# Who Trusts Automated Vehicles? Investigating Tensions in Automated Driving Imaginaries.

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**Abstract.** The ongoing automatization of driving tasks is accompanied by manifold imaginations of future mobilities and corresponding expectations and concerns, that shape acceptance and foster (or hinder) trust. Although road registration of automated vehicles has repeatedly been postponed into undefined futures, the formation of trust, we argue, is already being shaped by anticipating their prospective affordances, which are based upon discourses around automatization in general as well as societal problems and possibilities associated with and arising from automated driving technologies. Our research points out that expected benefits of automated driving systems (ADS) are distributed unequally within societal groups, reinforcing notions of digital inequalities. As a key explaining factor, we discuss the role of *technology affinity* for the future adoption of new technologies and reveal the prevalent “tensions” of anticipated imaginaries that drive today’s expectations towards ADS: A notion of an algorithmically established “posthuman security” that guarantees safety by eradicating human error and the simultaneous perception of automations “overstepping” their legitimate algorithmic autonomy at the expense of human agency.

## 1 Introduction

The persistent debate around automated driving systems (ADS) within scientific and public discussions revolves around numerous discursive narratives: the (im)possibilities of implementing "autonomous" vehicles, the polarized debate around safety benefits and the simultaneous emergence of new risks under algorithmic control, the promise of ecological alternatives to contemporary transportation systems, the redundancy and obliteration of human supervision and autonomy, the ultimate eradication of an already contested privacy (Kaur and Rampersad, 2018), and the further deepening of digital divides (Fussey and Roth, 2020). Without going into detail about the actual implementation of this technology and its surrounding “politics of buzzwords” (Bensaude-Vincent, 2014), our contribution asks how people's trust in future technical innovations already manifests itself in the present, what is structuring the assessment of trustworthiness and therefore “who trusts automated vehicles?”

## 1.1 Automated Driving

ADS bear the promise of making driving and road traffic safer, more efficient and ecological; increase productivity by allowing work to be done whilst commuting, attending virtual meetings or simply relaxing on long drives; make mobility more inclusive for marginalized groups (esp. elderly drivers and people with disabilities) and make private car ownership obsolete by providing “mobility as a service” – in short – revolutionize current forms of mobility and shift contemporary paradigms of transportation towards the “road to *autopia*” (Hancock, 2019, p. 3). These seemingly utopian visions, carefully crafted by the automotive industry to expand their business models into new (datafied) realms and promising billions in revenue (McKinsey, 2023), are being partially shared by the European Union and other governmental bodies that identify the potential of additional safety effects delivered by automation to contribute towards the “vision zero” of a near casualty-free road traffic by 2050 (European Commission, 2023). However, as recent years have presented several milestones in automating isolated driving tasks, media attention, triggered by the perceived dangers arising and the emergence of unwanted consequences thwarting the rather positive expectations, was often focused on the negative side effects. Erring systems leading to wrong or even fatal decisions while drivers are degraded to helpless “users” deprived of agency and unable to intervene, excessive surveillance and an erosion of privacy due to the constant need for precise sensor data analysis, as well as cybersecurity threats caused by novel attack vectors resulting from networking with other road users and infrastructure. As a key feature that sets it apart from other trends in automation, the extent of safety risks posed by vehicles with ADS in mundane interactions with everyday road-traffic and the public sphere in general that are hardly to be avoided is particularly striking and gives rise to reservations. As a reaction, the question of the "trustworthiness" of ADS and thus how people not only accept new and potentially harmful technologies, but indeed trust them, arose within wider academic and industrial communities.

## 1.2 Trust in automated vehicles

Despite technical hurdles, legislative setbacks, and a lack of approvals for road traffic still hindering the deployment of ADS, media attention and academic interest have already sparked extensive questions around how users experience trust towards the automation of driving tasks and how their acceptance is publicly negotiated. While in an everyday understanding, these terms often appear to be interchangeable, we want to highlight their conceptual difference: acceptance can be habitual, a learned and nonreflexive experience resulting from everyday encounters, mediated through societal norms and/or power relations and may result merely from the lack of a better option, even when trust is absent.

Considering the conceptual components of trust (Zenkl and Griesbacher, 2020), we can conclude that trust, as a mutual faithfulness on which all social systems ultimately depend upon (Lewis and Weigert, 1985), that shapes expectations and hence serves as a function of complexity reduction (Luhmann, 2017), should not only be considered a central concept for interaction between humans, but also as an important mediator of relations with non-human entities. Furthermore, “trust must be conceived as a property of *collective units* [...], not of isolated individuals” (Lewis and Weigert, 1985, p. 978) and should therefore be conceptionally expanded from narrow theoretical (e.g. psychological) limits. Just as societies are built on trust, trust in technology is socially mediated and embedded in complex socio-technical settings at the intersection of human and non-human activities. As a defining feature of all interactions and a result of inherent situational uncertainty, trust, in our understanding, is an integral part of the facilitation of technology that becomes especially relevant when interacting with non-deterministic technologies based on algorithmic decision making. Acting with relative “autonomy”, endowed with the capacity for “reactivity”, oriented towards activities ("pro-activeness") and with reference to other agents ("sociability"), modern automated systems remain algorithmic in the sense that they don’t qualify as moral actors (Rammert, 2003), but open up increasing degrees of freedom for their outputs, which alter the quality of the associations people have with them. As a “growing source of and factor in social order, in a shared social reality […] which is increasingly being co-constructed by automated algorithmic selection” (Just and Latzer, 2017, p. 254) on the internet and beyond, algorithmic actors are steadily approaching phenomenological parity with human actors and therefore must be analytically taken into account by attributing qualities formerly reserved for human relationships to those with algorithmic actors.

Trust, as a property of relations and facilitator of interactions that mediates (uncertain and potentially harmful) interactions between human, artificial and/or hybrid agents and changes the way in which these actions occur (Taddeo, 2017), is not static, but requires constant adjustment and *calibration*, as inappropriate trust (“over-trust“) can lead to a system’s misuse or abuse, and too little trust (”under-trust“) to its rejection, i.e. non-use (Lee and See, 2004). It should therefore be clear that the ongoing automatization of driving tasks, an undertaking which is associated above all with the risks involved, must necessarily be based on trust to be steadily adopted; as Hancock (2019, p. 10) concludes: the “primary penetration rate of automated vehicles into near-term markets will be directly contingent on, and dominantly controlled by perceived trust”. However, both automatization and the calibration of trust towards it must be understood as processual. While questions surrounding trust in ADS often focus on sudden *trolley problems* of anticipated “autonomous” vehicles, the gradual nature of the automatization of driving functions is often neglected. Crucial for ADS classification but rarely considered in both public discourse and marketing communication, is the level of automation defined

by SAE (Society of Automotive Engineers), ranging from level 0 (no driving automation) to 5 (full driving automation) and representing a range of possible steps in between, each describing the functions and corresponding roles and responsibilities of users (SAE International, 2021). While under current legislation, vehicles implementing functions with SAE Level 3[75] might apply for road registration in certain countries, labels for automation services such as “full-self driving” or “autopilot” have been criticised for suggesting more capabilities than they are able to provide and inspiring a false sense of confidence (“over-trust”) among users.

Since these assessments of trustworthiness are, in the case of dynamic algorithmic technologies, directed towards systems that, due to their complexity and/or (intended) opacity, often cannot be fully understood by users, their encounters are being structured by “imaginaries” (Bucher, 2017) that mediate their affordances (Davis, 2020) as an epistemic rational for the explanation of what they enable and constrain. However, trustworthiness is being shaped already prior to a technology’s existence and real-life encounters, a process leading to “dispositional trust” (Hoff and Bashir, 2015), that subsequently shapes and steers it’s future “domestication” (Hirsch and Silverstone, 2003), i.e. its embedding and use in practice. During this “imagination phase”, characterised by the absence of practical knowledge and experience, people rely on public discourses between advertisement, media, as well as cultural and societal ideals to construct and assign meaning to a technology and mark it’s “boundary between fantasy and reality” (Silverstone, 1994, pp. 125–126). In this process, actors anticipate affordances in the sense that they speculate on what possibilities for action an artefact might offer to them in the future. Opinions derived from these considerations then “bracket these speculations as analytically distinct from explorations of actual affordances” (Johannessen, 2023, p. 4) in order to draw conclusions about a technology’s desirability – regardless of its actual performance or possibilities. To understand how future innovations are already being discursively shaped in the present and to conclude our theoretical framework, we argue that trust is a necessary property of relating to and acting with technologies that forms from users’ assessments of trustworthiness. Since currently only limited experiences with ADS are available, and, due to the uncertainty of development paths, no objective evaluation of emerging risks and opportunities is possible, we can instead focus on imaginaries that mediate the assessment of trustworthiness to understand how (un)trustful relationships are being structured already today. These imaginaries, consisting of anticipations of how ADS are expected to function and associations with emerging societal problems and opportunities

[75] SAE Level 3 describes a conditional automation in which an ADS controls all aspects of a current driving task while human drivers are expected to intervene when requested by the automation (SAE International, 2021).

associated with them, can be operationalized as expectations and concerns of their anticipated affordances.

### 1.3 Public Opinions & Vulnerable Road Users

As a technology that has the potential to not just influence individual mobility patterns but affect road traffic for everyone participating in it and entire mobility regimes, the analytical examination of trust cannot be limited to those who anticipate actively using ADS in the future. Although the perspectives of other (vulnerable) road users have received increasing attention in recent research (Saleh, Hossny and Nahavandi, 2017; Jayaraman *et al.*, 2018, 2019), their role in the discursive negotiation of ADS and the resulting shaping of imaginaries was, and often is still, only treated peripherally in favour of drivers' perspectives. Even when pedestrians, cyclists or passengers are recognized as an important group in road traffic, their trust and acceptance is often researched as momentary interactions detached from the social and cultural influences that define, shape and lead these groups to their embodied experiences of technologies (with some exceptions, see e.g. Yerdon *et al.*, 2016; Hulse, Xie and Galea, 2018; Schmidt *et al.*, 2019; Raats, Fors and Pink, 2020).

The importance of a broader societal perspective in the formation of trust towards new technologies is especially relevant when considering its widespread and disruptive effects at all ends of the imaginative spectrum that go far beyond the immediate impacts on road traffic and its users. Transformation processes associated with ADS concern a shift in workforce (skilled instead of unskilled labour) and the disruption of labour markets (Nikitas, Vitel and Cotet, 2021), settlement patterns and urban land use (Heinrichs, 2016), car ownership structures (Mourad, Puchinger and Chu, 2019) and effects on ecosystems through emissions and pollution (Silva *et al.*, 2022).

While market research is prone to neglect people whose trust is not directly involved in the decision to use ADS, these actors can exert significant force, either in the active exercise of their democratic power thus influencing legislation or by their participation in the discursive shaping of imaginaries. This is especially relevant when considering reports around potential dangers for certain demographics, as activists demonstrated by revealing a series of tests on Tesla's "Full Self-Driving" software and showing it is seemingly unable to correctly identify children (The Dawn Project, 2022). The realisation of ADS's predicted benefits, therefore, depend on the trusting uptake of this technology, which in turn relies on the public imaginaries that form around them (Regan *et al.*, 2017).

## 1.4 Who Trusts Automated Vehicles?

As different groups of stakeholders are affected differently by the implementation of novel technologies, so their expectations and concerns differ, not only between usage scenarios, but also along demographic and cultural lines. Gender seems to be an important factor structuring expectations of ADS, with men generally being more optimistic and associating ADS with benefits more than concerns (Schoettle and Sivak, 2014; European Commission And European Parliament, 2018; Hulse, Xie and Galea, 2018; European Commission, 2020). Age is another important factor, with older people commonly anticipating fewer benefits and expressing more concerns over ADS (Nees, 2016; Deb *et al.*, 2017; Bansal and Kockelman, 2018).

Trust in ADS is stratified along sociodemographic and cultural lines and contested in polarized discourses between industry narratives and public debate. Disregarding the technological hurdles of their actual feasibility, our contribution wants to raise the question of "who trusts automated vehicles?" by quantitatively operationalizing common imaginaries of automated mobility solutions along their anticipated expectations and concerns. It is based on our assumptions that trust is a necessary precondition for the adoption of any new technology; that the negotiation of such trust is rooted in specific societal conditions and starts even before first hand experiences with concrete artifacts are available; and finally, that a broad spectrum of affected stakeholders, not just those anticipating a future uptake, must be considered when analysing the formation of (dis)trust. To be more precise, and because a comprehensive discussion of the survey material is not possible within the scope of this text[76], we address the question of the antecedents of trust by focussing on one central dimension and precondition for the formation of attitudes towards innovation: affinity for technology. As a personality trait that expresses itself in a positive attitude, enthusiasm and confidence of a person towards technology (Karrer-Gauß *et al.*, 2009), affinity for technology has been identified as a key factor for the uptake of certain technologies (e.g. Winter, Chudoba and Gutek, 1998). However, in ADS's current "imagination phase", we see anticipated imaginaries not as mere hallucinations detached from the actual development, which only collide with the "hard reality" after a technology's materialization, but as productive and influenced by an affinity for technology in the here and now. Therefore, the process of reciprocal calibration of imaginaries, affordances and materialities does not take place in a social vacuum but is based on pre-existing associations of and experiences with technologies, which are then reflected in the actor's personal affinity for them. This is where our research questions are located: under the premise that the positive reference to technological innovations in the present has an impact on the willingness to perceive

[76] See Section 2 for a detailed description of the questionnaire and argumentation for why other dimensions had to be neglected within this contribution.

them as trustworthy in the future, we ask what role an affinity for technology plays in the anticipation of ADSs trustworthiness and how imaginations are structured by it accordingly:

- What role does an affinity for technology play in structuring anticipated imaginaries and affordances of future technologies?
- Does an affinity for technology account for a consistent reference to expected improvements (and thus a homogeneous and one-sided image of automation), or are contradictory elements also integrated into these imaginaries?

## 2 Methodology

The research was conducted within the interdisciplinary project VERDI[77] (2019-2021). Initially focussed on ADS implementing SAE Lv. 3 (that at the time appeared close to being marketable), the understanding of trust as a gradual process forming along different levels of automatization outlined above lead to a widened focus and the inclusion of fully automated vehicles within the scope of the research. This was done to account for imaginaries of future developments potentially impacting and shaping perceptions of earlier stages.

Based on a support study, which provided an overview of the state of the sociological literature on automated driving and represented a summary of a total of 25 international studies of varying quality and breadth, the questions raised therein were analysed regarding partially automated driving (SAE Level 3) to develop a quantitative questionnaire. In order to further address the research gaps identified in this way (e.g. a lack of focus on partially automated driving in favour of anticipated expectations of fully automated vehicles; a neglect of the perspectives of other road users and the anticipation of further societal consequences caused by ADS), both well researched and novel dimensions were operationalized towards wide imaginations associated with automated

[77] „Vertrauenswürdigkeit und Zertifizierung in der Digitalisierung am Beispiel von Systemen zum assistierten und autonomen Fahren“, eng.: „Trustworthiness and certification in digitalisation using the example of systems for assisted and autonomous driving“. Due to the extent of the questionnaire, consisting of a total of 102 items and including other independent variables (e.g., possession of a driver's license, perceptions of road safety, experience with accidents, preferred mobility modes, “driving pleasure”) as well as proxy questions on trustworthiness (such as trust in government institutions or manufacturing companies), only selected correlations addressing the specific research questions for this contribution can be discussed here. More comprehensive evaluations, the analysis of additional significant dimensions affecting “trust” and the complete research report of the project are available at: https://www.rechtundit.at/projekte/.

driving to allow the drawing of a more comprehensive picture of the sociological criteria of the trustworthiness of (partially) automated vehicles within the framework of the empirical survey presented here.

### 2.1 Dimensions

**Demographic** variables were included as previous research consistently suggested correlations between and personal attitudes towards the automation of driving functions[78]. An assessment of participants' **driving behaviour** (Nees, 2016) aimed to record personal automotive experiences in road traffic (driving licence possession, frequency of driving), the assumption of roles other than that of "driver" (e.g. cyclist, co-pilot) and basic confidence/well-being in road traffic. Under the assumption that a generally technology-savvy positioning also has an influence on the attitude of trusting ADS, an **affinity for technology** index was used to group participants into more technology-savvy and more technology-averse persons. Topics surrounding **automated driving** (inspired by (Kyriakidis, Happee and de Winter, 2015; Bansal and Kockelman, 2018) are above all characterised by the different levels of automation. Under the assumption that many aspects associated with automated driving are often (wrongly) negotiated under the term "autonomous driving", but nevertheless have a powerful impact on the expectations and fears generally placed on automated driving functions, this section was comprised of a survey of attitudes towards the automation of driving tasks that are not specific to a certain level of automation. To deal with the specific restrictions and possibilities of the SAE Level 3, a more detailed explanation of the term was followed by questions that surveyed attitudes towards the **partial automation of driving tasks**. In this way, the characteristic role definition of the driver as a "fallback ready user" and the associated constant readiness to take over the steering wheel again when requested to do so by the vehicle was considered. Finally, and based on the assumption that attitudes towards **fully automated vehicles** already affect the negotiation of trustworthiness of lower levels of automation, a final cluster aimed at surveying expectations towards what is often called "autonomous driving" and the imaginaries that accompany it.

[78] All demographic variables were mandatory, based on self-identification within predefined categories and inspired by the Eurobarometer surveys to allow comparison (e.g. European Commission, 2020, additional/diverging categories are highlighted): age (15-24, 25-39, 40-54 and 55 or above years old), gender (female, male, *diverse/other*), education (*highest degree, 6 options*) and place of residence/city size *(< 5.000, 5001 – 10.000, 10.001 – 50.000, > 50.000 residents*).

## 2.2 Implementation

The research design was implemented as a preliminary quantitative online questionnaire study to explore the allocations and occurrences of ADS imaginaries that manifest as assemblages of expectations and concerns. Restrictions for sampling resulted from the consideration that only people who had already heard of or dealt with ADS (and therefore have developed imaginaries around them) could be considered for the research.

The dissemination of the questionnaires in the first phase (“experts”) was carried out via the monthly newsletters of two cooperation partners, “AustriaTech” and “Verkehrsclub Österreich” (VCÖ), resulting in 144 datasets after filtering. Participants from this group were assumed to show a certain knowledge of and affinity for topics around mobility and their social relevance, however, their designation as “experts” must be regarded as a rough simplification for matters of practicality.

As a control group and for comparison with these “experts”, “students” of the University of Graz were contacted via E-Mail using the university’s “student.survey” service, resulting in 115 participants after filtering. With the insight gained from other studies that education is correlated with knowledge about ADS (Acheampong and Cugurullo, 2019), this group was identified as likely to be aware of developments in driving automation but without having expert knowledge about it and hence qualified as a comparative counterpart to the “experts”. Response rates for both dissemination phases cannot be evaluated due to unclear accounts given from the research partners, yet must generally be considered quite low in view of around 700 self-reported subscribers to the mailing list from “AustriaTech”, “a few thousand” to the newsletter of VCÖ and several thousand subscribed “students”.

Due to the restrictions mentioned above, the VERDI survey does not claim to represent the Austrian population or any of its specific subpopulations, but rather serves primarily as an exploratory attempt to investigate additional dimensions affecting “trust” and to gain insights into the structure of contemporary imaginaries surrounding ADS.

# 3 Results

## 3.1 Descriptive analysis – independent variables

The restrictions in sampling manifested in the distribution of demographic variables in both chosen subpopulations, drawing a clear yet polarized picture between them: Experts were predominantly male (73.9%), had a university degree (63.9%) and were older than 55 years (59.6%) whereas students were predominantly female (60.9%), graduated from school (59.6%) or university (38.6%) and were between 15 and 24 years old (55.7%). Most participants in both groups lived in cities with more than 50,000 inhabitants (57.6% of experts, 49.1% of students). Since only 0.7% of respondents self-identified as outside or beyond a binary understanding of gender (category “divers/other”), this category was not considered in the gender-specific evaluations.

| ID | | strongly agree | agree | disagree | strongly disagree |
|---|---|---|---|---|---|
| TA1 | I love owning new technological devices. | 20,0% | 34,9% | 30,6% | 14,5% |
| TA2 | Technology is fascinating to me. | 38,2% | 37,0% | 18,9% | 5,9% |
| TA3 | It is easy for me to learn how to operate a new technical device. | 36,5% | 38,0% | 20,0% | 5,5% |
| TA4 | I prefer to do things the way I'm used to doing them instead of using new technologies. | 11,5% | 33,7% | 41,7% | 13,1% |
| TA5 | There are tasks in my life that have been made easier by computers doing the work for me. | 36,4% | 41,2% | 15,6% | 6,8% |
| TA6 | New technologies make things more cumbersome. | 5,1% | 20,6% | 51,0% | 23,3% |
| TA7 | I use technologies such as digital voice assistants, smart watches, or smart home devices. | 12,7% | 13,1% | 19,0% | 55,2% |

**Table 1:** Items of Index “technology affinity” and corresponding responses

84.3% of the respondents were in possession of a driving licence, of which 59.6% had held it for more than 10 years. 82.2% said they generally felt safe in road traffic (38.8% "strongly agree", 43.9% "agree"). On the other hand, only 46.5% felt that road traffic generally was becoming safer (n=245, 9.4% "strongly agree", 37.1% "agree"). 64.6% said they liked driving (37% " strongly agree", 27.3% "agree"), yet only 8% admitted to sometimes driving just for fun and without a destination. Regarding the everyday mobility modes, respondents showed a strong preference for bicycles / e-bikes or public transport, with cars only in third place in terms of daily or weekly mobility modes. None of these categories showed significant differences regarding the different samples (experts, students).

Seven items were used to operationalise the dimension “technology affinity” (Cronbach's alpha = .841) to assess general attitudes towards technological progress (see **Table 1**)[79].These items were first translated into a mean value index, which was further translated into a dichotomous index (1 = tech-savvy, 2 = tech-averse) using 2.5 (middle value of categories) as separator value, thus dividing the sample into 63.9% generally technology-savvy and 36.1% generally technology-averse participants.

No differences in the demographic distribution of the two groups in terms of age and level of education were recorded, nor was an urban-rural divide evident in the data. Only the category "gender" showed significant influence on the affinity for technology ($T(159)=2.114$, $p<.05$), whereby men tended to be more tech-savvy than women.

### 3.2 Descriptive analysis - dependent variables

98.7% of respondents were aware of "automated driving", 80.2% stated that they had already heard of accidents with such vehicles. 94.6% had already heard of fully automated or "autonomous" driving. The evaluation of specific driving situations showed that automated driving functions would be particularly popular for monotonous journeys ("strongly agree" or "agree": 81.8%%) and when tired ("strongly agree" or "agree": 70.4%). This rather positive and seemingly trusting attitude is partly compromised when including passengers in the imaginations: 49.7% would rather drive themselves than use automated driving functions with passengers in the car. A large proportion of respondents (68.6%) think that automated driving will help improve road safety.

[79] The scale for measuring “technology affinity” presented here was inspired by Karrer-Gauß *et al.* (2009, items TA1, TA3 & TA6), Nees (2016, TA2, TA4 & TA5) and aimed at representing attitudes that capture affinity/excitement of technologies. TA7 was inspired by Reig *et al.* (2018) to further include experiences with (at the time) novel technologies. The omission of items from the original constructs resulted from the necessary shortening of the questionnaire. Adjustments were based on the criteria of accuracy (e.g., cost factors were not relevant in this context) and on pretests. Both pretests and the high internal validity of the scale confirmed minimal trade-offs between accuracy and item exclusion for questionnaire economy.

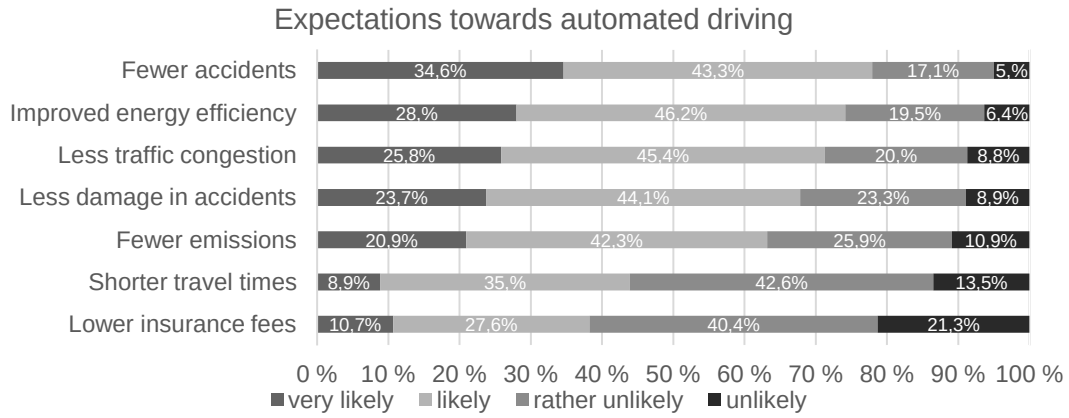


**Figure 1:** Expectations towards automated driving

Regarding the general expectations for the introduction of ADS in road transport, respondents indicate that they particularly expect fewer accidents (77.9% very likely or likely) and better energy efficiency (74.2%) of ADS (see **Fig. 1**). Regarding their reservations and fears, it is evident that the effects of device or system errors on road safety (72.4% very concerned or concerned), safety from computer hackers (72.1%) and the legal liability of drivers (71.7%) are perceived as particularly worrisome, while factors such as learning to use them causing very little concern (see **Fig. 2**). Of particular interest in this context is that only a small proportion of respondents are concerned about ADS not being able to drive as safely as human drivers, while at the same time expressing concerns about reliability and the impact of system failures: a seemingly contradictory relationship that will be discussed later.

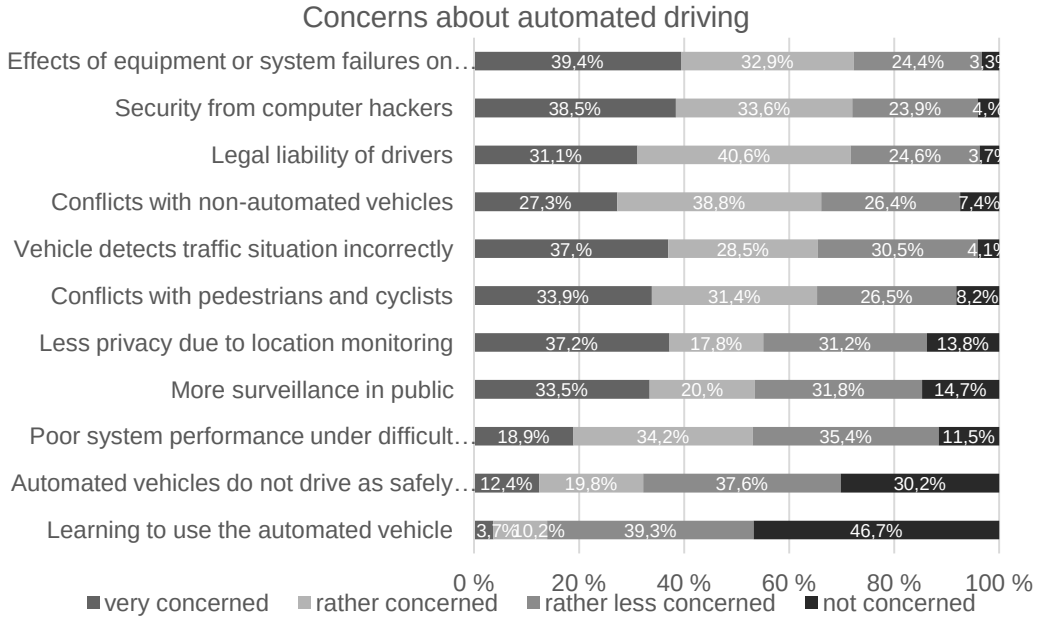


**Figure 2:** Concerns about problems associated with automated driving.

## 3.3 Analysis of selected interrelationships

### *3.3.1 Demographics*

Men are less concerned than women about the idea of fully automated vehicles on the road (T(217)=-5.023, p<.001), are more likely than women to say that they would trust fully automated vehicles to get them to their destination safely (T(215)= 3.355, p<.001) or to transport friends and family (T(211)=3.661, p<.001) and think that they would help to improve road safety (T(213)=2.973, p<.01). The items summarised under "autonomy" around the willingness to relinquish control of the vehicle are also closely related to gender: women are generally more sceptical about conveying driving tasks to an automation (T(239)=3.141, p<.01), express a stronger need to be able to take control at any time (T(236)=-2.537, p<.01) and think that it is less likely that automated driving will contribute to an improvement in road safety (T(233)=2.102, p<.05).

With the exception of being more convinced than women that fully automated vehicles pose a threat to existing jobs (T(208)= -3.336, p<.001), men consistently express more optimistic expectations towards ADS and the benefits associated with them, while simultaneously being less concerned about any of their potential dangers than women.

The age of the respondents manifested only regarding increased positive expectations by younger participants towards fully automated cars enabling environmentally friendly mobility (r=.153, p<.05). This finding contradicts other studies that show that higher ages correlate with an increase in concerns towards driving automation, yet is likely to stem from the “experts” sample consisting of older but more technology-savvy participants compared to the total population.

### *3.3.2 Technology affinity*

All positive attitudes towards fully automated driving correlate with having and affinity for technology in the sense that technology-savvy people are more likely to say they will trust fully automated vehicles in general (T(219)=-6.205, p<.001), will trust them to transport themselves and their family safely (T(215)=-5.576, p<.001), to make road traffic safer (T(217)=-6.193, p<.001) and to improve mobility in general (T(221)=-7.035, p<.001).

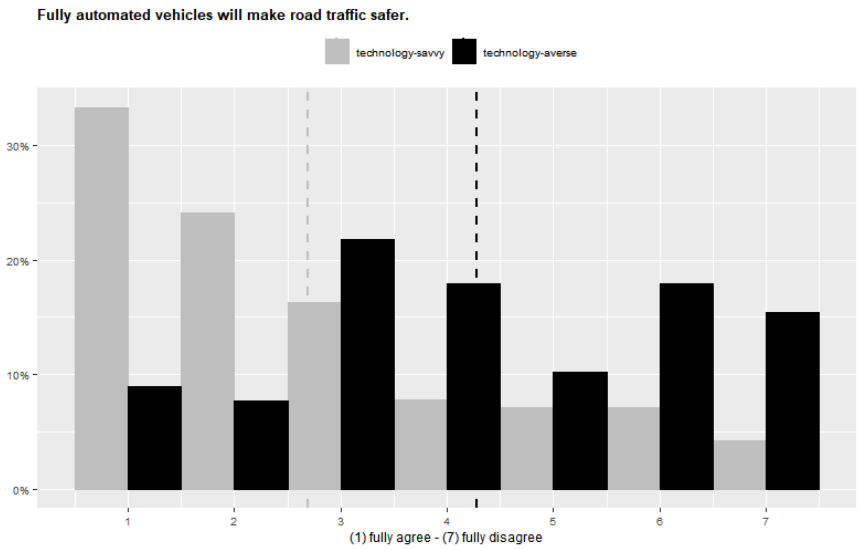


**Figure 3:** Distribution of item “fully automated vehicles will make road traffic safer” grouped by “technology affinity”.

Positive expectations regarding the safety aspects of automated mobility are particularly strongly associated with a technology-savvy attitude (differences in anticipating "fewer accidents": T(238)=-6.261, p<.001 and "less damage in accidents": T(234)=-5.602, p<.001). This optimism is most clearly expressed in the agreement with the statement that automated driving contributes to improving road safety (T(237)=-7.112 p<.001). Those with an affinity for technology also tend to see more positive aspects regarding safety for all other road users (e.g.: “Do you think road safety will increase for children and other risk groups?”: T(214)=-4.21, p<.001). This group is more willing to hand over control to an automated vehicle (T(243)=-5.906, p<.001), trusts more that they would be transported safely by an automated vehicle (T(242)=-7.050, p<.001) and expresses less need to always have the option to take control (T(240)=3.069, p<.01).

In terms of positive expectations, the data thus reflect a clear separation between the technology-savvy and -averse groups, which manifests in consistent and significant differences in mean value with respective large effect sizes and shows a fundamentally more optimistic expectation from technology-savvy participants towards the automation of driving tasks. However, a slightly different pattern emerges when considering the negative expectations and concerns about ADS, where these differences persist, but to a much lesser extent. This is especially relevant for items that include the “human factor” in the consideration of ADS’s effects. While technology-savvy participants are still less concerned with legal liability in the case of accidents (T(242)=3.538, p <.001), the effect size as measured by Cohen’s d is reduced to d=.474, while the differences between the two groups lose significance in the items “fully automated vehicles are a threat to existing jobs” (T(212)=.775, p=.439, d=.111) and concerns over “conflicts with pedestrians and cyclists” (T(240)=.624, p=.532, d=.083).

## 4 Discussion

As previous studies have shown, demographic variables exert a relevant influence on attitudes towards automated mobility (Bansal and Kockelman, 2018; European Commission, 2020; Hulse, Xie and Galea, 2018; Schoettle and Sivak, 2014). This is also the case in the research presented here, whereby decisive correlations could be found, especially between the age and gender of the respondents. Older respondents and women are generally more sceptical about handing over driving tasks to automation and are more sceptical about the expected improvements of automated mobility. However, due to the strong homogeneity of the sample examined regarding the proportion of participants with a high level of formal education, further influences can be assumed, as they have been found in representative cross-country evaluations (European Commission, 2020).

More influential than sociodemographic variables, however, was participants affinity for technology, which plays a central role in shaping expectations towards positive changes regarding more ecological and more inclusive transport systems through automation. Despite displaying generally positive attitudes and expectations towards automated driving technologies, technology-savvy participants also express high (though comparatively lower) levels of concern towards safety, privacy, and security. Technology-savvy participants consistently share a more optimistic assessment of automated mobility while at the same time are more indifferent to associated threats and more likely to expect extensive benefits in road traffic for all participating road users through the automation of driving tasks (less traffic congestion, shorter driving times, fewer emissions, etc.).

The safety-relevant aspects of automated driving reveal an ambivalent picture among the respondents: although the improvement of road safety is one of the most important expectations of automated mobility, which is expressed by the prospect of fewer accidents and less damage in accidents. At the same time, however, strong fears are expressed about new threats, such as those anticipated from hacker attacks, the effects of device and system errors or data security problems. This tendency also continues regarding other road users and the assumption of other roles in road traffic: although only a few believe that the introduction of automated vehicles will worsen the safety of various road users, two thirds of the respondents are concerned or very concerned about potential conflicts between automated vehicles and pedestrians or cyclists in traffic.

With a specific focus on partially automated driving, it becomes apparent that although just under half of the respondents would take their hands off the steering wheel under the given legal conditions, only just under a quarter would carry out secondary activities such as reading. The possibility of being able to intervene in the driving process at any

time and the certainty that sufficient time and information would be available to safely take over the driving task are the most frequently cited factors that influence trust in partially automated vehicles. In contrast, the most frequently mentioned fear of partially automated driving is the reduction of the driver's attention and the resulting artificial feeling of safety.

These findings, where imaginaries of automated vehicles on the one hand are being perceived not only as safe, but as *safer* than human drivers who – due to their physical and mental limitations, inattention, distractions, or skill level – pose an inherent and obvious risk to road traffic and on the other hand also contain an anticipated moment of danger, which is expressed by the desire to influence the driving process at any time, feeding into what Beer (2023) refers to as a dimension of “tensions in algorithmic thinking”: the notion of the simultaneous in- and exclusion of the human in algorithmic systems. These “tensions” arise around the competing forces between seeking “[technological] advancement by limiting the human as much as possible” or, in our case, automating “other” drivers that are being perceived to pose risks in road traffic, while simultaneously aspiring “acts of reinsertion [that] seek to limit human erasure and [that] re-establish the value of the human and human decision making” (Beer, 2023, p. 8) as an unwillingness to give up one's own oversight and control over automation. This “meshing of human and machine agency” that is being imagined using the example of automated vehicles therefore also reflects the “defining and competing forces” in the ongoing process of automation, where “different features and approaches pull in different directions, creating tensions in the process” (Beer, 2023, p. 7). Central to these contradicting forces are the sentiments related to them, as expressed by the dream of an algorithmically established “posthuman security” that guarantees safety by eradicating human error and the simultaneous perception of an automation “overstepping” its algorithmic autonomy, therefore revealing the “limits of what is possible or what are considered to be the acceptable extents of automation” (Beer, 2023, p. 42). Central to both aspects, despite their disparate directions, is that they both foster a sense of legitimacy for further automation, either by overcoming the fallible “human factor” or by avoiding the “overstepping” of perceived limits and undesirable independence of an automated agent. This serves as an explanation as to why specifically technology-savvy respondents were often found to embody these tensions in their answers.

## 5 Conclusions

Using common imaginaries of automated vehicles' anticipated affordances, trust in ADS was operationalized by the expectations and fears associated with them, involving perspectives not only from drivers, but from all people potentially affected by them. The importance of this broader societal perspective in the formation of trust towards new technologies is especially relevant when considering its widespread disruptive effects at all ends of the imaginative spectrum, that go far beyond its immediate impact on road traffic and its users: the shift in workforce (skilled instead of unskilled labour) and the disruption of labour markets, settlement patterns and urban land use, car ownership structures and effects on ecosystems through emissions and pollution.

Next to replicating common demographic splits in opinions within our study, "technology affinity" was found a key explanatory factor structuring the anticipated affordances of ADS in the context of our research. However, a closer examination reveals that these anticipations are not without contradictions. Drawing from the idea of "tensions in algorithmic thinking", we see our findings embedded into a wider process of automatization and the sprawling "will to automate" (Beer, 2023, p. 128).

However, as a preliminary study with a relatively small sample size of very specific populations aimed to explore tentative trends within distributions of imaginaries, we do not claim the study to be representative. Rather, we would encourage further exploration of the role of "technology-affinity" and its social stratification, especially regarding the temporal and spatial aspects of its formation as well as further analysis of how the "imagination phase" and the appropriation of particular imaginaries structure the "domestication" of future innovations. Through this, the differences in age, gender, and education and the respective distribution of "technology-affinity" that emerge from the data should not only sensitise us to questions of how and among whom powerful ideas about "innovative" technologies resonate socially and how they reflect the underlying ideals in the development process, but also invite us to ask who ultimately benefits from them, what imaginations of broader societal transformations are associated with individual expectations, and ultimately who is being left out of this process. We therefore recommend investigating the immanent "tensions" of algorithmic imaginaries as a theoretical lens through which seemingly contradictory and competing forces in expectations and concerns towards automated vehicles can be integrated, not only through a comprehensive concept of algorithmic thinking, but also within a wider societal process of automatization, which entails new challenges in the negotiation and attribution of agency between human and artificial agents.

## Disclosure

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