data questions (name, class, age, gender, and place of residence) and questions about prior information on robots. We asked, "Do you know what a robot is?" and "Do you know cartoons or other TV programs or movies with robots?" This section was followed by a series of questions, the results of which have already been published (Fortunati, Esposito, Sarrica, & Ferrin, 2015). This study had taken the social representations theory (Moscovici, 1981) as the theoretical framework of reference. Because social representations are situated forms of knowledge, we did not look at social groups in general; we investigated the specific economic, social, and cultural environment of these two cities in Friuli, characterized by advanced levels of industrialization and a peculiar presence of the maker movement, fab labs, and Maker Faire. Our expectations were that this specific environment could express a particular sensitivity toward the topic of car robotization. The gathered data were analyzed by means of *t* tests for independent samples, univariate analysis of variance (ANOVA), and content analysis.

In the second survey, 801 questionnaires were collected in different high schools in Veneto, a neighboring region. The sample was composed of 392 males (48.9%) and 409 females (51.1%). The respondents, the majority of whom were adolescents, were between 13 and 25 years old (the average age was 16.42, *SD* = 1.674). We have recoded the age in three groups: 13–15, 16–17, and 18–25. The place of residence also has been recoded in three groups: below 5,000 inhabitants; from 5,000 to 50,000; and 50,000 and above. The eight typologies of high schools[4] have been recoded in three groups: scientific lyceums, humanistic lyceums, and technical institutes.

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[3] The Comprehensive Institutes are the territorial organizational structures of the Italian school system, which include kindergarten, primary, and lower secondary school.

[4] A scientific lyceum; a scientific lyceum with a specialization in applied sciences; a language high school; a human science lyceum; a human science lyceum with a specialization in socioeconomic sciences; a technical institute in audiovisual technologies; technical institute in mechanics; a technical institute for means of transport maintenance and technical institute in buildings, environment, and territory.

This study adopts the educational robotics and the theory of the artificial worlds of learning (Papert, 1993) as the main framework of reference. The data were analyzed by means of *t* tests for independent samples, univariate ANOVA, contingency tables and χ^2 test, and Pearson correlation coefficient.

Results

The two Special Eurobarometer surveys taken into account represent the scaffold of any European data on autonomous systems (Eurobarometer, 2015) and on attitudes toward the impact of digitalization and automation on daily life (Eurobarometer, 2017). As previously mentioned, we focus on the first survey because it is the only one for which the microdata were released. This survey has the merit of investigating autonomous vehicles with respect to transportation of both passengers and goods: In this respect, 35% of Europeans stated that they would feel totally or fairly comfortable traveling in driverless cars. By disaggregating the data by country, the situation that emerged in 2014 was quite varied: The percentage of respondents who would feel comfortable traveling in driverless car ranged from 35% in Poland (highest percentage) to 12% in Cyprus and Greece (lowest percentage). Two regressions were run to understand the main predictors of feeling comfortable traveling or transporting goods in a driverless car (Table 1).

Table 1. OLS Regression Analysis (Beta Coefficients) Related to the 2014 Survey.

	Feeling comfortable traveling in a driverless car		Feeling comfortable with goods being transported in a driverless car	
	β	*p* <	β	*p* <
Age	−.078	.0001	−.053	.0001
Gender[a]	−.109	.0001	−.106	.0001
Education[b]				
Low	−.085	.0001	−.122	.0001
Medium	−.049	.0001	−.069	.0001
High	.039	.0001	.015	.0001
Community[c]				
Large	.015	.0001	.027	.0001
Medium	−.012	.0001	−.020	.0001
Attitude toward robots	.278	.0001	.302	.0001
Use of robots[d]	.028	.0001	.014	.0001
Constant	1.817	.0001	2.005	.0001
R^2 (adjusted)	.149		.164	

[a] Gender: 0 = *male*; 1 = *female*.
[b] Reference group: still studying.
[c] Reference group: small community.
[d] Use of robots: 0 = *no*; 1 = *yes*.
$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Interpreting the results of the first regression analysis, it turns out that Europeans feel less comfortable traveling in a driverless car as age increases: The most uncomfortable are older people—those who, according to the literature review, could in principle benefit more from driverless cars. These communities in fact are often used to promote the benefits of technology, but they are not consulted, and, in the end, the benefits do not usually reach them. For example, who will assist them in getting in/out of the vehicles if they have physical impairments? In line with the review is also the finding that women feel less comfortable than men traveling in a driverless car. Regarding education, those with a low or medium level of education feel less comfortable than those who are still studying and those with a high level of education. As for feeling of safety in a driverless car, results show that those who live in a large community feel safer than those who live in a medium or small community. The semantic closeness of robots and driverless cars emerges from respondents' attitude toward robots: The higher the positive attitude, the more respondents feel at ease traveling in a driverless car. Additionally, respondents who already use a robot at home, at work, and/or elsewhere feel more comfortable than those who do not.

The second regression analysis generally shows that all the social groups expressed the same feelings about transportation of goods as they did about passenger transportation in a driverless car. A further result is that there is a net distinction in the comfort declared by respondents between transporting goods in autonomous vehicles and transporting people. In fact, 42% of respondents answered that they would be totally or fairly comfortable with goods being transported in an autonomous or driverless commercial vehicle or lorry. This is higher than the percentage that emerged regarding passenger transportation (35%).

The 2017 Eurobarometer study (Eurobarometer, 2017) shows that Europeans' confidence in driverless cars has increased 4 percentage points, from 35% to 39% (Table 2).

Table 2. Comparison Between Europeans' Feelings Toward Driverless Cars in 2014 and 2017.

	2014 (Base = 27,801), %	2017 (Base = 27,901), %
Feeling totally or fairly comfortable traveling in a driverless vehicle (scores 5–10)	35	39
Gender		
Men	27	28
Women	16	17
Age		
15–24	27	29
25–39	25	28
40–54	22	25
55+	16	15
Education		
15 years	11	11
16–19 years	20	20
20+ years	28	29
Still studying	28	32

Socio-professional categories		
Self-employed	27	31
Managers	31	31
Other white-collar workers	25	27
Manual workers	20	21
Stay-at-home moms or dads	15	16
Unemployed	20	21
Retired	15	14
Students	28	32

Source: Eurobarometer surveys 427 (Eurobarometer, 2015) and 460 (Eurobarometer, 2017).

As previously mentioned, because the microdata of the 2017 survey have not yet been released, we can only refer to the data illustrated in the published report. Unfortunately, the comparison between the data of 2014 and 2017 regarding transportation of goods in autonomous vehicles is not possible because this question was not asked in the 2017 survey.

The Survey on Children in Northeast Italy

This survey was administered to 704 children in elementary and secondary school (mean value for age was 11.16, *SD* = 1.408). The aim was to explore children's knowledge and imaginary about robots and their awareness of current robotization technology, including cars (Fortunati, Esposito, Sarrica, & Ferrin, 2015). On the one hand, we avoided proposing an objective definition of robots, and we simply asked them if they knew what a robot was. Among the 704 children and preteens interviewed, 98.2% provided an affirmative answer. On the other, we elicited children's and preteens' imaginary about robots, asking them, "Do you know cartoons or other TV programs or movies with robots? If yes, please list them." Among the interviewed children, 65.6% reported knowing the names of some visual products with robots. Overall, we collected 1,243 names of cartoons, movies, and TV programs with robots (the question could include multiple open answers), and children overall named 125 unique visual products with robots (Fortunati, Esposito, Sarrica, & Ferrin, 2015). The most named visual products, together with their naming frequency, media genre, and the country of production, are reported in Table 3.

These data show that these children and preteens cite visual products with robots (movies, TV series, cartoons) that come from mass media. In these products, the mythical features of robots have given way to the mystification power of mass culture (Fortunati, 1995). With the exception of *The Fairly OddParents* and *Power Rangers*, in which magic plays a central role, in all the remaining most-cited visual products, robots are the result of technological efforts, either terrestrial or alien.

Table 3. The Most Named Visual Products With Robots.

	Absolute Number (%)	Media Genre	Country
Transformers	156 (18.7)	Cinema	USA
Futurama	122 (14.6)	TV-Animation	USA
Iron Man	110 (13.1)	Cinema	USA
Star Wars	108 (12.9)	Cinema	USA
Wall·E	91 (10.9)	Cinema-Animation	USA
I, Robot	90 (10.8)	Cinema	USA
The Terminator	55 (6.6)	Cinema	USA
Dragon Ball	34 (4.1)	TV-Animation	JP
Power Rangers	25 (3.0)	TV-Series	USA
UFO Robot	24 (2.9)	TV-Animation	JP
The Fairly OddParents	21 (2.5)	TV-Animation	USA
Subtotal	836 (100.0)		

Source: Fortunati, Esposito, Sarrica, & Ferrin (2015).

Then, we also proposed to pupils a list of technologies (including the car) used in everyday life, and we asked them to answer to the question, "Are they a robot?" Mean values derived from the scores given to the set of statements on a 4-point Likert scale are illustrated in Table 4. Standard deviations are reported in parentheses. As Table 4 clearly shows, the car as robot has obtained the third to last place in this rank.

Table 4. Are They Robots? (Base = 704 pupils).

Machine	Mean (*SD*)
A computer is a robot	2.88 (1.11)
A PS3/Xbox is a robot	2.63 (1.09)
A vacuum cleaner is a robot	2.61 (1.07)
A vending machine is a robot	2.57 (1.04)
A robot-shaped toy is a robot	2.55 (1.22)
A food processor (chopper, blender, grinder) is a robot	2.41 (1.11)
A mobile phone is a robot	2.40 (1.10)
A validation machine on a bus is a robot	2.35 (1.14)
A car is a robot	2.32 (1.09)
An airplane is a robot	2.16 (1.10)
An oven is a robot	2.15 (1.07)

Note. Scale from 1 to 4: 1 = *not at all*; 2 = *a little*; 3 = *enough*; 4 = *for sure*.

The statement about the car as a robot obtained an average of 2.32, which corresponds to an evaluation between a little and enough, which does not speak in favor of a great awareness of the robotization process concerning the car. A *t* test was applied to the scores attributed to this statement by the elementary school children (M = 2.23) and by the secondary school preteens (M = 2.40) and highlighted that the scores of the preteens were significantly higher than those of the children ($t = -1.989$, $df = 685$, $p < .05$). The same happens for the global environment in which children and preteens live: According to the *t* test, the mean values attributed by the respondents in Udine were significantly lower than those attributed in Pordenone (M = 2.00 vs. M = 2.37; $t = -3.106$, $df = 685$, $p < .01$). We recall that in Pordenone, there is a more intense concentration of advanced industries, as well as robotics, domestic appliances, furniture, and so on, than in Udine.

The Survey on Adolescents in the Northeast of Italy

The last study was carried out among adolescents, again in the northeast of Italy. The same question that was used with children and preteens—"Are they a robot?"—was presented to 801 high school students in 2017. We only added the washing machine to the list of the technologies proposed. The results are reported in Table 5.

Table 5. Are They Robots? (Base = 801 high school students).

Machine	Mean (*SD*)
A computer is a robot	3.02 (.98)
A mobile phone is a robot	2.73 (1.03)
A vending machine is a robot	2.58 (.99)
A PS3/Xbox is a robot	2.57 (1.01)
A vacuum cleaner is a robot	2.49 (1.00)
A washing machine is a robot	2.43 (.98)
A food processor (chopper, blender, grinder) is a robot	2.49 (1.06)
A validation machine in a bus is a robot	2.31 (1.00)
A robot-shaped toy is a robot	2.28 (1.11)
A car is a robot	2.24 (1.02)
An airplane is a robot	2.13 (1.00)
An oven is a robot	2.00 (.93)

Note. Mean values derived from the scores given to this set of statements on a 4-point Likert scale: 1 = *not at all*; 2 = *a little*; 3 = *enough*; 4 = *for sure*.

The general evaluation of the robotization of current technologies by these adolescents is between *a little* and *enough*. In particular, the technologies perceived as more robotized are the computer and the mobile phone. These are probably at the top of students' lists as strong candidates for the robot status thanks to the presence of robotic agents inside them, such as Siri and Cortana. "A car is a robot" has remediated, even in high schools, at third to last place. When comparing adolescents' scores with those expressed by children and preteens, it emerges that the evaluation of the robot-ness of many of these machines is higher among children. This result probably can be explained in terms of animism, which is children's propensity to confer more autonomy/agency on inanimate things.

We ran a series of analyses to explore more deeply the evaluation of this statement. The *t* test for independent samples shows no significant gender differences. The application of the univariate ANOVA to the variables age, typology of high school, and place of residence also show no differences.

As for the previous research in elementary and secondary schools, we divided the respondents into two groups: those who gave low scores (1–2) for the statement "A car is a robot" and those who gave high scores (3–4) for this statement. Our purpose was to investigate if the awareness of the car robotization process was associated with the direct use of robots and with the emotions toward robots. The use of robots by adolescents turned out to be quite widespread at home (56.7%) and/or at school (43.2%), and the most relevant emotions toward these were curiosity (79.4%), interest (67.4%), wonder (30.8%), fun (26.6%), fear (21.5%), and joy (6.5%). The direct use of robots at home and/or at school by students was shown to be positively associated with a sensitivity toward the robotization of cars. This means that, among the adolescents who attributed a higher score to the statement "A car is a robot," 70.2% responded that they use a robot at home ($\chi^2 = 36.086$, $df = 1$, $p < .0001$) and 58.6% at school ($\chi^2 = 46.936$, $df = 1$, $p < .0001$). Even the emotional reaction toward robots is somehow relevant. Among the adolescents who attributed a higher score to the statement "A car is a robot," 83.4% declared that robots inspire in them curiosity ($\chi^2 = 4.845$, $df = 1$, $p < .05$) and 68.9% not fun ($\chi^2 = 5.105$, $df = 1$, $p < .05$).

A specific question about the feeling of confidence in the driverless car was introduced in the questionnaire administered to adolescents. The question was, "Would you trust getting in a car that drives itself?" (with a Likert scale from 1 to 5). The average of scores is barely positive: 2.54 ($SD = 1.35$). The independent-samples *t* test tells us that males are slightly more confident than females ($M = 2.81$ vs. $M = 2.34$; $t = 4.314$, $df = 626$, $p < .0001$). The age (recoded in three groups: 13–15, 16–17, and 18–25 years old) is unrelated to the answers to this question. The univariate ANOVA applied to the typology of schools recoded in three categories (scientific lyceums, classical lyceums, and technical institutes) shows that the typology of high school is significant ($F = 10.461$, $df = 2{,}625$, $p < .001$). The post hoc test Student–Newman–Keuls highlights that students who are enrolled in scientific lyceums attributed the highest scores ($M = 2.88$), showing that they are less wary toward driverless cars. It is worth noting that overall, technical institutes attributed the lowest scores to this statement ($M = 2.15$). The interpretation of this result is not univocal; for example, this may show that whenever technical knowledge is not accompanied by critical analysis, the awareness of the important processes of automation and robotization occurring in society and the trust toward a self-driving car remain low. Or, it may instead show that students from technical lyceums may be appropriately more cautious because they know more about the technologies. The students in scientific lyceums then might be judged as overtrusting, knowing about the concepts but unable to assess the technical implementation challenges.

Finally, confidence in the driverless car is significantly related to emotions toward robots (Table 6) and the intensity of the desire to have one's own robot.

Table 6. Emotions by Trust in Driverless Cars (N = 628).

Emotion	Absolute Number (%)	Average Score	*t*	*p* <
Fear			−5.490	.0001
Yes	138 (22.0)	2.06		
No	490 (78.0)	2.70		
Wonder			6.357	.0001
Yes	194 (30.9)	3.04		
No	434 (69.1)	2.32		
Interest			6.366	.0001
Yes	420 (66.9)	2.78		
No	208 (33.1)	2.07		
Curiosity			3.551	.0001
Yes	497 (79.1)	2.64		
No	131 (20.9)	2.18		
Joy			4.574	.0001
Yes	38 (6.1)	3.50		
No	590 (93.9)	2.48		
Fun			4.539	.0001
Yes	160 (25.5)	2.96		
No	468 (74.5)	2.40		

Note. This table summarizes six *yes/no* tables. The percentages are calculated by column.

The *t* test shows that those who declare that robots do not inspire fear in them are less diffident toward driverless cars. Also, those who declare that robots inspire in them wonder, interest, joy, and fun are more confident in driverless cars.

However, the scores of the perception related to the item "The car is a robot" and confidence in driverless cars are not correlated (r = .06, *ns*). By contrast, the application of the Pearson correlation coefficient shows that confidence in the driverless car is significantly correlated with the intensity of the desire to have one's own robot (r = .42, p < .0001). All in all, the emotional impact of robotics emerges as a quite strong factor in determining the feeling toward driverless cars.

Final Remarks

This study has several limitations. First, the results of the two Eurobarometer surveys were not completely comparable because Eurobarometer had not yet published the microdata of the second survey when we carried out this study. Second, the research on children and preteens, and the other on adolescents, presents both convenience samples whereby their results are not generalizable. Third, all the measures presented and discussed here are self-reported measures and thus may be affected by interpretative biases related to the presentation of the self and to social desirability, a limit that characterizes almost all the surveys. Fourth, when we interviewed or surveyed respondents in the schools, it was not possible to present realistic scenarios and situations on car robotization in order to support their answer with adequate information.

Future research should continue monitoring people's attitudes, especially those of the young generations, toward both driverless cars and the robotization of current cars. Particularly urgent is work to further investigate the car as a complex hub of activities, such as driving and communication. As a key node of the IoT, will autonomous driving and other technological developments contribute to ease human cognitive overload, or add new and currently underestimated cognitive complexities?

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