The adoption of fully autonomous vehicles: investigating the effect of seating orientation on

trust and motion sickness by mediating vehicle transparency

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Abstract

Recent advancements in vehicle autonomy have enabled passengers to engage in non-driving related tasks (NDRT) while traveling. Social interactions as NDRT were rated as most preferred, implementing a redesign of the autonomous vehicle´s (AV) interieur. This study explores the impact of seating orientation, specifically rearward facing, on trust, motion sickness, and behavioral intention to use AVs, while considering the role of vehicle transparency, split into intention transparency and perception transparency as a mediating effect between those variables. Moreover, the effects of trust and motion sickness on behavioral intention were tested on their own.

Participants experienced six vehicle journeys, with three in each seating direction, and were presented with three different vehicle transparency displays per seating orientation (intention transparency on; Live Feed; Off), which were mounted between the seats. Perception transparency was measured as a between-group variable. Results indicate a significant negative effect of rearward seating on trust, intention transparency, and behavioral intention, while motion sickness levels increased. However, display manipulations failed to show significant differences between conditions so no causal conclusions of the effect of vehicle transparency can be drawn. Trust emerged as a strong predictor of behavioral intention to use an AV in rearward facing seating orientation, suggesting the importance of trust in AV acceptance. While trends regarding the effect of vehicle transparency were observed, further investigation is needed to establish causality.

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Introduction

For several decades now, automation is researched in a diversity of domains but especially for performing time-sensitive or safety-critical tasks (Janssen et al., 2019). Automation is "technology that actively selects data, transforms information, makes decisions, or controls processes" (Lee & See, 2004, p. 50). Hence, it can execute specific tasks in autonomy, not needing a human operator. The concept of road vehicle automation was already introduced at the New York World's Fair at the end of the 1930s (Ekman, 2023), marking the start of a key research topic in the automotive industry (Hecht et al., 2020). Over the years, the vision of self-driving cars became more and more of a reality with a widespread availability of automation systems in vehicles today (Politis et al., 2018; Raats et al., 2020). Besides an increase in safety by reducing human error, improved convenience, fuel economy and low emissions, improving traffic throughput, and providing personal mobility for people unable or unwilling to drive (Diels & Bos, 2015; Dixit et al., 2019; Jorlöv et al., 2017; Kaur & Rampersad, 2018; Tang et al., 2020), automation in vehicles is demonstrating another potential as well: 46% of people are experiencing their time in a car as lost, while only 13% of train travelers are having the same feeling about their time of the transportation ride (see Hecht et al., 2014). With higher automation levels, the time in the vehicle can be used for other tasks than driving which might be perceived as a more valuable use of time to the occupant (Salter et al., 2019). This kind of task is often referred to as non-driving related task (NDRT).

Considering the future potential of performing NDRTs during vehicle journeys, Tang et al. (2020) discovered that the presence of another person in the vehicle led participants to prefer social activities, such as playing video games, board games, or chatting. Even when alone in the car, participants engaged in social activities like making (video) calls. Other studies by Jörlov et al. (2017), Östling and Larsson (2019), and Pettersson and Karlsson (2014) explored redesigning vehicle interiors to facilitate such NDRTs preferences. They found that rotating one of the seating rows by 180 degrees, creating a face-to-face seating arrangement inside the autonomous vehicle (AV), was preferred by participants. This configuration, known as the "living room position" (Jörlov et al., 2017, p. 16) as it turns the car into a space of comfort, social activities, and relaxation (Pettersson & Karlsson, 2014), enhances social interaction by allowing direct face-to-face interaction. However, Han et al. (1998) found a preference for forward-facing positions in transportation, suggesting that such seating orientations might trigger motion sickness symptoms and trust issues as passengers cannot anticipate upcoming events or maneuvers (Paddeu et al., 2020; Salter et al., 2019). Additionally, these interior changes are only feasible in highly autonomous vehicles.

To clearly distinguish the specific capabilities of automation levels, several taxonomies were developed. The Society of Automotive Engineers (SAE) has come up with a taxonomy and definitions for terms related to driving automation systems (SAE, 2021). In their taxonomy, they specify six levels of automation of on-road motor vehicles (see Appendix A) which are widely used as a

classification system to determine the degree of autonomy in a vehicle (Kaur & Rampersad, 2018). Hereby, Level 0 to 2 are categorized as "driver support features" (Walker et al., 2023, p. 5), where the human driver still performs part of up to all of the driving related tasks and holds the responsibility of the ride. Levels 3 to 5 are classified as "automated driving features" (Walker et al., 2023, p. 5), where the responsibility of the ride is given (up to a specific point) to the vehicle so that the person in the vehicle becomes a passive occupant, watching the vehicle's performance during (part of) the vehicle journey. Compared to Level 3, vehicles with Level 4 and 5 autonomy features do not require a driver taking back control but are able to bring the vehicle to a safe standstill when the system reaches its limits (SAE, 2021; Walker et al., 2023).

The present study will focus on SAE Level 5 AVs as NDRTs might get even more valuable with increasing autonomy level: people might get bored when they have no active role in the ride anymore and might become more engaged in NDRTs as a consequence (Kyriakidis et al., 2015; Sun et al., 2021; Tang et al., 2020). Studies have shown the interest in social activity and social exchange as NDRTs during the vehicle journey (Jörlov et al., 2017; Östling & Larsson, 2019; Pettersson & Karlsson, 2014; Tang et al., 2020). Bringing together the living room seating orientation with the execution of NDRTs should account for this preference. The present study, hence, investigated people´s intention to use such vehicle constellation as this is one step to the success of a new technology.

Several influential factors have been identified in studies assessing the efficacy of a technology. One example is held by Davis (1989), who has analyzed influential success factors and summarized powerful components in his Technology Acceptance Model (TAM). Within his model, Davis (1989) expounded user acceptance as the most crucial factor of success and outline factors influencing it. Davis (1989) states that system design features, perceived usefulness, and perceived ease of use are influencing the attitude toward the use of the technology and, consequently, the people's intention to use and actual usage behavior. Cited and investigated in numerous papers, the TAM was expanded several times by adding further components found to be important for people's technology acceptance and eventual adoption. Especially trust was found to be a relevant factor for future AV acceptance, next to perceived usefulness, performance expectancy and comfort (Kaur & Rampersad, 2018; Paddeu et al., 2020; Zhang et al, 2021).

Given the importance of trust for the acceptance of AVs, the living room seating layout poses a particular challenge since the passengers are unable to see what is happening in front of the vehicle. Consequently, their level of trust towards the performance of a fully AV needs to be higher than in a normal seating arrangement. Moreover, the level of trust towards a technology is not determined as an independent concept but based on several external influences (Lee & See, 2004). For the passengers in a driving simulator study carried out by Beggiato et al. (2015), vehicle transparency was one of the key information needs for establishing their level of trust. Vehicle transparency implies the presentation of system information to the passenger in a transparent way. The amount of information

participants asked for from the vehicle varied between the participants. Wintersberger et al. (2019) found in their higher-level AV simulator study that transparency indeed increased user acceptance and trust in such seating constellations. Hence, particular emphasis should be placed on the aspects of trust and vehicle transparency when investigating users' acceptance of AVs, especially when investigating a living room seating layout.

Besides trust and system transparency within such a socially focused AV design, another factor influencing the adoption of was found to be comfort (Paddeu et al., 2020). Sitting rearwards in a vehicle can lead to motion sickness symptoms in some passengers as they cannot foresee the future motion of the vehicle, consequently having a neural mismatch between anticipated and actual movement (Isu et al., 2014; Östling & Larsson, 2019; Salter et al., 2019). In this regard, motion sickness is expected to negatively influence living room AV acceptance as well (Diels & Bos, 2015). Consequently, the level of motion sickness in passengers is important to control for when exploring the acceptance of this new seating position.

To sum up, there are several factors which might influence the adoption of such a new interieur design in a SAE Level 4/5 AV. In an effort to condense these factors, Rottmann (2023) introduced the Autonomous Driving Acceptance Model (ADAM; Figure 1). It should help understand how the acceptance of a living room seating orientation in AVs comes about. Hereby, special focus is given to seating orientation of the passenger: the more negative vehicle journey experience for rearward facing passengers should be minimized by the vehicle transparency differentiated between intention transparency and perception transparency, i.e., what the AV intends to do and what it can perceive from the environment, respectively. Rottmann (2023) suggest that making such transparency visible to the passenger by displaying intended maneuvers and the AV´s perception of the environment, counteracts to the negative effects of rearward seated passengers, still leading to a positive behavioral intention in the end.

Figure 1

Autonomous Driving Acceptance Model (ADAM; Rottmann, 2023)
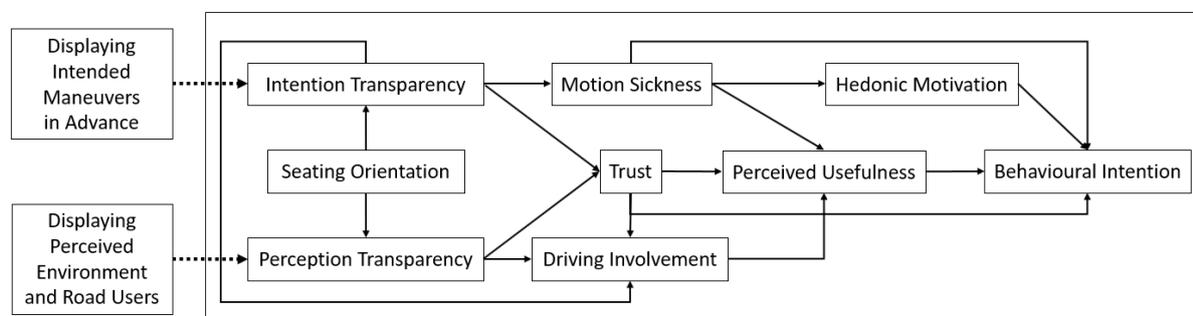
The present research paper aimed to investigate parts of the ADAM introduced by Rottmann (2023). Specifically, the effects of seating orientation on intention transparency and perception transparency, and the transparency variables´ effects on motion sickness and trust were investigated.

Moreover, the effect of trust and motion sickness on behavioral intention were tested. Lastly, the effect of displaying intended maneuvers and the vehicle´s perception on intention transparency and perception transparency, respectively, were under investigation. The latter were manipulated using displays mounted inside the vehicle. The overarching goal was to gain insights into the intensity of the factors' influence on user acceptance in the context of fully AVs furnished with a living room seating layout. Since earlier research made use of lower SAE level vehicles, driving simulators or hypothetical research studies, this study utilizes a real vehicle manipulated to be a self-driving car using a steering and pedal robot. This is a system mounted on the steering wheel and pedals of the vehicle, so that the system can drive the vehicle autonomously based on a predefined route. The route was placed within a test track including four scenarios which should challenge the participants´ trust level in the AV. Thereby, this study wanted to gain knowledge about people´s behavioral intention to use higher-level AVs which eventually should be usable in real-world driving environments. Following, the concepts of the ADAM (Rottmann, 2023) relevant for the present research study will be explained in more detail, closing with a list of corresponding hypotheses which will be tested in this paper.

Trust

Trust is a concept that is defined in various ways across different research fields, with each definition emphasizing different aspects (Hoff & Bashir, 2015; Lee & See, 2004). Common characteristics used to define trust include the trustor's expectations regarding the outcomes of interactions, their intention or willingness to act, vulnerability, and the goal-directed nature of trust (Lee & See, 2004). One frequently cited definition of trust in automation describes it as "the attitude that an agent will help achieve an individual's goals in a situation characterized by uncertainty and vulnerability" (Lee & See, 2004, p. 54; Walker et al., 2023). In the context of the present study, the agent refers to the automated system, i.e., the AV, while the situation pertains to the vehicle journey.

Expanding on this definition, Walker et al. (2023) note that literature is borrowing trust concepts from interpersonal (i.e., human to human) trust. In their opinion, trust in automated vehicles is less directly observable than in interpersonal interaction but observable by behavioral components such as reliance (Walker et al., 2023). According to them, trust is neither a unidimensional nor categorical construct which is why they extended the definition by Lee and See (2004):

> *"Trust in automated driving functions refers to road users' **subjective** evaluation of the ability of an automated vehicle to drive safely. **Trust is a multi-layered concept, combining different trust variables, namely dispositional trust, initial learned trust, situational trust and dynamic learned trust**. Trust is the result of a **dynamic psychological process** that varies over time, depending on the driving scenarios and users' **experience**."* (Walker et al., 2023, p. 2)

Similar critique was expressed by Hoff and Bashir several years before. They introduced the concepts of dispositional trust, i.e., an individual's enduring tendency to trust automation, situational trust, i.e., trust which is developed in a specific context of an interaction, and learned trust, which is guided by past experienced although closely related to situational trust, as concepts for developing trust. Walker et al. (2023) simplified this framework as they argued that those concepts would be too alike to make clear distinguishments possible. Therefore, they propose to use the terms *expectations*, i.e., dispositional and initial learned trust established before or within the first contact with the system, and *calibration*, i.e., situational and dynamically learned trust derived from the interaction with the system throughout various situations. The present study used these insights as a theoretical foundation by measuring initial trust towards technology, however the focus was put on its development throughout the course of the study by letting the participants experience different trust challenging scenarios.

Several studies have already investigated the development of trust throughout the course of AV interaction. Paddeu et al. (2020) explored trust dynamics using an SAE Level 4 autonomous shuttle bus equipped with both forward and rearward facing seating rows. Adopting a dynamic view of trust akin to Hoff and Bashir (2015), they investigated changes in initial, interactional, and final trust levels throughout the experiment. By manipulating seating orientation and vehicle speed, Paddeu et al. (2020) found that passengers seated rearward in a faster shuttle exhibited lower subsequent trust levels. However, the study's closed circuit setting, with predetermined maneuvers and speeds of 8 km/h and 16 km/h, may not accurately simulate real-world traffic conditions, potentially influencing trust ratings. Speed and risk scenarios are known to impact users' trust levels (Paddeu et al., 2020; Strauch et al., 2019). While Paddeu et al. (2020) observed trust dynamics during AV interaction, it remains uncertain whether participants gained genuine experience with fully autonomous vehicles. The present study aims to address this gap by building upon their findings.

In the opinion of Walker et al. (2023), experience cannot only be measured using kilometers driven alone but considering the range of situations experienced which eventually influence trust development. Based on this definition, the participants of Paddeu et al. (2020) may not be classified as having developed experience throughout the study. Hence, trust ratings may not be as valid. Similarly, Haeuslschmid et al. (2017) caution against drawing firm conclusions about AV related research results about trust which might be drawn upon simulators or hypothetical brainstorming but not experience as stressed by Walker et al. (2023). It might be that trust is developing differently when safety-critical situations are added to a real-world AV ride. To the present author's knowledge, no study to date has investigated the effect of seating orientation on trust in a fully autonomous car by considering real-traffic and safety-critical situations.

Motion sickness

When driving a vehicle, driver and passengers are exposed to several motions of the vehicle, including magnitude, frequency, direction, and duration (Griffin & Newman, 2004). Especially horizontal motion can increase the chance of motion sickness by the person, whereby drivers experience less motion sickness than passengers in general (Griffin & Newman, 2004; Salter et al., 2019; Wada et al., 2018). Motion sickness includes several symptoms like sweating, dizziness, fatigue, eyestrain, headache, burping, salivation, apathy, nausea, and retching (Diels & Bos, 2015; Kesharvarz & Hecht, 2011; Keshavarz et al., 2019). A high level of motion sickness can occur with a mismatch between the vehicle's dynamics and the sensory information of body movement (Diels & Bos, 2015; Isu et al., 2014; Reason, 1978).

In the context of AVs, motion sickness has gotten considerable attention, particularly in the context of NDRTs. With the expectation that passengers will engage in various activities during their car rides in the future (Diels & Bos, 2015; Isu et al., 2014), understanding the impact of NDRTs on motion sickness development and overall ride experience is crucial for future adoption. For instance, Isu et al. (2014) observed a 25% increase in motion sickness incidence when reading compared to watching a movie, highlighting the potential negative effects of certain activities on motion sickness. This has implications for the success of AVs, as they may not be able to replicate the office or living room environment that passengers desire (Diels & Bos, 2015). Salter et al. (2019) was one of the first to implement this topic into the context of rearward facing seating position, finding that all participants experienced some kind motion sickness after having ridden in backwards facing position, while almost no motion sickness was reported in forward riding position.

In contrast, Schmidt et al. (2019) reported low instances of motion sickness during highway and inner-city AV journeys while participants were engaged in one of three NDRTs. Around 90 percent of the participants in either of the conditions had a motion sickness score between 0 and 1, representing no problems or feeling of uneasiness. Facing forward versus rearward or the use of different NDRTs displays caused no significant difference in the level of motion sickness of the participants in this study. Schmidt et al. (2019) suggest that the expected risk of motion sickness in AVs may be exaggerated. However, Rottmann et al. (Under Review) identified motion sickness as a significant predictor for the behavioral intention to use rearward facing AVs, indicating that motion sickness may indeed influence users' willingness to adopt AV technology. Thus, the relationship between motion sickness and behavioral intention in AV usage remains ambiguous, warranting further investigation. Therefore, in the present study motion sickness was used as a control variable measured during vehicle journeys, accounting for possible influence in the model outcomes.

Vehicle transparency

Vehicle transparency implies the communication between the vehicle and the passenger regarding what is happening inside and outside of the vehicle. It is about providing the driver with awareness of and understanding about what the system can do, will do, or has already done (Debernhard et al., 2016). The goal is to provide the driver with the right amount of information about the system, implying transparency, comprehensibility, and predictability of current and future system actions, to support them in maintaining a feeling of control over the situation (Beggiato et al., 2015; Debernhard et al., 2016; Springer et al., 2019).

System transparency was found to be important for building trust in the system, but participants require less information as trust increases (Beggiato et al., 2015; Detjen et al., 2021; Haeuslschmid et al., 2017; Löcken et al., 2020). Moreover, more information does not necessarily lead to better user experiences, and simple but precise and relevant representations were preferred (Chang et al., 2019; Politis et al., 2018; Sun et al., 2021). In lower-level automation, vehicle transparency is already implemented, but information needs to differ due to the given automation status of the vehicle (Beggiato et al., 2015; Bolton et al., 2015; Springer et al., 2019). While information requested during manual driving was classified as important for the current driving task (e.g., current speed limit), Beggiato et al. (2015) found that participants in higher-level AVs demanded information for system supervision.

Current and planned maneuvers of the system, hence its status and intention, but also the AV's perception of the environment, i.e., road users and critical situations, were rated as essential information for participants in higher-level AVs (Beggiato et al., 2015; Detjen et al., 2021; Springer et al., 2018; Springer et al., 2019). Most often, studies investigate these aspects interdependently; Rottmann (2023) has divided these aspects of vehicle transparency into *intention transparency*, which implies "the vehicle's ability to adequately communicate its planned driving maneuvers to the passengers" (p. 3), and *perception transparency*, which is the "vehicle's ability to adequately communicate what elements of the driving environment it recognizes" (p. 3). These concepts are in so far different from one another, that perception transparency is providing system transparency by giving information to the passenger which can be used to gain an idea about the vehicle, however it has no direct consequence if they do not. Intention transparency, on the other hand, focuses on system´s predictability as it reflects the (upcoming) maneuvers of the vehicle, thereby actively predicting the motions of it. Consequently, intention transparency may not only be useful for building trust, as investigated by several previous studies, but may also lessen the experience of motion sickness when passengers can prepare for the vehicle´s motion ahead, thereby decreasing the mismatch between the vehicle's dynamics and the sensory information.

Breaking up the concepts like that makes it possible to investigate how far these concepts individually account for trust and motion sickness in the end. Hence, questionnaires per concept were

given to the participants between vehicle journeys, measuring the subjective perception of it. Moreover, this subjective perception was manipulated using displays showing different levels of vehicle transparency. The latter accounted for Rottmann´s (2023) "Displaying Intended Maneuvers in Advance" and "Displaying Perceived Environment and Road Users" variables which were expected to influence intention and perception transparency scores.

Vehicle transparency in the scope of a living room seating arrangement was investigated by only two studies (Sun et al., 2021; Wintersberger et al., 2019). Sun et al. (2021) investigated the effect of a transparency display on the take-over performance of the driver in safety-critical situations when the driver's seat was turned by 180 degrees in a SAE Level 3 driving simulator. The display was a foldable in-vehicle roof-mounted display with a forward-facing view, affixed between the first and second row of the AV and positioned as close to the driver's normal sightline when sitting rearward facing. Showing real-time information about the performance of the AV as well as warnings of urgency decreased the take-over time significantly compared to rearward facing take-over time without visual support. The visual support had the highest situational awareness ratings and lowest crash rates compared to the other conditions. Consequently, making the driver aware of what is going on in front of the car can increase the safety of the journey. However, this was only tested in a SAE Level 3 AV.

Wintersberger et al. (2019), on the other hand, investigated the effect of augmented reality assistance on user acceptance and trust in fully autonomous vehicles in forward and rearward viewing seating directions in two studies. Using a head-mounted display, arrows were presented in two types of visualization for rearward facing passengers: arrows pointing in the perceived direction, i.e., facing downwards, and arrows pointing in the driving direction, i.e., facing upwards, both controlled by a baseline condition without visualization. They found that presenting upcoming driving maneuvers would increase user acceptance and trust, at least for the perceived direction of the visual; however, no difference in motion sickness scores was found. Overall, semi-structured interviews revealed that the negative feeling of loss of control in fully AVs increases as vehicle behavior cannot be foreseen with the help of vehicle transparency, for instance. Further, this study shows that display presentations need to be adjusted to the seating orientation of the passengers. As overall results, both studies found that vehicle transparency can increase the situational awareness of rearward facing occupants but also their trust level towards the AV. Vehicle transparency was found to be an important instrument for the adoption of fully AVs; further investigation of what and how to display information in specific is needed (Detjen et al., 2021; Haeuslschmid et al., 2017; Sun et al., 2021; Wintersberger et al., 2019).

Eye tracking

Questionnaires examining trust provide valuable insights into how individuals evaluate trust in specific situations. However, they do not uncover the underlying factors influencing participants' ultimate trust levels (Strauch et al., 2019). Likewise, Walker et al. (2023) argue that assessing trust in

AVs solely based on the AV-passenger relationship is insufficient; instead, behavioral indicators such as reliance should be considered. Given the subjective nature of questionnaires, and their inability to assess behavior, objective measurements like monitoring physical behavior and body responses offer valuable insights (Strauch et al., 2019). Eye tracking, a commonly used behavioral measurement, correlates significantly with trust assessments obtained through questionnaires, capturing participants' gaze behavior. Specifically, reduced monitoring of the automated system corresponds to higher trust ratings (Lu & Sarter, 2019; Strauch et al., 2019; Walker et al., 2018; Walker et al., 2019). Thus, eye tracking emerges as a suitable method for assessing trust in AVs.

Gaze behavior serves as a potential indicator not only of participants' trust levels but also of other constructs. Murdin et al. (2011) proposed that individuals utilize stable visual reference points, such as the horizon, to mitigate motion sickness by reducing visual-vestibular conflicts, a known predictor of motion sickness. Consequently, it is plausible that individuals experiencing higher motion sickness levels would exhibit increased gaze towards the window during AV rides. Additionally, eye tracking analysis during AV journeys could enhance understanding of individuals' behavior and needs, potentially revealing their priority information. Particularly in the context of virtual travel via display manipulation, eye tracking data may illuminate usage patterns of the displays. To the best of the authors' knowledge, these aspects have not been extensively explored in prior research. Therefore, eye tracking data will be collected during this study, although it will not be analyzed within the scope of this paper. The exploratory research questions to be addressed at a later point in time are: Is there a correlation between increased eye gaze fixations outside of the AV and increased motion sickness? And, to what extent are participants using virtual travel displays mounted inside an AV?

Research aim

Based on the current state of research, a lot of insights regarding possible variables influencing AV use of people can be gained. However, most of the papers used (expert) focus groups, simulators, or study designs which do not reflect real-world experiences of AVs to come to their conclusions. Moreover, although aspects around seating orientation as a main variable and its effect on trust or motion sickness in fully AVs have been investigated, only one driving simulator study has taken into consideration the effect of vehicle transparency on this relationship (Wintersberger et al., 2019). Consequently, some of the relationships visualized in in the ADAM (Figure 1) have already been studied, but it never was done considering all these influences at once or in a real-world driving environment implying various (safety-critical) scenarios. These research gaps are addressed in the present study. Since exploring the whole model at once would exceed the volume of this paper, a simplified version of the ADAM (Rottmann, 2023) was used as a foundation for the present research (Figure 2).

Figure 2.

Simplified Autonomous Driving Acceptance Model (ADAM; Rottmann, 2023) with indicated
hypotheses under investigation in this study. Dotted lines indicate indirect relationships investigated
in this study.
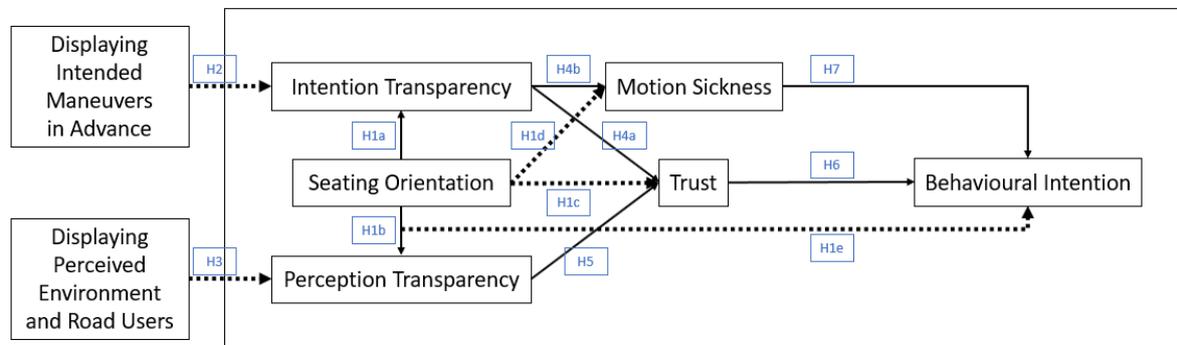
Within the scope of the present study, a 2x3x2 mixed design was implemented, incorporating
seating orientation (forward; rearward) as an independent within-subject variable, display
manipulation (intention transparency; live video stream; turned off) as a within-subject mediator, and
perception transparency (on; off) as a between-subject mediator. Each participant underwent six
vehicle journeys within one of the experimental groups, encountering three of the journeys in forward
facing seating position and three in rearward facing one, thereby experiencing each display condition
once within each seating orientation.

The decision to differentiate between within-subject and between-subject mediators was
based on several factors. Firstly, accommodating all conditions as within-subject variables would have
extended the duration to over two hours, increasing the risk of fatigue effects. Conversely, reducing
the duration of the driving course to accommodate all experimental conditions within an acceptable
time frame would have resulted in a course too short to yield meaningful results. Additionally,
increasing the number of rides through one course was expected to elevate the risk of a learning
effect, potentially obscuring differences in trust levels over the study's duration, as trust is anticipated
to stabilize over time (see Beggiato et al., 2015). Secondly, the ADAM (Rottmann, 2023) posits that
perception transparency exclusively influences trust but not motion sickness. Conversely, intention
transparency is expected to influence both trust and motion sickness. Furthermore, participants in the
study by Flohr et al. (2023) also expressed a preference for intention transparency alongside the
provided perception transparency representations, indicating a preference for information about
intention transparency compared to perception transparency alone. Hence, this study prioritizes
intention transparency as a within-subject measurement.

Trust, motion sickness, and behavioral intention to use such a vehicle like the experimental
one employed in this study were examined as dependent variables. The study comprised two parts: a
pre-questionnaire that participants completed at home, and an in-situ study conducted on a test track.

Hypotheses

Sitting rearward faced has been found to impact situational awareness (Sun et al., 2021), trust (Paddeu et al, 2020), as well as motion sickness (Salter et al., 2019). Furthermore, it is assumed that seating orientation influences behavioral intention. Overall, it was expected that sitting rearward faced had a negative effect on the scoring of intention transparency, perception transparency, trust and behavioral intention, but leading to higher scores of motion sickness compared to sitting forward faced in an AV.

H1a: Rearward facing passengers report lower intention transparency scores measured between vehicle journeys than forward facing passengers.

H1b: Rearward facing passengers report lower perception transparency scores measured between vehicle journeys than forward facing passengers.

H1c: Rearward facing passengers report lower trust scores measured during and between vehicle journeys than forward facing passengers.

H1d: Rearward facing passengers report higher motion sickness scores measured during vehicle journeys than forward facing passengers.

H1e: Rearward facing passengers report lower levels of behavioral intention to use such a vehicle in rearward facing seating position measured between vehicle journeys than forward facing passengers.

Based on the study by Sun et al. (2021), vehicle transparency can increase situational awareness which is expected to be reflected in higher intention transparency and perception transparency scores compared to no vehicle transparency. Hence, it was predicted that the displaying of upcoming maneuvers on in-vehicle displays during the vehicle journey will lead to higher intention transparency scores measured between vehicle journeys, compared to not displaying upcoming maneuvers. Further, displaying detected traffic objects on in-vehicle displays during the vehicle journey was predicted to lead to higher perception transparency scores measured between vehicle journeys, compared to not displaying detected traffic objects.

H2: Displaying upcoming maneuvers on in-vehicle displays during the vehicle journey leads to higher intention transparency scores measured between vehicle journeys than not displaying upcoming maneuvers.

H3: Displaying detected traffic objects on in-vehicle displays during the vehicle journey leads to higher perception transparency scores measured between vehicle journeys than not displaying detected traffic objects.

Analogous to the study by Wintersberger et al. (2019), vehicle transparency is expected to mediate the effect of seating orientation. It was predicted that displaying upcoming vehicle maneuvers (intention transparency), measured between vehicle journeys, will mediate the effects of seating orientation. Specifically, sitting rearward faced was expected to have a less negative effect on trust scores measured during and between vehicle journeys when paired with high intention transparency, compared to when intention transparency is not displayed. Further, displaying upcoming vehicle maneuvers (intention transparency), measured between vehicle journeys, was predicted to mediate the effects of seating orientation. Specifically, it was anticipated that sitting rearward faced will have a less negative effect on motion sickness scores measured during the vehicle journey when paired with high intention transparency, compared to when intention transparency is not displayed. Lastly, it was predicted that displaying detected traffic objects (perception transparency), measured between vehicle journeys, will mediate the effects of seating orientation. Specifically, it was expected that sitting rearward faced will have a less negative effect on trust scores measured during and between vehicle journeys when paired with high perception transparency, compared to when perception transparency is not displayed.

H4a: Intention transparency measured between vehicle journeys mediates the effects of seating orientation, such that sitting rearward faced has less of a negative effect when paired with high intention transparency and leads to higher trust scores measured during and between vehicle journeys than when not displaying intention transparency.

H4b: Intention transparency measured between vehicle journeys mediates the effects of seating orientation, such that sitting rearward faced has less of a negative effect when paired with high intention transparency and leads to lower motion sickness scores measured during the vehicle journey than when not displaying intention transparency.

H5: Perception transparency measured between vehicle journeys mediates the effects of seating orientation, such that sitting rearward faced has less of a negative effect when paired with high perception transparency and leads to higher trust scores measured during and between vehicle journeys than when not displaying perception transparency.

Based on insights by Kaur and Rampersad (2018), Paddeu et al. (2020) and Zhang et al. (2021), trust is a key component for the adoption of AVs. It was predicted that higher levels of reported trust in the AV, as measured during and between vehicle journeys, will positively correlate with increased behavioral intention to use AVs in rearward facing seating positions. Specifically, it was anticipated that participants who report higher levels of trust in the AV during and between the vehicle journeys will demonstrate increased behavioral intention to use AVs in rearward facing seating positions, as measured between the vehicle journeys.

H6: Higher levels of reported trust in the AV measured during and between vehicle journeys lead to increased behavioral intention to use AVs in rearward facing seating position measured between the vehicle journeys.

Based on insights by Rottmann et al. (Under Review), motion sickness is expected to influence behavioral intention to use an AV in rearward facing seating position. It was predicted that lower levels of reported motion sickness experienced by participants during the vehicle journey will positively correlate with increased behavioral intention to use AVs in rearward facing seating positions. Specifically, it was anticipated that participants who report lower levels of motion sickness symptoms during the journey will demonstrate higher levels of behavioral intention to use AVs in rearward facing seating positions, as measured between the vehicle journeys.

H7: Lower levels of reported motion sickness measured during the vehicle journey lead to increased behavioral intention to use AVs in rearward facing seating position measured between the vehicle journeys.

Methods

The present research was approved by the ethics committee of the BMS faculty of the University of Twente, Enschede.

Participants

An a priori G*Power analysis for a mixed ANOVA using an effect size of .25, an α error probability of .05 and a power of .8 resulted in a required sample size of 60 participants by two groups and six measurements. Due to economic reasons, 51 participants eventually took part in this study ($M_{age} = 32.46$, $SD_{age} = 10.156$, $min_{age} = 19$, $max_{age} = 58$). Fifty-eight percent of the participants were men while the other fourty-two percent were women, all having a German citizenship. Most of the participants (64 %) were employed, followed by twenty-two percent of the participants being students. All participants were recruited via the mailing list of the DEKRA Automobil GmbH, having the inclusion criteria of not being in touch with autonomous vehicles or pedal and steering robots professionally, and being 18 years of age or older. Participants were individually compensated, either as working hours, with guided tours over the DEKRA Lausitzring, or financially with 30 Euros for about 120 minutes of participation.

Materials

Experimental vehicle

A Volkswagen T6 Multivan (2-liter Diesel engine, 200 HP, automatic Dual Clutch Transmission) was used as the experimental vehicle (see Figure 3). It featured three rows of seats, with the middle row rotated by 180 degrees, causing the seats of the second and third rows to face each other. The seats were mounted 60 centimeters (cm) apart, and the backrest was set at a 55-degree angle relative to the seat cushion. Positioned between the seats was a 13-inch display (Faytech n.d.), mounted at a height of about 85.5 cm (lower edge) and about 7 cm behind the seat, with a resolution of 1920x1080 pixels. Each display had the same viewing direction as the seats, making them visible to participants sitting in the opposite seating row (Figures 4, 5). For external representation, four magnet boards stating "autonomous vehicle" as well as four fake surveillance cameras attached by magnets were placed on each side of the experimental vehicle and on the car top, respectively. This should strengthen the perception of being driven by a real fully AV.

Figure 3.
Experimental vehicle from the outside including magnet boards on the side of the vehicle and fake surveillance cameras on the car top to strengthen the perception of being driven by a fully autonomous vehicle.

Figure 4.

Displays mounted between the seats visible for forward facing participants.

Figure 5.

Displays mounted between the seats visible for rearward facing participants.

A Logitech BRIO 4K STREAM EDITION webcam was fixed next to the rear mirror on the windshield, streaming a live video of the events up front onto those displays with 1280x720 pixels at 60 frames per second. It had a 90-degree field of view and was adjusted to record the scene horizontally to the ground to capture scenes in the back as well as events happening directly in front of the car without capturing the hood of the vehicle. To prevent overexposure from the sun, a polarizing filter was mounted in front of the webcam lens, dimming the scene. The display manipulations in the back of the vehicle (visible to rearward-sitting participants) showed a

horizontally mirrored video. Based on initial tests, using a mirrored live stream video during reverse driving resulted in a reduced discrepancy between expected and actual vehicle movements during turns. The mirrored screen correctly reflects the direction of the vehicle's movement, so no erroneous sensation of needing to lean in the opposite direction was experienced. As a result, this improvement in alignment between body movement and perceived vehicle motion contributed to a decreased subjective feeling of motion sickness symptoms, making lateral movements more predictable and reducing discomfort. Mirroring did not affect the presentation to participants, with the only drawback being the perception of left-hand driving. The display manipulations were processed by a Jetson AGX Orin Developer Kit (hereafter: Jetson; NVIDIA Corporation, 2023). The experimenter sat on the seat next to the driver's seat, controlling the Jetson and display manipulations from there.

On the driver's seat of the experimental vehicle, the automated driving system SFPhybrid for cars (Stähle GmbH, n.d.) was installed (Figure 6). It consisted of two individual systems: a Stähle robot, consisting of different actuators, combined with the internal measurement unit ADMA-SLIM of GeneSys. The Stähle robot combines actuators of the AUTOPILOT HYBRID series, including the acceleration and braking actuators, with the STEERING ACTUATOR SSP-FrontFree, both controlled by one mobile controller unit (Stähle GmbH, n.d.). ADMA-SLIM is a GPS-based system mounted on the car top, which can measure the vehicle's motion in all three axes to provide precise location and motion determination (GeneSys Elektronik GmbH, 2023).

Figure 6.

Stähle automated driving system SFPhyprid placed on the driver´s seat. The safety driver was monitoring the system at all times.

In the first step of programming the route, the course is driven manually, gathering the lateral and longitudinal motion of the vehicle by ADMA-SLIM. Synoptically, the systems do not use sensors of the vehicle to capture the environment; instead, all vehicle motion is hardcoded. Hence, incidents described in the subsequent sections are trained to a level where the scenarios respond to the vehicle's motion, rather than the vehicle adjusting to the incidents. Throughout the experiment, a safety driver sat in the driver's seat, observing the robot's performance. He was trained to turn off the technology and take back control of the vehicle if the robot did not perform as intended but had no influence on the driving performance in any other way.

Test track

The experiment was conducted at the DEKRA Testing Track Lausitzring in Klettwitz, Germany. The course utilized for this study encompassed segments mimicking urban and rural roads, as well as a highway. Speeds reached up to 50 km/h in the urban segments, up to 70 km/h in the rural areas, and up to 100 km/h on the highway. Within this course, four scenarios were presented to the participants, which will be introduced in the following section.

Scenarios. Scenarios for the experimental execution were constructed based on the design recommendations by Thorn et al. (2018) in combination with a study about scenario construction of the Austrian traffic recommendations (Bundesministerium Verkehr, Innovation und Technologie (BVIT), 2019). Requirements determined before development by the researchers implied that only scenarios should be incorporated which may happen in real-world traffic, i.e., realistic and meaningful traffic occurrences, by incorporating all kinds of roads, i.e., urban road, rural road, and highway. BVIT (2019) as well as Strauch et al. (2019) point out that the most relevant insights regarding AVs are gained using safety-critical or edge case scenarios. However, neither of the authors have defined what safety-critical might entail. Thorn et al. (2018) stressed the distinction between expected and unexpected incidents, and key infrastructure elements. Literature reviews of road user behavior by specifically filtering unexpected, i.e., safety-critical, situations (Mahadevan et al., 2019; Rasouli et al., 2020; Rasouli et al., 2018; Stoker et al., 2015) revealed little insights. Most of the studies focused on road users´ characteristics which were not evaluated to be relevant for the given context. It was not found to be relevant to investigate what leads road users to performing specific behavior but the action itself. One insight given by these studies is common rule violation practice of road users. Accordingly, German traffic rules (ADAC, 2024), rule adherence as well as rule violation behavior were discussed in expert workshops. Consequently, specific focus was put onto traffic signs with safety information or warnings as they were expected to give the greatest insights into possible safety-critical incidents in traffic. Together with rule-violating road user behavior and accident statistics, four scenarios were specified in the end which should also incorporate field of view differences due to seating orientation of the participants (Table 2). Hence, two of the scenarios should be observable for forward facing participants, while the other two should predominantly be monitored by rearward facing participants.

Table 2

Final scenario choice for the Testing Track Lausitzring. Rule corresponds to the traffic rule applied in that specific scenario.

No.	Conditions		Scenario
1	*Place*	Urban road Roundabout with bikeway	The ego vehicle is entering a roundabout. A cyclist enters the roundabout as well, using a cyclist priority street. When the ego vehicle wants to leave the roundabout, the cyclist just rides onto the street, intending to follow the roundabout further. The ego vehicle has to stop to let the cyclist pass before it can exit the roundabout.
	Object	Cyclist	
	Rule	The cyclist is allowed to go before the car.	
2	*Place*	Rural road	The ego vehicle is driving on a rural road at 70 km/h when a boar is unexpectedly crossing the street. The ego vehicle has to perform an emergency brake to prevent overrunning the boar.
	Object	Boar	
	Rule	Not given.	
3	*Place*	Highway Construction site	The ego vehicle is driving on a highway at 100 km/h. Ahead, a construction site appears with restricted speed of 60 km/h and including an S-curve to change the site of travel. Another car is overtaking the ego vehicle with 70 km/h at exactly at the S-part of the road. The ego vehicle has to stay in its lane.
	Object	Car	
	Rule	Stay in the lane.	
4	*Place*	Urban road Intersection	The ego vehicle is taking a right turn at an intersection. A pedestrian is unexpectedly crossing the street without a crosswalk. The ego vehicle has to perform a strong break up to a halt to let the pedestrian cross the street.
	Object	Pedestrian	
	Rule	Not given.	

Both the role of the cyclist and that of the pedestrian were played by a confederate. The overtaking vehicle in the highway scenario was driven by a professional test driver from DEKRA. Conducting several trial runs ensured a comparable timing between journey rides. To minimize learning effects, the route was driven in both directions, having the scenarios 1-4 happen in one route (hereafter: left-course), while the other has the order 4-1 of the scenarios (hereafter: right-course). An overview of the course is given in Figure 7, while the individual scenarios can be found in Figures 8-11.

Figure 7.

Schematic representation of the circuit developed for the study. X indicates the start and end point of the vehicle journey, while the numbers indicate the corresponding scenarios. Note: this course shows the left-course. For the right-course, the track and scenarios were experienced in reversed order.
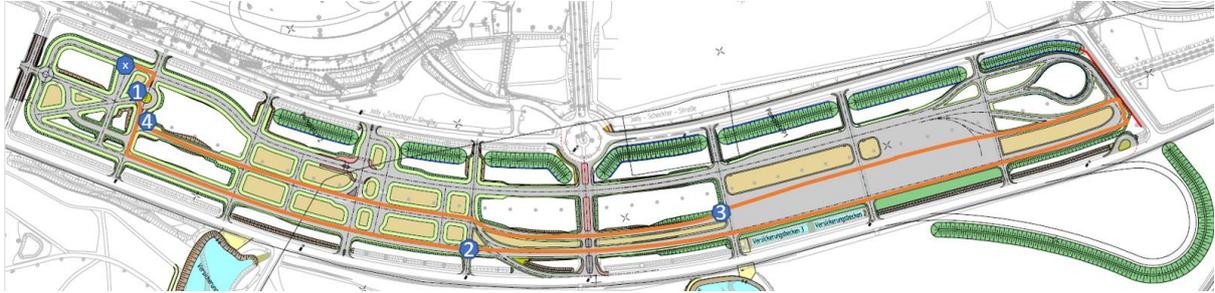
Figure 8.

Scenario no. 1: Cyclist using the roundabout on a bike-priority street.

Figure 9.

Scenario no. 2: A boar is crossing the road; the experimental vehicle must perform an emergency break.

Figure 10.

Scenario no. 3: The experimental vehicle is overtaken by another car inside the S-curve of the construction site.

Figure 11.

Scenario no. 4: A pedestrian is crossing the street without crosswalk.

Transparency displays

Depending on the experimental condition, the displays were either turned off, showed only the live stream or displayed an intention transparency overlay on top of the live stream, while perception transparency being either enabled or disabled in all three conditions, according on the corresponding grouping condition. Both overlays were programmed to superimpose the live stream video using Python 3.11 (64-bit).

Intention Transparency. The design of intention transparency was based on insights from previous studies investigating transparency in autonomous vehicles, the state of practice in navigation systems, German road signs, and Gestalt principles (ADAC, 2024; Beggiato et al., 2015; Bolton et al., 2015; Debernhard et al., 2016; Detjen et al., 2021; Graham, 2008). Additionally, an expert workshop was conducted, where a design proposal was evaluated by eight HELLA employees. Overall, the presentations were differentiated by navigation arrow, acceleration, braking, roundabout, turns, and a neutral state/standing (hereafter: navigation symbols; see Figure 12). Adobe Illustrator (Adobe, 2023) was used to design the navigation symbols, while Adobe Photoshop (Adobe, 2023) was utilized to put them into a degree perspective. DaVinci Resolve Version 18.6 (Blackmagic Design Pty. Ltd., 2023) was employed to create an animated video with the navigation symbols appropriate for each course and maneuver of the experimental vehicle. This overlay video was exported including the alpha channel color, allowing for a transparent background, and enabling it to be overlaid onto the live stream video without obstructing the view.

Figure 12.

Navigation symbols used for Intention Transparency display representation. From left to right: baseline arrow (turning up to 45 degrees to each side during turning); acceleration; Deceleration; roundabout upfront; 90-degree turn; 180-degree turn; 45-degree turn; emergency brake; halt.

Regarding the Gestalt principles, similarity was applied, as all presentations featured the same curve radius, perspective degree, color, and stroke weight. Additionally, proximity and similarity were utilized in the design of the acceleration and braking navigation symbols. Here, additional arrows were strategically placed with small gaps on top of the navigation arrow to create a perception of belongingness (Graham, 2008). The choice of presentation colors was guided by the figure-ground Gestalt principle, incorporating insights from Künzer (2015) regarding the perception of danger or safety based on coloration. Consequently, colors such as green or red were omitted, as they could erroneously imply safe or unsafe maneuvers of the experimental vehicle, potentially contradicting the actual situation (e.g., in the event of an emergency brake). Moreover, these colors are commonly interpreted as "stop" and "go" within the automotive context (Carmona et al., 2021). Cyan blue, recommended for external AV communication as a neutral color (Carmona et al., 2021; Dey et al., 2020), was deemed unsuitable in the present context, as it would not sufficiently contrast with the asphalt. Similarly, while purple was identified as a color neither denoting danger nor safety (Künzer, 2015), it was observed to face the same visibility issue as cyan. Previous AV designs have proposed prototypes featuring various colors, including magenta (Dey et al., 2015). Since purple is essentially magenta without any white proportion, the researchers concurred on this color due to its improved figure-ground effect compared to the more blueish purple or cyan, while still conveying a neutral vehicle state.

Previous research has frequently examined augmented reality (AR) representations of transparency, which emerged as a preferred representation by most participants (Bolton et al., 2015; Detjen et al., 2021). Given this prevalent preference, the researchers aimed to incorporate AR representations into their design, drawing inspiration from examples provided by Detjen et al. (2021). As part of this effort, the perspective of the navigation symbols was adjusted by two 8-degree rotations to create the illusion of them lying on the ground, with the experimental vehicle driving over them (Figure 13). Additionally, intention transparency functionality was integrated into the Python code, allowing it to function independently and in conjunction with perception transparency.

Figure 13.

Example of the intended Intention Transparency display manipulation.

Perception Transparency. Perception transparency was generated using Ultralytics' object recognition software YOLOv8 (Ultralytics Inc., 2023). YOLOv8 is a real-time object detection and image segmentation model based on deep learning and computer vision. It offers models of varying package sizes, with the small package selected for this study's execution. Larger packages were found to introduce increased display manipulation delays without significantly enhancing object detection performance under the given conditions.

YOLOv8 can detect objects belonging to different classes defined in the COCO dataset (Ultralytics Inc., 2023). For this study, only the categories of person, bicycle, and car were utilized to identify road users. Categories such as road signs were excluded due to the software's inability to identify all signs used in the course. Additionally, a variety of animals (cat, dog, horse, sheep, cow, elephant, bear) were employed to identify the boar, as there is no specific category for it in the dataset.

Assigning different color to each category resulted in a cluttered scene due to the software frequently switching categories based on confidence levels for individual objects. Therefore, the code was modified to assign a single color to all objects. To select this color, it was matched with the design of intention transparency to ensure sufficient contrast between both transparencies. Cyan was considered, given its common use in representing external AV communication. Since cyan encompasses a range of hues, a bluish direction was chosen, which was deemed safer than purple but not as safe as green (Künzer, 2015).

Processing both live stream video and vehicle transparency overlays, the Jetson delayed the live feed. To minimize this delay, intention transparency quality was decreased, leading to more scattered boundaries of the navigation symbols in the study itself (see Figure 14).

Figure 14.

Example of the vehicle transparency display used in the study implying Intention Transparency and Perception Transparency. Note: the quality of Intention Transparency representation was decreased to minimize delay in the live stream video.

Non-driving related task

During the ride, the participants engaged in a NDRT aimed at exploring the potentialities of fully autonomous vehicles and fostering social interaction. However, participants were not compelled to focus solely on the task, but rather encouraged to engage with it to the extent they felt comfortable. Thus, the criteria for selecting the NDRT were that it should be interactive and engaging, easy to play in a minimally equipped environment, have visual prominence, and entail manageable cognitive demands. Based on these criteria, researchers evaluated several game suggestions in expert workshops and ultimately chose the parlor game "Categories" as it best met these criteria. The NDRT was presented to participants via eight tables, each with a different set of categories, provided on paper and attached to clipboards.

Scales

All questionnaires and instructions were in German. Scales which were not available in German were translated using a back-translation method with an independent colleague. In this process, one of the researchers translated the questionnaire into the desired language, German, and the colleague then translated the questionnaire back into English. The new translation was compared with the original to identify any deviations and determine if further adjustments to the translation were necessary. All data were processed confidentially, with questionnaires pseudonymized using a participant code that participants were required to fill in at the beginning of each questionnaire. Online questionnaires were administered to participants using LimeSurvey Cloud Version 5.6.49.

Pre-questionnaire. Overall, the pre-questionnaire was divided into demographic and biographical questions, as well as several other rubrics. The latter will be discussed in the following segments. The entire questionnaire can be found in Appendix B.1.

Driving. This segment included questions about the participants' driving experience and their transportation behavior. The former was explored by asking about the number of years the participants have held their driver's license and their annual distance driven in kilometers. Additionally, participants were asked about the frequency with which they used various means of transportation (daily; several days a week; once a week; several times a month; once a month; several times a year; once a year) and their level of pleasure while driving (no pleasure; scarce pleasure; a little pleasure; much pleasure; a lot of pleasure). Both questions were differentiated regarding driving as a driver versus co-driver, drawing on insights of Paddeu et al. (2020). The frequency and pleasure of driving can influence acceptance of and trust in AVs. Furthermore, the question about means of transportation considers the aspect that individuals must trust the driver of the vehicle in such situations, as they are unable to take control themselves. Consequently, familiarity with not being able to control the vehicle may influence trust levels in autonomous cars.

Automation. A second segment comprised questions about the participants' prior knowledge of autonomous driving and their experience with various car automation systems, assessed using 5-point rating scales ($Scale_{PriorKnowledge}$: no prior knowledge; little prior knowledge; some prior knowledge; thoroughly prior knowledge; encompassing prior knowledge; $Scale_{Experience}$: no experience; little experience; some experience; thoroughly experience; encompassing experience). Additionally, participants were asked about their expectations regarding the driving style of an AV, rated on a Likert scale ranging from 1 (very cautious) to 6 (very sporty). This question was assessed during the pre-questionnaire as well as after each vehicle journey to compare expectations with actual perception afterwards. The performance of the pedal and steering robot was evaluated to determine how representative it was as an AV. Lastly, the participants were asked about their affinity to technology (ATI) using Franke et al.'s (2019) questionnaire with the proposed 6-point rating scale (completely disagree; largely disagree; slightly disagree; slightly agree; largely agree; completely agree). This provided insights into participants' level of interest in new technology, potentially influencing their trust levels.

Propensity to trust. The participants' propensity to trust was assessed using Sinha et al.'s (2008) Propensity to Trust Machines scale (see Merritt, 2011 and Merritt et al., 2013). This six-item questionnaire was assessed using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). It was translated to German using the back-translation method. As emphasized by Merritt et al. (2013), propensity to trust influences the pattern of actual trust over time, with individuals showing higher initial trust levels if their propensity is high. This elevated level tends to

persist until the automation makes errors, at which point these individuals experience a more significant drop in trust levels compared to those with a lower propensity to trust automation systems. To account for the initial level of trust toward the experimental vehicle and potential errors of the self-driving system, propensity to trust was assessed in advance.

Motion sickness. Finally, two questionnaires were administered to assess participants' susceptibility to motion sickness across different means of transportation. The first questionnaire was based on Han et al.'s (1998) research on preferences for using trains in a rearward-facing position. Han et al. (1998) employed magnitude estimation to quantify preferences for design alternatives on a 0 to 100 continuum. Adding means of transportation suggested to be susceptible to motion sickness (Golding, 2006), this study used several transportation modes to estimate its preference. Considering the focus on seating orientation of the present study, each mode of transportation was further categorized into forward and rearward-facing seating positions. Modes of Golding (2006) not suitable for rearward-facing seating (i.e., coaches, aircraft, swings in playgrounds) were excluded from the questionnaire. A scale derived from Han et al. (1998) was used, ranging from 0 (no preference / dislike) to 100 (strong preference) in increments of 10, additionally labeling 40 (some preference) and 70 (preference). Ultimately, the magnitude estimation of this survey helped categorizing participants' overall preference for rearward-facing seating.

Secondly, participants were asked about their history of motion sickness experiences as children and during the past ten years, using the Motion Sickness Susceptibility Questionnaire Short-form (MSSQ-Short; Golding, 2006). The results of the MSSQ-Short will be used as a reference variable to evaluate how well the study sample represents the motion sickness susceptibility of the broader population.

In-situ questionnaires. Two kinds of questionnaires were used during the in-situ study: a live scale asking about trust and motion sickness during the vehicle journey, and more elaborative questionnaires administered between the vehicle rides.

Live scales. During the vehicle journeys, participants rated their trust and motion sickness levels at the beginning and end of each journey, as well as approximately 10 seconds after each scenario. This was done using two one-item scales, presented in tables next to each other, with the aim of continuously measuring these two constructs (see Appendix B.2). Such scale format is advantageous to longer scales as it minimizes distraction from the NDRT or the vehicle ride itself, enabling the recording of data variability during stimulus presentation and capturing its time course (Keshavarz & Hecht, 2011). Consequently, it allows for higher temporal resolution, facilitating the monitoring of trust and motion sickness development over time.

To capture motion sickness during the ride, the Fast Motion sickness Scale (FMS; Keshavarz & Hecht, 2011) was used. It is a one-item scale ranging from 0 (no sickness at all) to 20 (frank

sickness). Given the divers symptoms of motion sickness, a brief description was provided to all participants in form of an information text above the respective table. For the assessment of trust, the scale utilized by Lu and Sarter (2019) was used, prompting participants to rate their current level of trust on a scale ranging from 0 ("I do not trust this vehicle at all") to 9 ("I completely trust this vehicle"). Hereby, the original term "these UAVs" was replaced by "this vehicle" to suit the given context.

The live scales were given to the participants on paper, which was clipped behind the NDRT on the clipboard in six editions. Both scales were assessed consecutively to minimize confusion or distraction from the NDRT.

Between the rides questionnaires. On a Samsung Tablet TabA8, questionnaires were assessed between each vehicle journey individually (Appendix B.3).

Trust was measured using the Situational Trust Scale for Automated Driving (STS-AD; Holthausen & Wintersberger et al., 2020). It is a six-item scale, developed to assess different aspects of situational trust corresponding to the trust dimensions proposed by Hoff and Bashir (2015). Thereby, it includes components about trust, performance, NDRT, risk, judgement, and reaction rated on a seven-point Likert scale ranging from 1 (fully disagree) to 7 (fully agree). Although originally designed to be assessed after each scenario, the questionnaire itself was found to be suiting for the given context, i.e., AVs. Consequently, the questionnaire was adapted for this study by changing "in this situation" into "during the ride" to account for the temporal shift.

Next, participants were asked about their perceived level of the vehicle's intention transparency and perception transparency using a self-devised scale by Rottmann et al. (Under Review). Responses were recorded on a six-point Likert scale ranging from 1 (fully disagree) to 6 (fully agree).

Perceived driving style was assessed using the same scale as in the pre-questionnaire, based on previously outlined reasons.

Behavioral intention to use such a vehicle in rearward facing seating position was measured using a dichotomous scale. Specifically, participants were asked "Would you use such a vehicle if you were seated against the direction of travel?".

Finally, feedback on the display representations was included. Participants were asked to report on the frequency of display monitoring and awareness using a six-point Likert scale ranging from 1 (fully disagree) to 6 (fully agree). Further, participants were asked to evaluate the display representations based on the short version of the User Experience Questionnaire (UEQ-S; Schrepp et al., 2017) in German. It is an eight-item short version to measure the subjective impression of users towards the user experience of products (Schrepp et al., 2017). It served as a reference measurement to determine if user experience ratings were related to the transparency ratings. Given that there were

conditions where the displays were turned off, a "not applicable" option was provided for all questions about the displays in all questionnaires administered between rides.

Procedure

Several days before the in-situ study, participants were provided with a link to the pre-questionnaire, which they were instructed to complete beforehand.

On the day of the study, participants were welcomed by the experimenter, who verbally explained the study's purpose, test procedure, and participants' rights. After addressing any queries, participants were given the informed consent form to review and sign. Next, the eye trackers were introduced and explained to participants before helping them setting those up. For participants wearing glasses, eyesight correction lenses were integrated into the eye-tracker´s head unit.

Before taking a seat inside the vehicle, the steering robot was presented to participants to make them more aware of the autonomy of the experimental vehicle. Questions about the steering robot's capabilities were deferred until the end of the study. This was done to avoid influencing trust ratings by disclosing that the robot follows a preprogrammed route. Only questions about whether the steering robot would drive on its own were affirmed. Throughout the study, the experimenter emphasized "automated" driving rather than "autonomous" driving to prevent misinformation.

From there, participants were requested to take their seat and wire the eye tracker to the ethernet cables inside the experimental vehicle. Instructions were provided for the questionnaires on the tablet, the NDRT and live scale on the clipboard including the NDRT´s rules, as well as the displays were explained. Regarding the NDRT, the researcher stressed that the scores would not be part of the analysis and that participants could engage in the task to the extent they are comfortable with it. Afterwards, the eye tracking glasses were calibrated, and the first ride would start if all remaining questions were answered.

Following each vehicle journey, participants were asked to hand the live scale corresponding to the ride number to the front of the car, and to complete the between the ride questionnaire on the tablet. When the participants were finished, they were instructed to change seats inside the car based on a predetermined randomization. This randomization included either changing seats with the person next to or in front of oneself, but not changes at both axes at once. Everyone experienced three journeys in forward facing and three journeys in rearward facing seating position. Moreover, the change between driver´s seating side and co-driver´s seating side ensured that every participant experienced the ride in forward facing seating position on the co-driver´s seating side at least once; this was the seat were the pedal and steering robot was visible best. To prevent losing time, ethernet cables of the eye tracking glasses were not unwired during change. When everyone was seated correctly, participants were asked to fill in the participant code on the next live scale, and the next ride would start. Overall, participants completed six rides, experiencing random orders of left-handed and right-handed courses.

After completing all courses and between the ride questionnaires following this same procedure, the experimenter assisted the participants in unwiring and taking off the eye trackers, thanked the participants for their participation, and provided contact details for any further questions. A debriefing about the robot's real capabilities was given to all participants via email at the study's conclusion to ensure consistent information about the vehicle's automation level. Participants should not be able to reveal such information to other future-participants they might know.

Data analysis

Trust was measured during the vehicle ride using a single item question (hereafter: intra-journey trust), as well as between the rides using the STS-AD, both tested separately in the data analysis. Furthermore, the first item of the STS-AD was used as it is declared by the authors to measure the construct of trust in specific (Holthausen & Wintersberger et al., 2020). Consequently, the first item of the STS-AD and intra-journey trust should measure the same construct which was tested accordingly throughout the analysis. Within the scope of this chapter, trust will be used to refer to all three variables, intra-journey trust scores, STS-AD scores and first item of STS-AD scores, but will be used separately from the Results section on. All quasi-continuous data, i.e., intention transparency score, perception transparency score, trust score and motion sickness score, were tested for normality using Shapiro-Wilk tests, with violated normality leading to the use of nonparametric tests.

As exploratory analyses, MSSQ-raw scores and percentiles were calculated using Golding´s (2006) instructions. Hereby, a close approximation of the percentile score using the given formula was used. Consequently, small deviations from Golding´s (2006) percentiles were possible as those were calculated with raw to percentile conversions. The magnitude estimation method of Han et al. (1998) was used to calculate preference scores of sitting rearward versus forward in transportation. Driving style expectations measured in the pre-questionnaire were compared with the perceived driving style during the study using a two-tailed paired t-test. Moreover, the relationship between perceived driving style during the study and the variables seating orientation, trust, and motion sickness were investigated.

Based on the condensed version of the ADAM (Rottmann, 2023) tested in the present study, seating orientation (forward; rearward) was handled as an independent variable which effect was tested upon all other variables in the model, i.e., intention transparency, perception transparency, trust, motion sickness, and behavioral intention. The effect of seating orientation on the variables measured by a Likert scale, hence having quasi-continuous values, were tested using a one-tailed paired t-test. The effect of seating orientation on behavioral intention was tested using a Pearson chi-square test due to comparing two dichotomous variables with each other.

To facilitate drawing causal inferences regarding the impact of intention transparency on trust and motion sickness and perception transparency on trust, display manipulations (intention

transparency; live video stream; turned off) as a within-subject mediator and perception transparency (on; off) as a grouping mediator of the model were used to manipulate intention transparency scores and perception transparency scores. To assess the success of the manipulation, a manipulation check was conducted for each of this mediator. The effect of display manipulation on intention transparency scores was tested using individual one-tailed paired t-tests for each display manipulation option on intention transparency scores. To test the effect of perception transparency on perception transparency scores a one-tailed pairwise sample t-test was done.

Based on the results of the manipulation check, intention transparency and perception transparency were used as control variables. Hence analyses were done but no causal conclusions could be drawn. Hereby, the influence of intention transparency scores on the dependent variables motion sickness and trust as well as the influence of perception transparency scores on the dependent variable trust were tested using a Generalized Linear Multilevel Model (GLMM) using Template Model Builder (TMB) with a logit link beta distribution. This specific GLMM model uses maximum likelihood estimation via TMB (Magnusson, 2017). Beta distributions are suitable for (quasi)continuous scales like Likert scales (Schmettow, 2021). Models created within these analyses were compared to the baseline model only including participant ID as a random intercept (to account for repeated measurement) and number of vehicle journeys as a random slope. Further, all possible constellations of predictor variables models were tested. The model fit was evaluated using the smallest χ^2 and lowest Akaine Information Criterion (AIC).

The dichotomous variable behavioral intention was used as a dependent variable, using trust and motion sickness as control variables. The influence of trust and motion sickness on behavioral intention was investigated using binomial multilevel modelling, i.e., a mixed effects logistic regression. Models created within these analyses were compared to the model only including participant ID as a random intercept to account for repeated measurement and individual development, models adding number of vehicle journeys as a random slope, and models including each predictor variable on its own as well as combined. The model fit was evaluated using the smallest χ^2 and lowest Akaine Information Criterion (AIC). All analyses were done using R version 4.3.1 (The R Foundation, n.d.).

Results

Descriptive analysis

Descriptive analyses were based on a sample of 45 participants, as one participant did not fill out the pre-questionnaire. Of the initial 51 participants, five participants (10%) prematurely abandoned the study due to high motion sickness. These dropouts were excluded from the analyses and only used for a descriptive comparison. The remaining participants of the study owned their driving license for 13.79 years on average (*SD* = 9.93, *min* = 0, *max* = 33). On average, they drove

18,389 km per year (*SD* = 11,558, min = 0, max = 40,000), and had greater joy driving as a driver compared to being driven (driver: *M* = 4.36, *SD* = .86, *min* = 1, *max* = 5; co-driver: *M* = 3.18, *SD* = .84, *min* = 1, *max* = 4). Using a car as mode of transportation was most frequently used by the participants (see Table 3). Prior knowledge in the field of autonomous driving averaged 2.1 (*SD* = .69, *min* = 1, *max* = 3.67). Mean ATI was 4.2 (*SD* = .91, *min* = 1.67, *max* = 6), while Propensity to Trust Technology was rated 3.66 on average (*SD* = .74, *min* = 1.83, *max* = 5).

Table 3.

Proportion of means of transportation usage per year.

Means of transportation	Daily	Several times a week	Once a week	Several times a month	Once a month	Several times a year	Once a year
Car as driver	75.6	17.8	2.2	0	2.2	0	2.2
Car as co-driver	0	26.7	13.3	35.6	13.3	6.7	4.4
Train	2.2	6.7	2.2	7	4.4	35.6	48.9
Bus	2.2	4.4	2.2	2.2	4.4	24.4	60

The mean MSSQ-Short raw score was 8.35 (*SD* = 8.54, *min* = 0, *max* = 32.38). Compared to the population tested by Golding (2006), participants´ susceptibility scores were between the 0th and 96.58th percentile with an overall mean of 38.5th percentile against Golding´s (2006) population. The percentile including dropout participants shifted the overall mean to the 43.8th percentile (*min* = 0th percentile, *max* = 100.2nd percentile), showing higher motion sickness susceptibility in dropout participants. Based on magnitude estimation, sitting forward was clearly preferred over sitting rearward in transportation means, with sitting rearward in cars was rated as third least preferred means of transportation (see Appendix C.1).

Variable exploration

Analyzing the dependencies of intention transparency scores and perception transparency scores, both measured on a scale from 1 to 6 between each vehicle journey hence six times in total, Kendall´s tau correlation was used due to violated normality (intention transparency: *W* = .98, *p* = 0.001, *M* = 3.74, *SD* = 1, *min* = 1, *max* = 6; perception transparency: *W* = .97, *p* < .001, *M* = 4.43, *SD* = .74, *min* = 2.67). It revealed a significant relationship (*z* = 2.95, *p* = .003) with a small effect size (*τ* = .132).

Trust was measured during the vehicle ride using a single item question (hereafter: intra-journey trust) asked six times throughout one vehicle journey on a scale ranging from 0 to 9, hence 36 times in total. Further, it was measured between the rides using the STS-AD ranging on a scale from 1 to 7, hence six times in total. Due to violated normality of the data, the mean scores of during (i.e., intra-journey trust) and between (i.e., STS-AD) the vehicle journeys trust scores (intra-journey trust:

W = .86, p < .001, M = 7.87, SD = 1.23, min = 3, max = 9; STS-AD: W = .99, p = .048, M = 4.79, SD = 0.89, min = 2.17, max = 7) revealed a significant Kendall´s tau correlation (z = 9.66, p < .001, τ = .42), which can be interpreted as a small to moderate effect. The comparison of scores of the first item of STS-AD (M = 5.5, SD = 1.24, min = 2, max = 7) with mean intra-journey trust scores found a significant correlation with an effect size of τ = .584 (z = 12.43, p < .001). The correlation might be interpreted as moderate to large, but the extent is not in line with the expectations of the researchers. Therefore, the questionnaires cannot be seen as equivalents of one another, and separate analyses will be carried out for each variable.

Motion sickness using the FMS ranging from 0 to 20 was assessed six times throughout one vehicle journey, hence 36 times in total. An analysis using Kendall´s tau due to violated normality (W = .73, p < .001, M = 1.76, SD = 2.56, min = 0, max = 11) found a negative correlation with weak effect (z = -5.92, p < .001, τ = -.27) between intra-vehicle trust scores and FMS scores. Histograms visualizing the distributions of the scores of the analyzed variables, i.e., intention transparency, perception transparency, intra- journey trust, STS-AD, and motion sickness can be found in Appendix C.2.

Driving Style

Driving style was measured on a scale from 1 (very cautious) to 6 (very sporty) in the pre-questionnaire and after each vehicle journey. Using a two-tailed paired t-test, the perceived driving style during the study (M = 4.41, SD = .81) was rated as significantly more sporty than the optimal driving style (M = 2.78, SD = 1) asked beforehand (t(44) = 8.355, p < .001), with Cohen´s d = 1.8. This represents a large effect size (Cohen, 1992).

There was a significant correlation between perceived driving style and STS-AD scores (z = 3.768, p < .001, τ = -.223) as well as FMS scores (z = 2.137, p = .022, τ = .103), implying weak effects for both correlations. Perceived driving style and intra-journey trust revealed no significant correlation. Hence, higher ratings of perceived driving style correlated with lower inter-journey trust ratings, while motion sickness ratings increased within the same increase of driving style scores. Using a two-tailed paired t-test, perceived driving style differed only descriptively between both conditions of seating orientation (forward: M = 4.362, SD = 1.053; rearward: M = 4.507, SD = .953; t(137) = -1.926, p = .056).

Development along the number of journeys

Visual inspection of the development of intra-journey trust over the course of vehicle journeys showed no noticeable difference between the vehicle journeys. Descriptively, the development throughout queries is similar, starting and ending with higher individual Trust scores compared to scores during the ride. Comparing curves including and excluding dropouts, the curve including dropouts is visually lower.

Over the course of vehicle journeys, motion sickness showed a linear-like development with a stagnation after the fifth journey (see Figure 15). Descriptively, the pattern within journeys is similar, having a steep development in the beginning which slightly decreases after half of the route, subsequently starting off again lower after the break between the journeys. The mean development values are descriptively higher including data of the five dropout-participants compared to data without dropouts.

Figure 15.

Mean motion sickness development over the course of the vehicle journeys with and without dropouts, measured using the FMS. Note that motion sickness was depicted on a scale from 0 to 20. For visibility reasons, the scale is only depicted from 0 to 4.5.
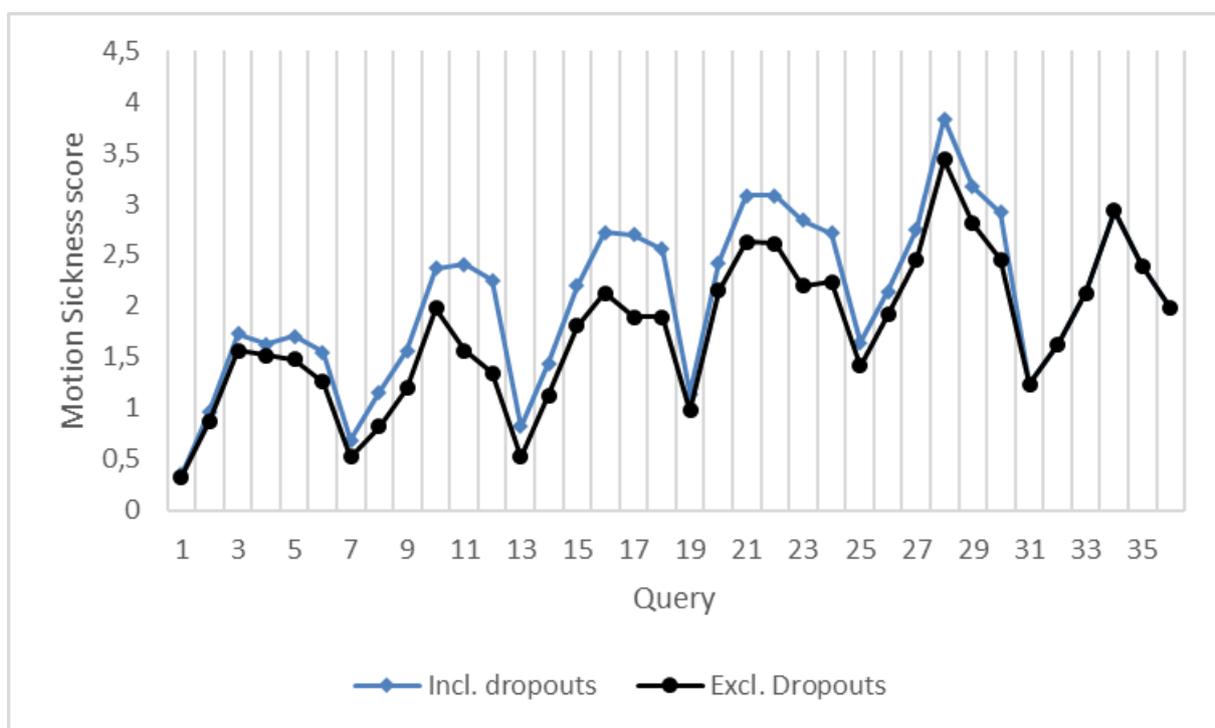
Seating orientation

A one-tailed paired t-test was used to estimate the effect of seating orientation on intention transparency scores and perception transparency scores, respectively. Intention transparency scores for rearward facing participants ($M = 3.48$, $SD = 1.03$, $SE = .088$) were significantly lower compared to forward facing participants ($M = 4$, $SD = .90$, $SE = .08$; $t(137) = 5.56$, $p < .001$). The effect size calculated by Cohen´s d was small ($d = .47$). Hence, H1a, rearward facing passengers report lower intention transparency scores than forward facing passengers, was confirmed. For perception transparency scores, the difference between sitting rearward facing ($M = 4.39$, $SD = .72$, $SE = .061$) versus sitting forward facing ($M = 4.473$, $SD = .758$, $SE = .064$) was not significant ($t(137) = 1.435$, $p = .077$). Consequently, H1b, rearward facing passengers report lower perception transparency scores than forward facing passengers, was rejected.

A one-tailed paired t-test showed that intra-journey trust in rearward facing seating position ($M = 7.76$, $SD = 1.34$, $SE = .11$) was significantly lower compared to forward facing seating position ($M = 7.98$, $SD = 1.1$, $SE = .09$; $t(137) = 3.63$, $p < .001$). However, the effect was small ($d = .31$). The same test was used for comparing the effect of seating orientation on the mean scores of STS-AD. Rearward facing participants ($M = 4.71$, $SD = .889$, $SE = .08$) experienced significantly lower levels of trust compared to forward facing participants ($M = 4.89$, $SD = .9$, $SE = .08$; $t(137) = 2.66$, $p = .004$). However, the effect size was small as well ($d = .23$). Hereby, H1c, rearward facing passengers report lower trust scores than forward facing passengers, is confirmed.

A Wilcoxon signed rank test with continuity correction showed that motion sickness in the rearward facing seating position ($M = 2.02$, $SD = 2.78$, $SE = .24$) was significantly higher compared to the forward facing seating position ($M = 1.51$, $SD = 2.3$, $SE = .2$; $V = 1189.5$, $p < .001$). The effect size was small ($d = -.34$). Consequently, H1d, rearward facing passengers report higher motion sickness scores than forward facing passengers, was confirmed.

A Pearson chi-square test was used to estimate the relationship between seating orientation on behavioral intention. This relationship was found to be significant with $\chi^2(1) = 12.42$ ($p < .001$) and an effect size of Cramer´s V of .22, representing a small effect. A post-hoc test confirmed the difference in responses between forward and rearward facing participants. Consequently, H1e, rearward facing passengers report lower levels of behavioral intention to use such a vehicle in rearward facing seating position than forward facing passengers, was confirmed.

Manipulation check

For conducting a manipulation test whether the displays have successfully manipulated the perception of intention transparency and perception transparency, individual one-tailed paired t-tests for display manipulations (intention transparency on vs. Live Feed vs. Off) on intention transparency scores, and a one-tailed pairwise sample t-test for perception transparency grouping (perception transparency on vs. perception transparency off) on perception transparency scores were executed. For intention transparency, the display manipulations were tested against intention transparency scores individually (intention transparency on: $M = 3.81$, $SD = 1.05$; Live Feed: $M = 3.76$, $SD = .9$; Off: $M = 3.65$, $SD = 1.05$). None of the combinations showed significant differences (see Table 4). Consequently, H2, displaying upcoming maneuvers on in-vehicle displays during the vehicle journey leads to higher intention transparency scores than not displaying upcoming maneuvers, was rejected.

Table 4.

Two-tailed paired t-test of display manipulations on intention transparency scores.

Compared display manipulations	t-value	df	p-value
Intention transparency on vs. Off	1.27	91	.1
Intention transparency on vs. Live Feed	.5	91	.31
Live Feed vs. Off	1.37	91	.09

The independent t-test between the groups (perception transparency on: $M = 3.71$, $SD = .63$; perception transparency off: $M = 3.73$, $SD = 0.68$) was not significant ($t(274) = -.24$, $p = .6$). Therefore, H3, displaying detected traffic objects on in-vehicle displays during the vehicle journey leads to higher perception transparency scores than not displaying upcoming maneuvers, is rejected. Since rejecting both hypotheses means that neither manipulation was successful, only descriptive statements on the relationships between intention transparency and perception transparency on trust and motion sickness can be drawn. Consequently, H4a, H4b, and H5 can only be answered descriptively. Hence, intention transparency and perception transparency will not be used as mediators but control variables for further analysis. Visualization of the manipulation variables can be found in Figures 16 and 17.

Figure 16.

Boxplots including individual data points of intention transparency scores separated in display manipulation and grouped by seating orientation.
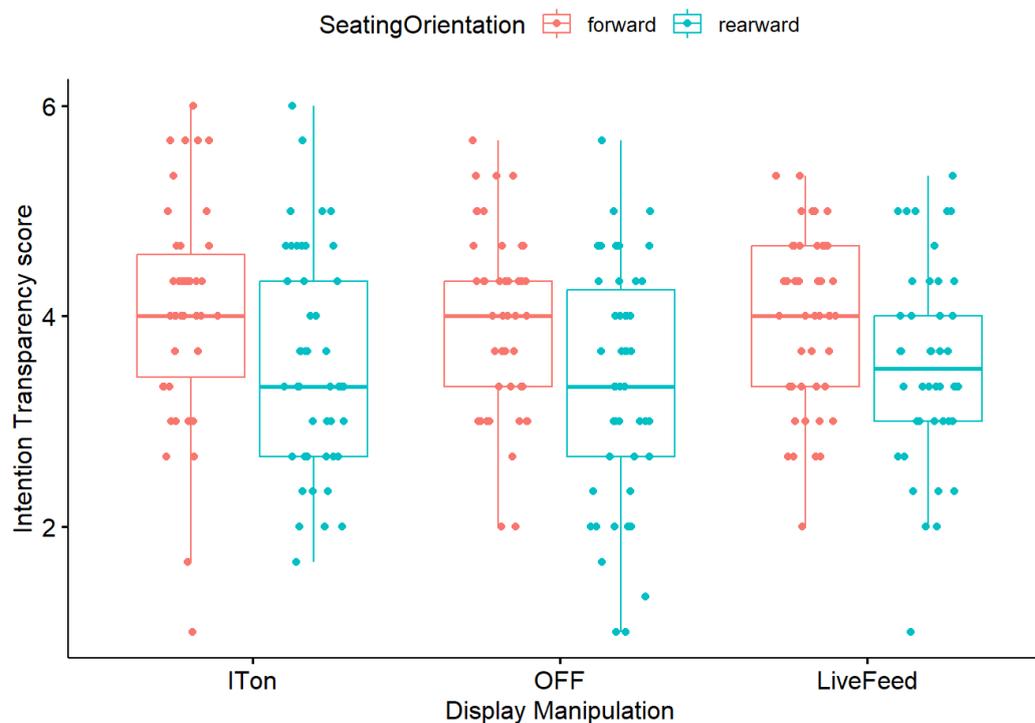
Figure 17.

Boxplots including individual data points of perception transparency scores separated by experimental perception transparency grouping condition and grouped by seating orientation.
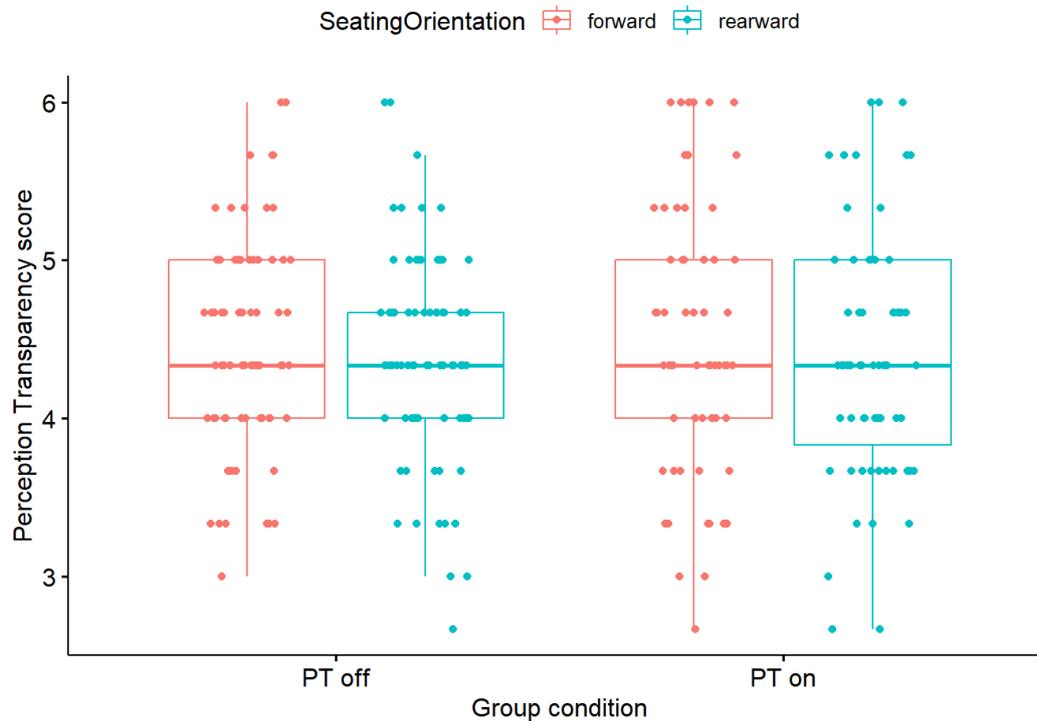
Display usage and experience

Subsequent testing was done to investigate the failure of display manipulation by considering perceived display usage, assessed on a scale 1 to 6, and user experience measured using the UEQ-S on a scale from 1 to 7, all assessed after each vehicle journey, hence, six times in total. On average, display usage was rated 3.88 ($SD = 1.58$, $min = 1$, $max = 6$). Evaluating the histogram of display usage (Figure 18), it indicates a clear distinction between participants who used the displays and those who did not, showing few scores around the mean but more scores towards the extremes. A comparison between display manipulations regarding display use using a pairwise t-test with Bonferroni corrections found significant difference between the conditions "intention transparency on" ($M = 4.34$, $SD = 1.38$) and "Off" ($M = 2.84$, $SD = 1.46$; $t(97.51) = 5.77$, $p < .001$) and between the conditions "Live Feed" ($M = 4.06$, $SD = 1.57$) and "Off" ($t(107.55) = 4.47$, $p < .001$), but not between "intention transparency on" and "Live Feed" ($t(154.83) = 1.19$, $p = .71$). A Welch two sample t-test revealed a significant effect of experimental group on display usage (perception transparency on: $M = 4.274$, $SD = 1.425$; perception transparency off: $M = 3.54$, $SD = 1.6355$; $t(206) = -3.46$, $p < .001$). An unpaired t-test found no significant difference between display usage and seating orientation, however descriptively, differences can be seen (Forward: $M = 3.71$, $SD = 1.61$; Rearward: $M = 4.04$, $SD = 1.54$; $t(206) = -1.54$, $p = .125$).

Figure 18.

Histogram of display usage frequency sampled on a scale from 1 to 6 between the vehicle journeys in blocks of .83 points in the score.
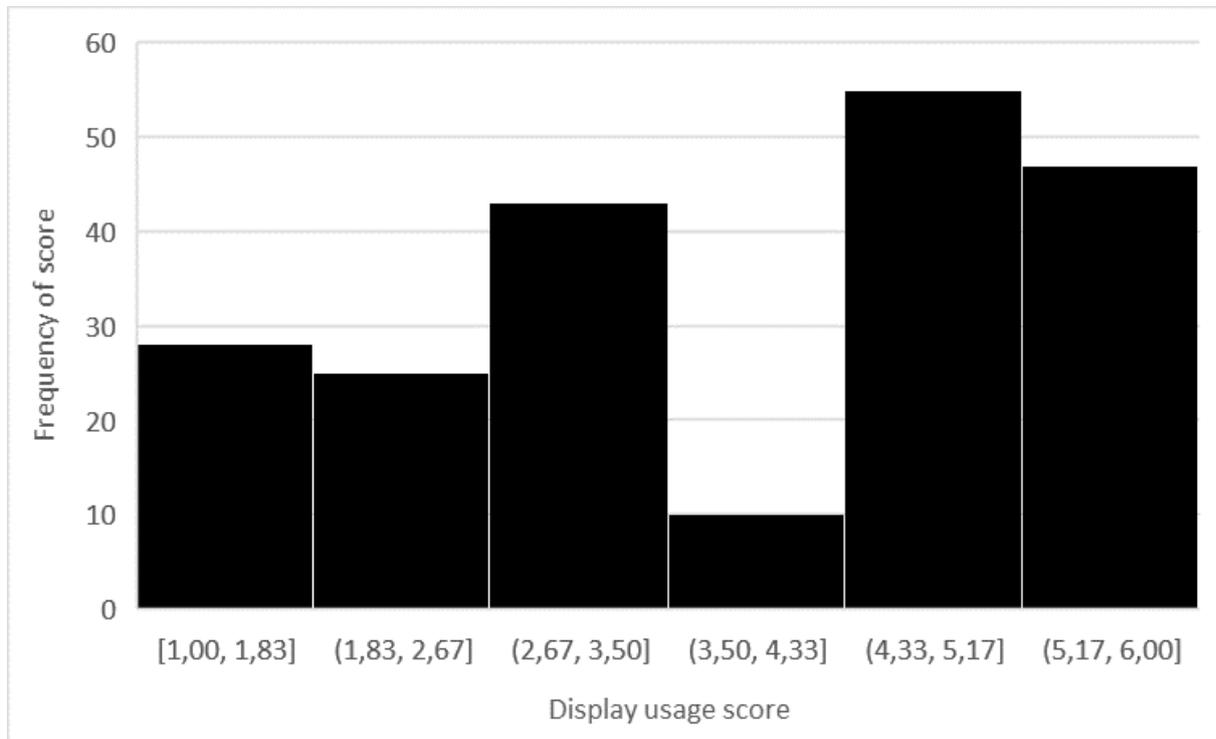
When comparing the UEQ-S scores between display condition "intention transparency on" and "Live Stream" using a Wilcoxon rank test due to violated normality of the data, a significant difference was found for the item "usual/leading edge" ($W = 3502.5$, $p = .027$; see Figure 19). Overall, the scores for hedonic quality of "intention transparency on" are higher compared to "Live Stream", however lower for pragmatic quality.

Figure 19.

Visual comparison of the normed UEQ-S scores between the display manipulations Intention transparency on and Live Feed with mean scores on the bars. The numbers on the y-axis represent the respective items of the UEQ-S. * indicates a significant difference between the conditions (p ≤ .05).
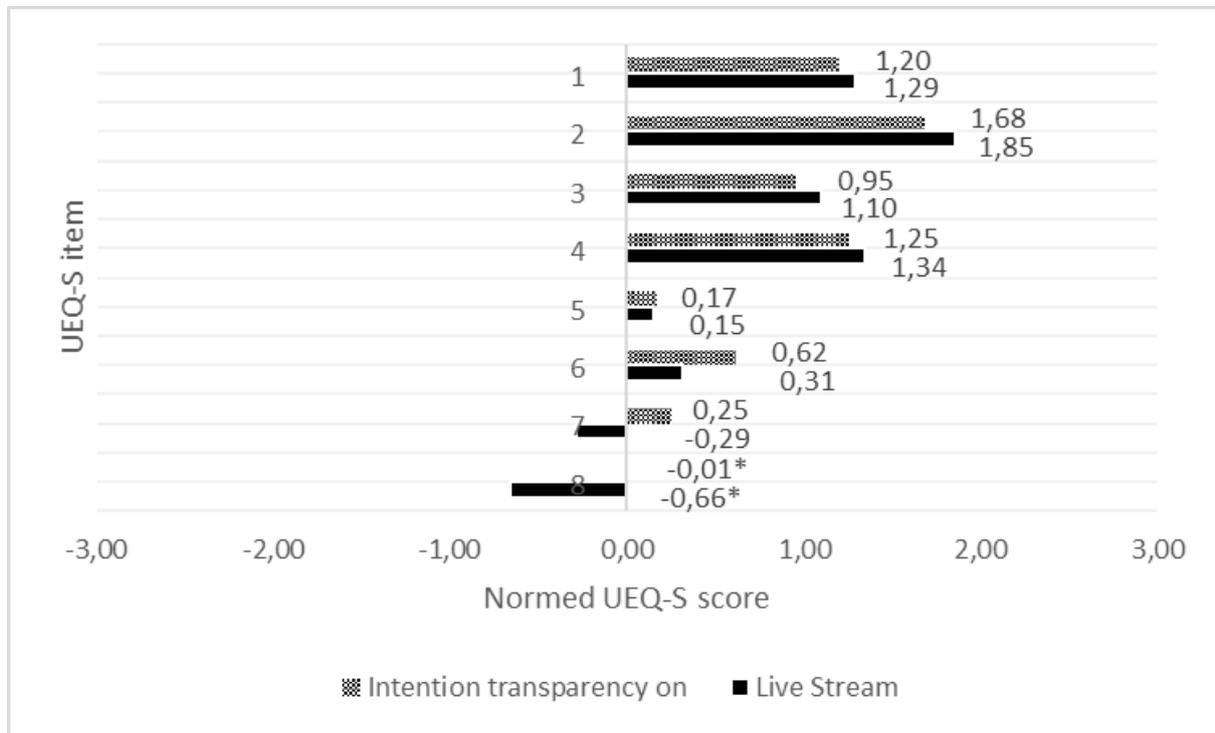
Vehicle transparency

Using a GLMM with TMB and logit link beta distribution, the effect of intention transparency and perception transparency on intra-journey trust scores was tested. Participant ID showed significant variance in intercepts across participants ($SD = 1.91$, *95%-CI*: 1.49, 2.44) as well as number of vehicle rides as random slope ($SD = .27$, *95%-CI*: .2, .38). Further, the intercepts and slopes were negatively and significantly correlated, *cor* = - .62 (*95%-CI*: -.78, -.31), leading to an improved model fit of $\chi^2(2) = 10.79$, $p = .005$. Perception transparency scores showed a significant relation with intra-journey trust ($b = .272$, $SD = .097$, $p = .005$, *95%-CI*: .083, .462), but not intention transparency scores ($b = .069$, $SD = .072$, $p = .341$, *95%-CI*: -.073, .211). This implies that an increase in perception transparency score had a positive influence on the intra-journey trust score. Consequently, using the intra-journey single-item to assess trust, a reformulated H4a, intention transparency mediates the effects of seating orientation, such that sitting rearward faced has less of a negative effect when paired with high intention transparency and leads to higher trust scores than when not displaying upcoming maneuvers, was rejected while H5, perception transparency measured between vehicle journeys mediates the effects of seating orientation, such that sitting rearward faced has less of a negative effect when paired with high perception transparency and leads to higher trust scores than when not displaying perception transparency, was confirmed.

The same GLMM was used to investigate the influence of intention transparency and perception transparency on STS-AD scores. Participant ID showed significant variance in intercepts across participants (SD = .562, $95\%\text{-}CI$: .538, 1.046) as well as number of vehicle rides as a random slope (SD = .01, $95\%\text{-}CI$: .07, .15). The intercepts and slopes were negatively but not significantly correlated, cor = - .49 ($95\%\text{-}CI$: -.78, .13), still leading to an improved model fit of $\chi^2(4)$ = 29.6, $p <$ .001. Intention transparency scores showed a significant relation with STS-AD scores (b = .08, SD = .04, p = .02, $95\%\text{-}CI$: .01, .15), but not perception transparency scores (b = .09, SD = .05, p = .08, $95\%\text{-}CI$: -.01, .19). This implies that an increase in intention transparency score had a positive influence on the STS-AD score Consequently, using the inter-journey STS-AD to assess trust, H4a was confirmed while H5 was rejected.

Again, the same GLMM was used to investigate the influence of intention transparency on FMS score. Participant ID showed significant variance in intercepts across participants (SD = 1.52, $95\%\text{-}CI$: 1.15, 2.03) as well as number of vehicle rides as a random slope (SD = .32, $95\%\text{-}CI$: .24, .44). Further, the intercepts and slopes were negatively and significantly correlated, cor = - .46 ($95\%\text{-}CI$: -.7, -.07), leading to an improved model fit of $\chi^2(3)$ = 40.76, $p <$ .001. Intention transparency scores showed a significant negative relation with FMS scores (b = -.19, SD = .08, p = .01, $95\%\text{-}CI$: .08, .46), implying that an increase in intention transparency scores led to a lower FMS score. Consequently, H4b, intention transparency mediates the effects of seating orientation, such that sitting rearward faced has less of a negative effect when paired with high intention transparency and leads to lower motion sickness scores than when not displaying upcoming maneuvers, was confirmed.

Behavioral intention

Behavioral intention was assessed as a dichotomous variable (yes vs. no) after each vehicle journey, hence six times in total per participant. In total, it was stated 241 times that an AV would be used when sitting in the direction of travel and 35 times that it would not be used when sitting in the direction of travel. It was stated 191 times that an AV would be used when sitting against the direction of travel and 85 times that it would not be used when sitting against the direction of travel.

Using a mixed effects logistic regression to test for the effect of trust and motion sickness on behavioral intention, the model implying all influential variables did not lead to the best model fit measured by χ^2 and AIC. Nevertheless, participant ID (SD = 10.46) and number of vehicle journeys (SD = .93) both showed significant variances in intercepts and slopes across participants, respectively, showing an improved model fit compared to the baseline model ($\chi^2(6)$ = 187.59, $p <$ .001). Only intra-journey trust scores as predictor variable were significant (b = 1.96, SE = .97, p = .044, $95\%\text{-}CI$: .08, 10.16). Intra-journey trust had an odds ratio of 7.11, which implies that a one unit increase in intra-journey trust scores accounts for an increase of more than 600 % in the relative probability to use a vehicle in the experienced seating orientation. Within this model, neither of the other variables

showed a significant effect on behavioral intention (STS-AD: $b = .58$, $SE = .77$, $p = .456$, 95%-CI: -2.09, 6.35; motion sickness: $b = .12$, $SE = .4$, $p = .763$, 95%-CI: -.69, 1.98).

The model showing the best model fit included intra-journey trust alone. Hereby, participant ID showed significant variance in intercepts across participants ($SD = 9.96$) while number of vehicle journey showed a significant variance in slopes across participants ($SD = .99$). This led to an improved model fit compared to the baseline model ($\chi^2(4) = 187$, $p < .001$). Intra-journey trust scores as predictor variable were significant ($b = 2.32$, $SE = .89$, $p = .009$, 95%-CI: .58, 9.78). Intra-journey trust had an odds ratio of 10.22, which implies that a one unit increase in intra-journey trust scores accounts for an increase of more than 900 % in the relative probability to use a vehicle in the experienced seating orientation.

Considering only STS-AD scores as predictor variables on behavioral intention to use an AV in rearward facing seating orientation showed no significant effect ($b = 1.52$, $SE = .68$, $p = .027$, 95%-CI: -.046, 7.94). Consequently, the effect of the first STS-AD item on behavioral intention only was tested as this item has a higher correlation with intra-journey trust compared to STS-AD as a whole. Hereby, the differences between STS-AD and intra-journey trust on behavioral intention were presumed to lay in the context of what the STS-AD is asking. Within this model, participant ID showed significant variance in intercepts across participants ($SD = 11.58$), showing an improved model fit compared to the baseline model ($\chi^2(2) = 179.55$, $p < .001$). Including a random slope decreased model fit. Scores of the first STS-AD item as predictor variable were significant ($b = 1.12$, $SE = .39$, $p = .004$, 95%-CI: .039, 3.515). STS-AD had an odds ratio of 3.076, which implies that a one unit increase in intra-journey trust scores accounts for an increase of 207.6 % in the relative probability to use a vehicle in the experienced seating orientation.

FMS scores showed no significant effect on behavioral intention in either of the models. Consequently, H6, higher levels of reported trust in the AV measured during and between vehicle journeys lead to increased behavioral intention to use AVs in rearward facing seating position, was confirmed while H7, lower levels of reported motion sickness measured during the vehicle journey lead to increased behavioral intention to use AVs in rearward facing seating position, was rejected.

Discussion

The present study investigated the effect of seating orientation on the level of trust and motion sickness experienced by participants as well as the effect of the latter variables on the behavioral intention to use such a vehicle in rearward facing seating position. Moreover, experimental manipulation of intention transparency and perception transparency was attempted using three different display presentations (intention transparency on; live video stream; turned off) and two experimental groups regarding perception transparency presentation (perception transparency on vs. perception transparency off) on displays mounted between the seats of the participants. This manipulation was done to allow for investigation of their effects on trust and motion sickness. The

manipulations showed no significant effects between display presentations and intention transparency scores, nor between experimental group conditions and perception transparency score. Hence, the manipulations failed so no causal conclusions of intention transparency and perception transparency on the other variables can be drawn. Further, number of vehicle journey and perceived driving style were found to impact some of the variables. This leads to a different model of the adjusted ADAM (Rottmann, 2023) introduced in the beginning. This new model implying all insights of the present study is shown in Figure 20. Following, this model will be reflected upon based on the hypotheses and results of this experiment.

Figure 20.

Adjusted ADAM (based on Rottmann, 2023) based on the results of the present study. Note: the display manipulations showed no significant difference between conditions on intention transparency scores and perception transparency scores; therefore, it cannot be concluded whether such display presentations would have an effect, thus the variables are marked in red; dotted arrows represent descriptive relationships; arrows in both directions represent correlations.
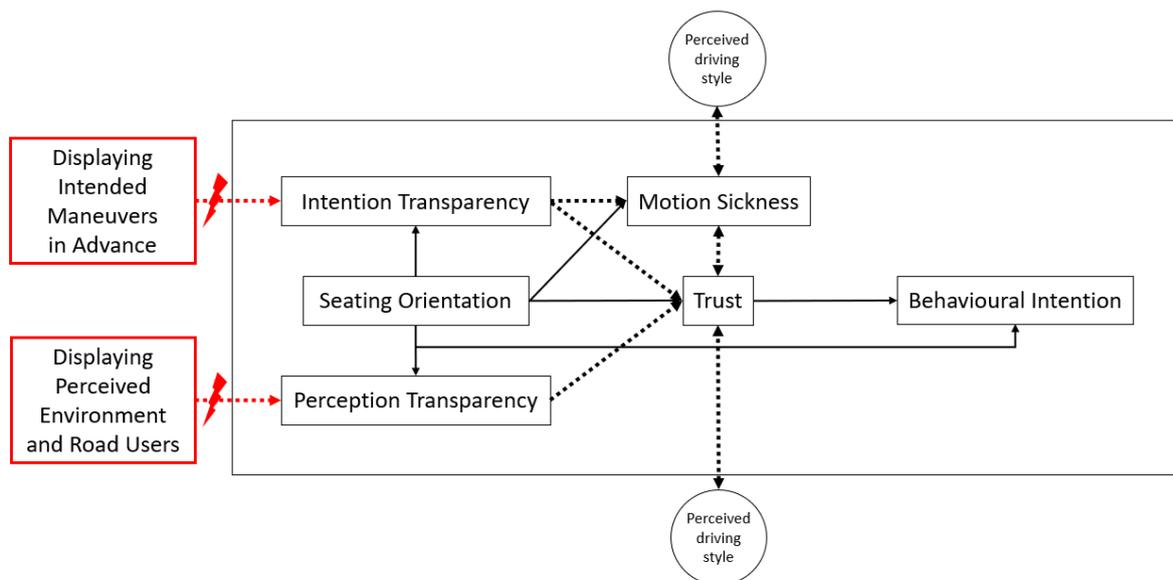
Seating orientation (forward vs. rearward) was hypothesized to have an impact on all variables of the modified ADAM. Those included intention transparency, i.e., the vehicle´s transparency about its planned maneuvers, perception transparency, i.e., the vehicle´s transparency about what it perceives in the environment, trust measured during the vehicle journey using a single-item questionnaire (adapted from Lu and Sarter, 2019) as well as measured between the vehicle journeys using the STS-AD (Holthausen & Wintersberger et al., 2020), motion sickness measured during the vehicle journey using the FMS (Keshavarz & Hecht, 2011), and behavioral intention to use such a vehicle measured on a dichotomous yes versus no scale. The results of this study are in line with these hypotheses and previous insights, except for perception transparency (Han et al., 1998; Paddeu, 2020; Rottmann, 2023; Rottmann et al., Under Review). Intention transparency, trust, and

behavior intention, showed lower ratings, while motion sickness showed higher ratings for rearward facing participants. The lack of significant impact of seating orientation on perception transparency may be attributed to the previously postulated assumption that perception transparency primarily concerns system information, which may not have as a noticeable physical effect on the passengers as compared to intention transparency, where the vehicle's intention, i.e., motion, is perceptible. Engaged in a NDRT, participants might not have consciously registered these vehicle-related perceptions at the time. Next, regarding behavioral intention in specific, the tendency to have significantly lower scores when sitting rearward faced could already be observed in the preferences for transportation means reported before the study. Participants' ratings regarding the use of transportation means in a rearward-facing seating position were rated as least preferred for all given possibilities (see Appendix C.1). This indicates that expectations may already be formed prior to the actual usage experience and need to be positively challenged during the initial use of an AV. There is a need for an improved experience for rearward-facing passengers if these types of vehicles are to be used in the future. Overall, seating orientation showed the highest effect on the intention transparency score; hence, it may represent a promising variable for future manipulation.

The display manipulations within this study, which should have decreased the downside of sitting rearwards faced, failed to show significant differences between intention transparency scores and perception transparency scores between conditions. Hence, no conclusions can be drawn on whether display presentations of the vehicle´s intention transparency or perception transparency can help improving trust or motion sickness experience. Ratings of perceived display usage may explain parts of this failure, as no significant differences were found between intention transparency overlay and live video stream. However, a significant difference in display usage between experimental perception transparency groups was found, indicating higher usage of the displays when perception transparency was shown. The difference might be due to perception transparency showing bounding boxes popping up more unexpected than the navigation arrows of intention transparency which were designed to be smooth and less disrupting. Using YOLOv8 as an object detection software which acted according to confidence levels, it was habitually the case that objects were detected for fractions of time, resulting in flickering bounding boxes. This flickering might have led to higher peripheral visibility and looking to the display more often (Tobitani et al., 2012). Putting this together, the reason for perception transparency manipulation to not get significant results in the manipulation check but in the usage behavior might be traced back to the representation of the perception transparency. Perception transparency might have not fulfilled the information needs passengers were asking for (Beggiato et al., 2015). This led the presentation of perception transparency not to be superior to the presentation of intention transparency or live video stream only. Other studies investigating vehicle transparency on in-vehicle displays used displays mounted directly in the view of the participant (Sun et al., 2021) or had information displayed on a bigger screen (Detjen et al., 2021; Flohr et al., 2023). Hence, having more prominent displays might have enhanced differences in information intake

between display conditions and eventual display usage. Future analyses of the eye tracking data will be used to gain insights in to what extent the perceived display usage was in line with the actual display usage.

Next to display usage behavior, user experience of the representations measured by the UEQ-S were not rated significantly better in the "intention transparency on" condition compared to the "live video stream" condition, except one aspect (compare Table 4). One possible reason for that may be that the resolution of the intention transparency overlay needed to be downgraded to increase live stream flow, i.e., decreasing delay and lagging of the video. This made the visual not as sharp as intended. Another deficiency was that the overlay itself was lagging so that intention transparency was not always presented on time. Moreover, having flickering bounding boxes, i.e., perception transparency, due to confidence changes of the software may have given the illusion that objects were detected only temporarily. Both may have resulted in the feeling of receiving incorrected information which was found to have a negative effect on user experience (Schneider et al., 2023). Based on the failed manipulation, no causal relationships between variables of this study except seating orientation could be drawn since no reference group was given.

As hypothesized, motion sickness was found to be influenced by intention transparency, however the study failed to show an effect between motion sickness and behavioral intention. This is not in line with previous research (Rottmann et al., Under Review) where motion sickness, measured by the MISC scale on a range of 0 to 10, accounted for a large effect on behavioral intention. Schmidt et al. (2019) have already suggested that that the expected risk of motion sickness might be exaggerated, however they have not tested whether motion sickness had an effect on the behavioral intention to use an AV in rearward facing seating position. Comparing the motion sickness scores of Rottmann et al. (Under Review; $M = .75$) with the scores found in the present study ($M = 1.76$), the approximate comparison between the two by normalization shows higher scores in the present study. This difference might be due to the driving style which was experienced as sportier in the given study ($M = 4.41$) compared to the perceived driving style in Rottmann et al.´s (Under Review) study ($M = 2.94$). Nevertheless, both measurements showed highly skewed data in the positive direction, implying predominantly low motion sickness scores. Consequently, it might be reasoned that the expectations of Schmidt et al. (2019) can be supported by the present study. Even higher motion sickness scores (compared to Rottmann et al., Under Review) have not shown any influence on the behavioral intention to use an AV in rearward facing seating direction. Trust was found to have a much stronger influence on the behavioral intention of AV users showing the importance to strengthen the feeling of trust in fully AV users with rearward facing seating orientation.

Trust was found to be influenced by intention transparency and perception transparency, and by itself to be a great influencer of the behavioral intention of participants to use such a vehicle in the end. Consequently, hypotheses regarding trust being influenced by intention transparency scores and perception transparency scores, and its own effect on behavioral intention could be confirmed.

However, differences were found between the effect of trust ratings during, i.e., single-item intra-journey trust question, and between vehicle journeys, i.e., STS-AD, which were found to have moderate to high correlations with one another. Except seating orientation, only one of each variable was influenced by intention transparency or perception transparency, respectively, and only intra-journey trust but not STS-AD was found to predict behavioral intention. Research is inconclusive if single-item surveys would lead to less meaningful results compared to multi-item surveys, or if there would be no difference if the to-be-measured construct is clear and measurable within one item (Allen et al., 2022; Sarstedt & Wilczynski, 2009). Given the situation, the use of a single-item survey was reasonable to minimize interference with the vehicle journey experience and the execution of the NDRT.

Comparing intra-journey trust scores with the first item of the STS-AD, a measure specifically for the construct of trust (Holthausen & Wintersberger et al., 2020), both influenced participants' behavioral intention to use rearward facing AV seating. However, intra-journey trust scores had over four times the impact on behavioral intention compared to the first item of the STS-AD (922% vs. 208%). Both these discrepancies may be attributed to two possible reasons: contentual differences and temporal shift. Firstly, the STS-AD is measuring multiple constructs, i.e., trust, performance, NDRT, risky judgment, and reaction, while intra-journey trust focuses solely on trust. This suggests that trust alone is pivotal for forming opinions about AV usage intention, emphasizing the importance of prioritizing trust in AV development. Secondly, the temporal difference indicates that opinions formed during the vehicle journey carry more weight on behavioral intention than those formed afterward. Therefore, ensuring a positive human-AV interaction throughout the journey, such as by providing favorable reactions to the environment, may be crucial for AV development. Moreover, interior design enhancements may foster trust perception, warranting further research with successful vehicle transparency manipulations, for instance, as those were found to be important predictors in the current study.

Limitations

The present study has investigated user acceptance of an automated vehicle on a test track, incorporating four challenging scenarios per ride. One clear limitation of this study was that the display manipulations failed to show differences between intention transparency scores or perception transparency scores on a statistical level, and no causal conclusions could be drawn about its influence on trust and motion sickness of AV-users. Moreover, participants were German citizens only, not incorporating all possible age ranges (i.e., children/teenagers or elderly people). Previous studies have already investigated the effect of poor or good vehicle behavior (e.g., Walker et al., 2019), but experiencing critical or non-critical situations may have a similar effect on trust development as well. Research has shown that the management of critical situations gives the greatest impression of the capabilities of the system which helps building a mental model about this system (Huang et al., 2018).

Consequently, trust may be built upon reactions to critical situations the most, however, this needs to be tested for first.

Further, the effect of intra- journey trust on behavioral intention was found to be very high with over 900 % higher behavioral intention per one unit increase of intra-journey score. Looking at the distribution of scores (see Appendix C.2), intra-journey trust scores are highly skewed in negative direction, hence having primarily scores of 8 or 9 on a scale ranging from 0 to 9, implying a ceiling effect of the data. This might have been due to the test track being perceived as a safe space where no unplanned incidents would happen but also due to the presence of the safety driver which was introduced beforehand and visible during the ride. Even though participants were confirmed that the robot would drive on its own and demonstrations like putting the arms in the air while turning were given by the safety driver when asked, it may have influenced the experienced trust level of participants. Participants might have not gotten the real feeling of being seated in a fully AV. Hence, the great effect of intra-journey trust on behavior intention may lie in the hypothetical thinking of usage which may not reflect actual usage behavior (Miller et al., 2016). People have not experienced AVs so far and it is unclear to what extent the participants got the perception of experience in the present study. The idea of using such a vehicle in the near future might still seem inaccessible to the participants (Haeuslschmid et al., 2017), so the effect of trust on behavioral intention may be overestimated the same way as the intra-journey trust score is on its own. Nevertheless, trust as a construct has been demonstrated to be highly relevant in the development of fully autonomous vehicles, and future studies may be required to ascertain its true significance.

Implications for future research

As already pointed out, the current study has focused on safety-critical scenarios which have not changed throughout a participant group. However, to get a clear view on trust, trust development and trust repair, future research should investigate trust in AVs in situations which are safety critical as well as safe (Lewicki, 2006). Further, to state that a participant trusts a vehicle is not always in line with the actions of the user (Miller et al., 2016). Hence, future research should look deeper into how trust is shown behaviorally by participants instead of only relying on feelings which can be done using the eye tracking of the present study. Moreover, other aspects of the ADAM (Rottmann, 2023) should be investigated. Originally, trust is not expected to influence behavioral intention but perceived usefulness which then is an indicator for behavioral intention. Hence, it should be answered whether trust is the only predictor of behavioral intention or if the latter is influenced by other predictors as well.

Next to that, similar studies should be done in which display manipulations work as intended. Then, causal relationships can be drawn on the impact of intention transparency and perception transparency on trust and motion sickness, respectively. Further, user experience might be increased using other presentation means like light strips which performance can be compared with the

performance of displays. Light strips have the advantage to be perceivable in the peripheral view of the participants (Rottmann, 2023) while displays need to be actively used in the focal view where information is processed more slowly (Tobitani et al., 2012). This may not be in line with the wish of doing NDRTs during vehicle journeys so that more indirect means may have greater impact on the investigated variables. Regarding NDRTs, future research should investigate the effect of no NDRT, or participants´ level of engagement or performance in these on trust development to see if this might be an explanation for weak effects of intention transparency and perception transparency on trust scores. Lastly, vehicle ride length and incident rate should be extended to account for a more realistic driving experience since real world vehicle journeys are longer and imply more diverse situations experienced.

Conclusion

The present study tested predictions of a condensed version of the ADAM (Rottmann, 2023) in a fully automated vehicle equipped with a pedal and steering robot and a living room seating arrangement. The effect of seating rearward on vehicle transparency (distinguished between intention transparency and perception transparency), trust, motion sickness and behavioral intention to use such a vehicle was investigated having participants experience six vehicle journeys encountering four scenarios on a test track. Seating orientation was found to influence all variables except perception transparency to the extent that rearward facing participants showed significantly lower levels of intention transparency, trust and behavioral intention and higher levels of motion sickness. Moreover, vehicle transparency was manipulated to minimize the negative effect of sitting rearward faced by mounting displays between the seats; within each seating orientation, participants experienced displays either being turned off, showing a live stream from a camera mounted in the windshield, or having an intention transparency overlay over the live stream. Furthermore, participants were grouped regarding perception transparency presentations on the displays which was laid upon the live video stream. The display manipulation failed to show statistical differences between conditions which may be due to the user experience of the display presentations; due to technical issues, the display presentation was laggy while the intention transparency overlay had scattered boundaries. Nevertheless, analyses showed that higher intention transparency scores and perception transparency scores predicted higher trust, and a higher intention transparency score predicted decreased motion sickness scores. Trust but not motion sickness was found to predict behavioral intention to a great extent. Overall, this study confirmed several predicted relationships of the ADAM (Rottmann, 2023) but missed being able to draw causalities, except for the seating orientation variable. The relationships asserted in the ADAM could almost entirely be confirmed, implying a good model structure. However, seating orientation was found to affect all variables except perception transparency, which is not in line with the suggestions of the ADAM, but the greatest effect of seating orientation was found to be on intention transparency. Hence, future research must clarify in how far intention

transparency presentations can minimize the negative effect of sitting rearward faced in a fully AV to give more profound statements about the strength of the ADAM.

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Appendix

Appendix A: Summary of levels of driving automation (SAE, 2021)

Table 1 - Summary of levels of driving automation

	Level	Name	Narrative Definition	DDT [1] Sustained Lateral and Longitudinal *Vehicle* Motion Control	OEDR	DDT Fallback	ODD
			Driver Performs Part or All of the *DDT*				
	0	No Driving Automation	The performance by the *driver* of the entire *DDT*, even when enhanced by *active safety systems*.	*Driver*	*Driver*	*Driver*	n/a
Driver Support	1	*Driver* Assistance	The *sustained* and *ODD*-specific execution by a *driving automation system* of either the lateral or the longitudinal *vehicle* motion control subtask of the *DDT* (but not both simultaneously) with the expectation that the *driver* performs the remainder of the *DDT*.	*Driver* and System	*Driver*	*Driver*	Limited
	2	Partial Driving Automation	The *sustained* and *ODD*-specific execution by a *driving automation system* of both the lateral and longitudinal *vehicle* motion control subtasks of the *DDT* with the expectation that the *driver* completes the *OEDR* subtask and supervises the *driving automation system*.	System	*Driver*	*Driver*	Limited

Table 1 - Summary of levels of driving automation (continued)

Level	Name	Narrative Definition	DDT [1] Sustained Lateral and Longitudinal *Vehicle* Motion Control	OEDR	DDT Fallback	ODD
		ADS ("System") Performs the Entire *DDT* (While Engaged)				
3	Conditional Driving Automation	The *sustained* and *ODD*-specific performance by an *ADS* of the entire *DDT* with the expectation that the *DDT fallback- ready user* is receptive to *ADS*- issued requests to intervene, as well as to *DDT* performance-relevant *system failures* in other *vehicle* systems, and will respond appropriately.	System	System	*Fallback - ready user* (becomes the *driver* during *fallback*)	Limited
4	High Driving Automation	The *sustained* and *ODD*-specific performance by an *ADS* of the entire *DDT* and *DDT fallback* without any expectation that a *user* will need to intervene.	System	System	System	Limited
5	Full Driving Automation	The *sustained* and unconditional (i.e., not *ODD*-specific) performance by an *ADS* of the entire *DDT* and *DDT fallback* without any expectation that a *user* will need to intervene.	System	System	System	Unlimited

(Left vertical label spanning rows 3–5: **Automated Driving**)

[1] The *DDT* does not include strategic aspects of the driving task, such as determining destination(s) and deciding when to travel.

Appendix B: Questionnaires

Appendix B.1: Pre-Questionnaire

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Teil A: Intro

Sehr geehrte/r Teilnehmer/in,

vielen Dank für Ihre Teilnahme an dieser Studie!

Die Studie ist in zwei Teile unterteilt: den Vorabfragebogen, den Sie im Folgenden ausfüllen werden, und die Studie vor Ort. Bevor Sie die Studie beginnen, unterrichten wir Sie im Folgenden über die Studie sowie Ihre Rechte. Ihre Teilnahme an der Studie erfolgt freiwillig und kann zu jeder Zeit und ohne Angabe von Gründen abgebrochen werden. Letzteres wird keine negativen Konsequenzen für Sie mit sich tragen.

Absicht der Studie

Diese Studie befasst sich mit der Benutzererfahrung von Passagieren vollautomatisierter Fahrzeuge mit dem Automatisierungslevel SAE Level 5. Dies beinhaltet, dass das Fahrzeug jede Entscheidung zum Fahrgeschehen selbst macht und die Insassen im Fahrzeug nicht mehr in dieses Eingreifen können. Dadurch ist es den Passagieren möglich, sich anderen Aufgaben während einer Fahrt zu widmen. Um diese besser umsetzen zu können ist es möglich, das Interieur des Fahrzeugs umzugestalten. In dieser Studie werden zwei Sitze rückwärtig gedreht werden, sodass sich vier Fahrzeuginsassen während der Fahrt anschauen können. Mithilfe dieser Studie soll ermittelt werden, wie sich diese Sitzausrichtung auf die Akzeptanz autonomer Fahrzeuge auswirkt.

Inhalt der Studie

Ihre Teilnahme an der Studie besteht aus verschiedenen Komponenten. Nach dieser Einführung folgt die Frage nach Ihrer Zustimmung zur Teilnahme an dieser Studie, sowie nach demografischen, biografischen und sonstigen Details zu Ihrer Person. Der zweite Teil der Studie findet vor Ort an der bereits genannten Adresse statt, wo Sie gemeinsam mit drei weiteren Teilnehmern für circa 120 Minuten in einem selbstfahrenden Auto in verschiedenen Sitzausrichtungen fahren werden. Währenddessen wie auch vorher und nachher füllen Sie weitere Fragebögen aus. Zudem wird Ihr Sichtfeld und Blickverhalten durch eine Eye tracking Brille durchgängig aufgezeichnet.

Datenverarbeitung

Die Daten dieser Studie werden genutzt, um das Fahrerlebnis vollautomatisierter Fahrzeuge zu fördern und zu verbessern. Diese Studie wird für eine Promotion der Technischen Universität Braunschweig wie auch für eine Masterthese der University of Twente, Enschede, genutzt. Die Daten werden zu jedem Zeitpunkt pseudonymisiert und vertraulich behandelt, sodass eine Rückverfolgung auf einzelne Teilnehmer der Studie nicht möglich ist.

Kontakt

Sofern während oder nach Abschluss der Studie Fragen entstehen kontaktieren Sie gerne die verantwortungstragenden Personen:

Leonhard Rottmann, leonhard.rottmann@forvia.com

Alina Waldmann, a.waldmann@student.utwente.nl

Sofern Sie nach diesen Informationen noch immer an der Studie teilnehmen möchten, können Sie den ersten Teil der Studie durch klicken auf den Button unten rechts beginnen.

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Teil B: Intro 2

B1. **Teilnahme an der Studie**

Ich bestätige die zuvor beschriebenen Informationen zur Studie gelesen und verstanden zu haben. Ich nehme freiwillig an dieser Studie teil und habe verstanden, dass ich zu jeder Zeit die Beantwortung von Fragen verweigern kann. Ich weiß, dass ich zu jedem Zeitpunkt und ohne Angabe von Gründen die Teilnahme an der Studie beenden kann. Ich verstehe, dass ich für die Studie in einem selbstfahrenden Auto in verschiedenen Sitzausrichtungen fahren werde und dabei aufgezeichnet wird, was ich sehe und wohin ich schaue. Die Teilnahme umfasst keine Risiken. Ich bin mindestens 18 Jahre alt.

Nutzung der Daten der Studie

Ich verstehe, dass die Angabe demografischer, biografischer und sonstiger Daten zu meiner Person wie auch die Ausfüllung weiterer Fragebögen Teil dieser Studie sind. Ich verstehe, dass mein Sichtfeld und die Fixierung meiner Augen während der Studie aufgezeichnet wird.

Zukünftige Verwendung und Wiederverwendung der Daten durch Dritte

Ich verstehe, dass die Informationen, die ich gebe, für eine Doktorarbeit wie auch eine Masterthese benutzt und veröffentlicht werden. Ich weiß, dass alle Informationen pseudonymisiert und an einem sicheren Ort gespeichert werden.

Stimmen Sie der Teilnahme an dieser Studie zu?

Ja ☐

Nein ☐

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Teil C: Intro 3

C1. **Bitte erstellen Sie zur Pseudonymiserung Ihrer Daten Ihren individuellen Probandencode, der sich wie folgt zusammensetzt:**

Die ersten zwei Buchstaben des Vornamens Ihrer Mutter, die letzten zwei Buchstaben des Vornamens Ihres Vaters, der Geburtstag Ihrer Mutter und Ihres Vaters.

Beispiel: Anette, Maximilian, 13.06.1963, 04.08.1960 è ANAN1304

Hinweis: Dieser Code wird verwendet, um die Daten des Vorabfragebogens mit denen der Studie vor Ort zu synchronisieren. Daher werden Sie auch vor Ort dieselbe Anleitung zur Erstellung des Probandencodes erhalten. Bitte achten Sie darauf, dass die Codes bei jeder Abfrage identisch sind.

Teil D: DemoBio

D1. **Wie alt sind Sie?**

D2. **Womit identifizieren Sie sich?**

Mann ☐

Frau ☐

Divers ☐

Sonstige ☐

D3. **Welcher Ethnie sind Sie angehörig? Bitte wählen Sie alle zutreffenden aus.**

Hinweis: Diese Studie nutzt Eye tracking. Die Daten dieser Messmethode können durch die Ethnie gestört werden, weshalb diese Frage gestellt wird.

Asiatisch ☐

Schwarz oder Afroamerikaner ☐

Hispanisch oder Latino ☐

Weiß oder kaukasisch ☐

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Sonstiges ▼

Sonstiges

D4.   **Welchen Beschäftigungsstatus haben Sie derzeit?**

Keinen ☐

Auszubildene/r ☐

Student/in ☐

Angestellt ☐

Selbstständig ☐

Ruhestand ☐

Sonstiges ▼

Sonstiges

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D5. **Welchen Bildungsgrad haben Sie? Bitte wählen Sie den derzeit höchsten von Ihnen erworbenen Abschluss.**

Keinen ☐

Berufsreife (Hauptschule) ☐

Fachoberschulreife (Realschule) ☐

Allgemeine Hochschulreife ☐

Ausbildung ☐

Bachelor ☐

Master ☐

Promotion ☐

Habilitation ☐

Sonstiges ▼

Sonstiges

Teil E: Erkrankungen

E1. **Wurde bei Ihnen eine psychische oder neuronale Erkrankung diagnostiziert (z.B. Schizophrenie, ADHS/ADS, ASD, Depression, Multiple Sklerose, ...)?**

Hinweis: Diese Studie nutzt Eye tracking. Die Daten dieser Messmethode können durch solche Erkrankungen gestört werden, weshalb diese Frage gestellt wird.

Ja (Bitte spezifizieren.) ☐

Nein ☐

Ich weiß es nicht. ☐

Ich bevorzuge es diese Frage nicht zu beantworten. ☐

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Teil F: ET

F1. **Tragen Sie Kontaklinsen oder eine Brille?**

Ja ☐

Ja, aber nur in bestimmten Situationen (Bitte spezifizieren.) ☐

Nein ☐

F2. **Sind Ihre Kontaktlinsen oder Brille für:**

Weitsichtigkeit ☐

Kurzsichtigkeit ☐

F3. **Werden Sie am Tag der Studie vor Ort Kontaktlinsen oder eine Brille tragen?**

Hinweis: Diese Studie nutzt Eye tracking. Sofern möglich, wäre es zu bevorzugen Kontaktlinsen am Tag der Studie zu tragen. Andernfalls bitte die folgende Frage beantworten und wir werden die angegebenen Sehstärken in die Eye tracking Brille einbauen.

Kontaktlinsen ☐

Brille ☐

F4. **Bitte geben Sie die für Sie benötigten Dioptrien an:**

	1,5	1	0,5	-0,5	-1	-1,5	-2	-2,5	-3	-3,5	-4	-4,5	-5	-5,5	-6	-6,5	-7	-7,5	-8	
☐ ☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Linkes Auge
☐ ☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Rechtes Auge

F5. **Haben Sie weitere Sehschwächen oder -krankheiten neben Kurz- oder Weitsichtigkeit?**

Ja ☐

Nein ☐

F6. **Haben Sie grauen Star?**

Ja ☐

Nein ☐

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F7.	**Haben Sie ein Augenimplantat?**		
		Ja	☐
		Nein	☐

F8.	**Haben Sie grünen Star?**		
		Ja	☐
		Nein	☐

F9.	**Ist eine (oder beide) Ihrer Pupillen permanent geweitet?**		
		Ja	☐
		Nein	☐

F10.	**Haben Sie andere Augenkrankheiten, welche nicht genannt wurden?**		
		Ja (Bitte spezifizieren.)	☐
		Nein	☐

Teil G: Driving

G1. **Seit wie vielen Jahren sind Sie im Besitz eines Führerscheins der Klasse B?**

G2. **Welche der folgenden Transportmittel nutzen Sie wie häufig innerhalb eines Jahres?**

	Täglich	Mehrmals die Woche	Einmal in der Woche	Mehrmals im Monat	Einmal im Monat	Mehrmals im Jahr	Einmal im Jahr
Auto (als Fahrer)	☐	☐	☐	☐	☐	☐	☐
Auto (als Beifahrer)	☐	☐	☐	☐	☐	☐	☐
Bus	☐	☐	☐	☐	☐	☐	☐
Zug	☐	☐	☐	☐	☐	☐	☐

G3. **Wie viele Kilometer fahren Sie pro Jahr mit dem Auto als Fahrer?**

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G4. **Wie viel Freude bereitet Ihnen Autofahren?**

	Keine Freude	Kaum Freude	Ein wenig Freude	Viel Freude	Sehr viel Freude
Als Fahrer	☐	☐	☐	☐	☐
Als Beifahrer	☐	☐	☐	☐	☐

Teil H: Automatisierung

H1. **Bitte stufen Sie Ihre Vorkenntnisse im Bereich des automatisierten Fahrens ein:**

Keine Vorkenntnisse	Kaum Vorkenntnisse	Wenig Vorkenntnisse	Gute Vorkenntnisse	Umfangreiche Vorkenntnisse
☐	☐	☐	☐	☐

H2. **Wie viel Erfahrung haben Sie mit folgenden Systemen:**

	Keine Erfahrung	Kaum Erfahrung	Wenig Erfahrung	Viel Erfahrung	Umfassende Erfahrung
Automatisierte Autos	☐	☐	☐	☐	☐
Assistenzsysteme in Autos (z. B. Abstandsregeltempomat [ACC])	☐	☐	☐	☐	☐
Selbstfahrende Autos (auf bestimmten Teilstrecken)	☐	☐	☐	☐	☐

H3. **Im Folgenden geht es um den Fahrstil autonomer Fahrzeuge.**

	1 - sehr vorsichtig	2	3	4	5	6 - sehr sportlich
Bitte geben Sie an, welchen Fahrstil ein autonomes Fahrzeug Ihrer Meinung nach idealerweise aufweisen sollte.	☐	☐	☐	☐	☐	☐

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Teil I: ATI

I1. **Im Folgenden geht es um Ihre Interaktion mit technischen Systemen. Mit ‚technischen Systemen' sind sowohl Apps und andere Software-Anwendungen als auch komplette digitale Geräte (z.B. Handy, Computer, Fernseher, Auto-Navigation) gemeint.**

Bitte geben Sie den Grad Ihrer Zustimmung zu folgenden Aussagen an.

	Stimmt gar nicht	Stimmt weitgehend nicht	Stimmt eher nicht	Stimmt eher	Stimmt weitgehend	Stimmt völlig
Ich beschäftige mich gern genauer mit technischen Systemen.	☐	☐	☐	☐	☐	☐
Ich probiere gern die Funktionen neuer technischer Systeme aus.	☐	☐	☐	☐	☐	☐
In erster Linie beschäftige ich mich mit technischen Systemen, weil ich muss.	☐	☐	☐	☐	☐	☐
Wenn ich ein neues technisches System vor mir habe, probiere ich es intensiv aus.	☐	☐	☐	☐	☐	☐
Ich verbringe sehr gern Zeit mit dem Kennenlernen eines neuen technischen Systems.	☐	☐	☐	☐	☐	☐
Es genügt mir, dass ein technisches System funktioniert, mir ist es egal, wie oder warum.	☐	☐	☐	☐	☐	☐
Ich versuche zu verstehen, wie ein technisches System genau funktioniert.	☐	☐	☐	☐	☐	☐
Es genügt mir, die Grundfunktionen eines technischen Systems zu kennen.	☐	☐	☐	☐	☐	☐
Ich versuche, die Möglichkeiten eines technischen Systems vollständig auszunutzen.	☐	☐	☐	☐	☐	☐

Teil J: Trust

J1. **Bitte geben Sie den Grad Ihrer Zustmmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5 - Stimme voll und ganz zu
Normalerweise vertraue ich Maschinen, bis es einen Grund gibt es nicht zu tun.	☐	☐	☐	☐	☐
Zumeist misstraue ich Maschinen.	☐	☐	☐	☐	☐
Grundsätzlich würde ich auf Maschinen vertrauen, damit diese mich unterstützen.	☐	☐	☐	☐	☐
Meine Tendenz Maschinen zu vertrauen ist hoch.	☐	☐	☐	☐	☐
Es ist einfach für mich darauf zu vertrauen, dass Maschinen ihren Job machen.	☐	☐	☐	☐	☐
Es ist wahrscheinlich, dass ich Maschinen vertraue, selbst wenn ich wenig Wissen über diese habe.	☐	☐	☐	☐	☐

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Teil K: Motion Sickness

K1. **Bitte geben Sie den Grad Ihrer Vorliebe der folgenden Situationen an.**

	0 - Keine Vorliebe / Abneigung	10	20	30	40 - Leichte Vorliebe	50	60	70 - Vorliebe	80	90	100 - Starke Vorliebe	Nicht zutreffend - nie genutzt.
Auto fahren - vorwärts sitzend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Auto fahren - rückwärts sitzend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Bus - vorwärts sitzend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Bus - rückwärts sitzend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Zug - vorwärts sitzend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Zug - rückwärts sitzend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Kleine Boote - vorwärts sitzend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Kleine Boote - rückwärts sitzend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Schiff / Fähre - vorwärts sitzend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Schiff / Fähre - rückwärts sitzend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Karussell auf Spielplätzen - vorwärts sitzend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Karussell auf Spielplätzen - rückwärts sitzend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Achterbahn / Kirmesbahn - vorwärts sitzend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Achterbahn / Kirmesbahn - rückwärts sitzend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

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K2. **In Ihrer Kindheit (< 12 Jahre), wie oft haben Sie sich krank gefühlt oder Übelkeit verspürt in den folgenden Transportmitteln:**

	Nie krank gefühlt	Selten krank gefühlt	Manchmal krank gefühlt	Öfters krank gefühlt	Nicht zutreffend - nie genutzt.
Auto	☐	☐	☐	☐	☐
Bus / Reisebus	☐	☐	☐	☐	☐
Zug	☐	☐	☐	☐	☐
Flugzeug	☐	☐	☐	☐	☐
Kleine Boote	☐	☐	☐	☐	☐
Schiff / Fähre	☐	☐	☐	☐	☐
Schaukel auf Spielplätzen	☐	☐	☐	☐	☐
Karussell auf Spielplätzen	☐	☐	☐	☐	☐
Achterbahn / Kirmesbahn	☐	☐	☐	☐	☐

K3. **Über die vergangenen 10 Jahre, wie oft haben Sie sich krank gefühlt oder Übelkeit verspürt in den folgenden Transportmitteln:**

	Nie krank gefühlt	Selten krank gefühlt	Manchmal krank gefühlt	Öfters krank gefühlt	Nicht zutreffend - nie genutzt.
Auto	☐	☐	☐	☐	☐
Bus / Reisebus	☐	☐	☐	☐	☐
Zug	☐	☐	☐	☐	☐
Flugzeug	☐	☐	☐	☐	☐
Kleine Boote	☐	☐	☐	☐	☐
Schiff / Fähre	☐	☐	☐	☐	☐
Schaukel auf Spielplätzen	☐	☐	☐	☐	☐
Karussell auf Spielplätzen	☐	☐	☐	☐	☐
Achterbahn / Kirmesbahn	☐	☐	☐	☐	☐

LimeSurvey

Teil L: Outro

Sie haben das Ende des ersten Teils erreicht. Vielen Dank für Ihre Teilnahme bis hierhin!

Der Termin des zweiten Termins wurde Ihnen per Email mitgeteilt.

Sollten Fragen aufgetreten sein oder auftreten, wenden Sie sich gerne an die Versuchsleiter dieser Studie:

Leonhard Rottmann, leonhard.rottmann@forvia.com

Alina Waldmann, a.waldmann@student.utwente.nl

Teil M: Nicht-Zustimmung

Ohne Ihre Zustimmung ist die Teilnahme an der Studie nicht möglich.

Sie können das Fenster nun schließen.

Appendix B.2: Live scales

Bitte geben Sie Ihren individuellen Probandencode an:

Die ersten zwei Buchstaben des Namens Ihrer Mutter, die letzten zwei Buchstaben des Namens Ihres Vaters, der Geburtstag Ihrer Mutter und Ihres Vaters.

Beispiel: Annette, Maximilian, 13.06.1963, 04.08.1960 --> ANAN1304

Ihr Code: _____

- -

Die untenstehenden Tabellen sind für die Erfassung Ihrer empfundenen Motion Sickness und Ihres Vertrauens gegenüber dem Fahrzeug. Bei jeder verbalen Abfrage durch den Versuchsleiter soll ein Wert zwischen **0-20 für Motion Sickness** und **0-9 für Vertrauen** in die jeweils geforderte Tabelle eingetragen werden.

Motion Sickness	Vertrauen
Motion Sickness zeichnet sich durch allgemeines Unwohlsein (keine spezifischen Symptome), empfundene Wärme oder schwitzen, Schwindelgefühl, Kopfschmerzen, Magenprobleme/ein flaues Gefühl im Magen bis hin zur Übelkeit, Brechreiz oder Erbrechen selbst aus. Die Reihenfolge ist für jeden individuell, weshalb die **offene Skala 0-20** für die Einstufung gewählt wurde.	Vertrauen wird auf einer **Skala von 0-9** abgefragt.

Sollten Sie einen **Wert von 17 oder höher** eintragen geben Sie dem Versuchsleiter unverzüglich Bescheid!

0 – Ich vertraue dem Fahrzeug **überhaupt nicht**.

9 – Ich vertraue dem Fahrzeug **voll und ganz**.

Welches Level der Motion Sickness empfinden Sie derzeit?

Welches Level des Vertrauens empfinden Sie derzeit?

Motion Sickness	Skala 0-20
1. Abfrage	
2. Abfrage	
3. Abfrage	
4. Abfrage	
5. Abfrage	
6. Abfrage	

Vertrauen	Skala 0-9
1. Abfrage	
2. Abfrage	
3. Abfrage	
4. Abfrage	
5. Abfrage	
6. Abfrage	

Fahrt Nr. _____

Sitzrichtung: _____

Appendix B.3: Between the rides questionnaires

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Herzlich Willkommen und vielen Dank für die Teilnahme an unserer Studie zum Thema Sitzausrichtung in vollautomatisierten Fahrzeugen. Spezifisch geht es in der Studie darum, wie sich verschiedene Sitzausrichtungen in einem vollautomatisierten Fahrzeug auf verschiedene Aspekte und die damit verbundene Akzeptanz vollautonomer Fahrzeuge auswirken.

In den vergangenen Tagen haben Sie bereits einen Onlinefragebogen daheim ausgefüllt. Heute werden Sie Insasse eines vollautomatisierten Fahrzeugs sein. Dazu wurde dieser Lenkroboter in unser Fahrzeug eingebaut, welcher Sie selbstständig durch einen Rundkurs manövrieren wird. Die Person auf dem Fahrersitz, Herr X, ist lediglich dafür da die Performance des Lenkroboters zu überwachen und im Notfall einzugreifen, hat ansonsten jedoch keinerlei Einfluss auf die Fahrt.

Sie werden vier Mal mit dem Auto fahren und zu verschiedenen Zeitpunkten verschiedene Fragebögen ausfüllen, die ich gleich näher erklären werde. Während der Fahrt werden Sie gebeten Stadt-Land-Fluss zu spielen. Falls Sie dieses Spiel nicht kennen, ist das nicht schlimm; ich werde es gleich noch einmal erklären. Außerdem werden Sie mit Eye tracking Brillen ausgestattet, welche die Augenbewegungen und dadurch Ihr Sichtfeld verfolgen. Diese Daten werden in Form eines Videos aufgezeichnet und für die weitere Analyse verwendet. Alle Daten, die wir erheben, werden pseudonymisiert und vertraulich behandelt, sodass eine Rückverfolgung auf einzelne Personen nicht möglich ist. Auf Grundlage einer Standardprozedur für Forschungsdaten werden die hier erhobenen Daten für zehn Jahre gespeichert, welcher Sie jedoch widerrufen oder eine Löschung der Daten einfordern können, wenn Sie das möchten. Ihre Teilnahme an dieser Studie ist freiwillig und Sie haben zu jedem Zeitpunkt die Möglichkeit Ihre Teilnahme an der Studie zu beenden, ohne dass Ihnen dadurch Nachteile entstehen.

Bei Fragen wenden Sie sich bitte an die Versuchsleiterin.

LimeSurvey

Teil A: Vorab

A1. **Bitte geben Sie Ihren individuellen Probandencode an:**

Die ersten zwei Buchstaben des Vornamens Ihrer Mutter, die letzten zwei Buchstaben des Vornamens Ihres Vaters, der Geburtstag Ihrer Mutter und Ihres Vaters.

Beispiel: Anette, Maximilian, 13.06.1963, 04.08.1960 è ANAN1304

Hinweis: Dieser Code wird verwendet, um die Daten des Vorabfragebogens mit denen der Studie vor Ort zu synchronisieren. Bitte achten Sie darauf, dass die Codes bei jeder Abfrage identisch sind.

A2. **Tragen Sie derzeit Augen Make-up (z. B. Eyeliner, Mascara, Liedschatten, falsche Wimpern)?**

Ja ☐

Nein ☐

Teil B: Message

Vielen Dank.

Bitte sperren Sie das Tablet und wenden Sie sich an den Versuchsleiter für weitere Instruktionen.

Teil C: Zwischen1

Bitte beantworten Sie folgende Fragen basierend auf Ihren Eindrücken der soeben erlebten Fahrt.

C1. **Bitte geben Sie an an welchem Platz Sie gesessen haben.**

Fahrerseite - vorwärts ☐

Fahrerseite - rückwärts ☐

Beifahrerseite - vorwärts ☐

Beifahrerseite - rückwärts ☐

LimeSurvey

C2. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich habe viel darauf geachtet, was das Fahrzeug tat.	☐	☐	☐	☐	☐	☐
Ich habe viel darauf geachtet, was um das Fahrzeug herum geschah.	☐	☐	☐	☐	☐	☐
Ich habe nur wenig Zeit damit verbracht, die Umgebung zu beobachten.	☐	☐	☐	☐	☐	☐
Gedanklich war ich viel mit der Fahrt beschäftigt.	☐	☐	☐	☐	☐	☐
Ich könnte den Verlauf der Fahrt gut beschreiben.	☐	☐	☐	☐	☐	☐
Ich kann mich nicht mehr an viele bestimmte Verkehrssituationen aus der Fahrt erinnern.	☐	☐	☐	☐	☐	☐

C3. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme gar nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Ich vertraue dem automatisierten Fahrzeug während der Fahrt.	☐	☐	☐	☐	☐	☐	☐
Ich hätte die Fahrt besser gemeistert als das automatisierte Fahrzeug.	☐	☐	☐	☐	☐	☐	☐
Wenn das automatisierte Fahrzeug so arbeitet wie während der Fahrt, fällt es mir leicht etwas anderes (z.B. Lesen) zu tun.	☐	☐	☐	☐	☐	☐	☐
Diese Fahrt war riskant.	☐	☐	☐	☐	☐	☐	☐
Das automatisierte Fahrzeug hat unsichere Entscheidungen getroffen.	☐	☐	☐	☐	☐	☐	☐
Das automatisierte Fahrzeug hat angemessen auf die Umwelt reagiert.	☐	☐	☐	☐	☐	☐	☐

C4. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich hatte das Gefühl jederzeit zu wissen in welche Richtung das Fahrzeug fährt.	☐	☐	☐	☐	☐	☐
Die Manöver des Fahrzeugs sind absehbar für mich.	☐	☐	☐	☐	☐	☐
Ich bin oft überrascht von der Fahrzeugführung.	☐	☐	☐	☐	☐	☐

LimeSurvey

C5. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich denke, dass das autonome Fahrzeug die anderen Verkehrsteilnehmer wahrnimmt.	☐	☐	☐	☐	☐	☐
Ich bin mir oft unsicher, ob das autonome Fahrzeug andere Verkehrsobjekte erkennt.	☐	☐	☐	☐	☐	☐
Ich kann abschätzen, welche Elemente des Fahrzeugumfeldes dem autonomen Fahrzeug bewusst sind.	☐	☐	☐	☐	☐	☐

C6. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Die Nutzung autonomer Fahrzeuge macht Spaß.	☐	☐	☐	☐	☐	☐	☐
Die Nutzung autonomer Fahrzeuge ist angenehm.	☐	☐	☐	☐	☐	☐	☐
Die Nutzung autonomer Fahrzeuge ist sehr unterhaltsam.	☐	☐	☐	☐	☐	☐	☐

C7. **Im Folgenden geht es um den während der Studie erlebten Fahrstil.**

	1 - sehr vorsichtig	2	3	4	5	6 - sehr sportlich
Bitte bewerten Sie den während dieser Studie erlebten Fahrstil.	☐	☐	☐	☐	☐	☐

C8. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2 - Stimme nicht zu	3 - Stimme eher nicht zu	4 - Neutral	5 - Stimme eher zu	6 - Stimme zu	7 - Stimme voll und ganz zu
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs meine Fahrten einfacher machen kann.	☐	☐	☐	☐	☐	☐	☐
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs meine Fahrsicherheitsleistung verbessern kann.	☐	☐	☐	☐	☐	☐	☐
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs mir erlauben kann, während der Fahrt andere Dinge zu tun.	☐	☐	☐	☐	☐	☐	☐
Ich halte ein solches autonomes Fahrzeug für nützlich, wenn meine Fahrtüchtigkeit beeinträchtigt ist (z.B. bei Müdigkeit, Trunkenheit, Drogeneinfluss).	☐	☐	☐	☐	☐	☐	☐
Insgesamt halte ich ein solches autonomes Fahrzeug für nützlich.	☐	☐	☐	☐	☐	☐	☐

LimeSurvey

C9. **Würden Sie ein solches Fahrzeug nutzen, wenn...**

	Ja	Nein
...Sie entgegen der Fahrtrichtung sitzen?	☐	☐
...Sie in Fahrtrichtung sitzen?	☐	☐

C10. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu	Nicht zutreffend.
Ich habe oft auf das Display geschaut.	☐	☐	☐	☐	☐	☐	☐
Ich habe das Display nicht wahrgenommen.	☐	☐	☐	☐	☐	☐	☐

C11.

	1 - behindernd	2	3	4	5	6	7 - unterstützend	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

C12.

	1 - kompliziert	2	3	4	5	6	7 - einfach	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

C13.

	1 - ineffizient	2	3	4	5	6	7 - effizient	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

C14.

	1 - verwirrend	2	3	4	5	6	7 - übersichtlich	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

C15.

	1 - langweilig	2	3	4	5	6	7 - spannend	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

C16.

	1 - uninteressant	2	3	4	5	6	7 - interessant	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

C17.

	1 - konventionell	2	3	4	5	6	7 - originell	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

LimeSurvey

C18.

	1 - herkömmlich	2	3	4	5	6	7 - neuartig	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

Teil D: Message1

Vielen Dank.

Bitte sperren Sie das Tablet und wenden Sie sich an den Versuchsleiter für weitere Instruktionen.

Teil E: Zwischen2

Bitte beantworten Sie folgende Fragen basierend auf Ihren Eindrücken der soeben erlebten Fahrt.

E1. **Bitte geben Sie an an welchem Platz Sie gesessen haben.**

Fahrerseite - vorwärts	☐
Fahrerseite - rückwärts	☐
Beifahrerseite - vorwärts	☐
Beifahrerseite - rückwärts	☐

E2. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich habe viel darauf geachtet, was das Fahrzeug tat.	☐	☐	☐	☐	☐	☐
Ich habe viel darauf geachtet, was um das Fahrzeug herum geschah.	☐	☐	☐	☐	☐	☐
Ich habe nur wenig Zeit damit verbracht, die Umgebung zu beobachten.	☐	☐	☐	☐	☐	☐
Gedanklich war ich viel mit der Fahrt beschäftigt.	☐	☐	☐	☐	☐	☐
Ich könnte den Verlauf der Fahrt gut beschreiben.	☐	☐	☐	☐	☐	☐
Ich kann mich nicht mehr an viele bestimmte Verkehrssituationen aus der Fahrt erinnern.	☐	☐	☐	☐	☐	☐

LimeSurvey

E3. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme gar nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Ich vertraue dem automatisierten Fahrzeug während der Fahrt.	☐	☐	☐	☐	☐	☐	☐
Ich hätte die Fahrt besser gemeistert als das automatisierte Fahrzeug.	☐	☐	☐	☐	☐	☐	☐
Wenn das automatisierte Fahrzeug so arbeitet wie während der Fahrt, fällt es mir leicht etwas anderes (z.B. Lesen) zu tun.	☐	☐	☐	☐	☐	☐	☐
Diese Fahrt war riskant.	☐	☐	☐	☐	☐	☐	☐
Das automatisierte Fahrzeug hat unsichere Entscheidungen getroffen.	☐	☐	☐	☐	☐	☐	☐
Das automatisierte Fahrzeug hat angemessen auf die Umwelt reagiert.	☐	☐	☐	☐	☐	☐	☐

E4. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich hatte das Gefühl jederzeit zu wissen in welche Richtung das Fahrzeug fährt.	☐	☐	☐	☐	☐	☐
Die Manöver des Fahrzeugs sind absehbar für mich.	☐	☐	☐	☐	☐	☐
Ich bin oft überrascht von der Fahrzeugführung.	☐	☐	☐	☐	☐	☐

E5. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich denke, dass das autonome Fahrzeug die anderen Verkehrsteilnehmer wahrnimmt.	☐	☐	☐	☐	☐	☐
Ich bin mir oft unsicher, ob das autonome Fahrzeug andere Verkehrsobjekte erkennt.	☐	☐	☐	☐	☐	☐
Ich kann abschätzen, welche Elemente des Fahrzeugumfeldes dem autonomen Fahrzeug bewusst sind.	☐	☐	☐	☐	☐	☐

E6. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Die Nutzung autonomer Fahrzeuge macht Spaß.	☐	☐	☐	☐	☐	☐	☐
Die Nutzung autonomer Fahrzeuge ist angenehm.	☐	☐	☐	☐	☐	☐	☐
Die Nutzung autonomer Fahrzeuge ist sehr unterhaltsam.	☐	☐	☐	☐	☐	☐	☐

LimeSurvey

E7. **Im Folgenden geht es um den während der Studie erlebten Fahrstil.**

	1 - sehr vorsichtig	2	3	4	5	6 - sehr sportlich
Bitte bewerten Sie den während dieser Studie erlebten Fahrstil.	☐	☐	☐	☐	☐	☐

E8. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2 - Stimme nicht zu	3 - Stimme eher nicht zu	4 - Neutral	5 - Stimme eher zu	6 - Stimme zu	7 - Stimme voll und ganz zu
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs meine Fahrten einfacher machen kann.	☐	☐	☐	☐	☐	☐	☐
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs meine Fahrsicherheitsleistung verbessern kann.	☐	☐	☐	☐	☐	☐	☐
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs mir erlauben kann, während der Fahrt andere Dinge zu tun.	☐	☐	☐	☐	☐	☐	☐
Ich halte ein solches autonomes Fahrzeug für nützlich, wenn meine Fahrtüchtigkeit beeinträchtigt ist (z.B. bei Müdigkeit, Trunkenheit, Drogeneinfluss).	☐	☐	☐	☐	☐	☐	☐
Insgesamt halte ich ein solches autonomes Fahrzeug für nützlich.	☐	☐	☐	☐	☐	☐	☐

E9. **Würden Sie ein solches Fahrzeug nutzen, wenn...**

	Ja	Nein
...Sie entgegen der Fahrtrichtung sitzen?	☐	☐
...Sie in Fahrtrichtung sitzen?	☐	☐

E10. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu	Nicht zutreffend.
Ich habe oft auf das Display geschaut.	☐	☐	☐	☐	☐	☐	☐
Ich habe das Display nicht wahrgenommen.	☐	☐	☐	☐	☐	☐	☐

E11.

	1 - behindernd	2	3	4	5	6	7 - unterstützend	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

E12.

	1 - kompliziert	2	3	4	5	6	7 - einfach	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

LimeSurvey

E13.

	1 - ineffizient	2	3	4	5	6	7 - effizient	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

E14.

	1 - verwirrend	2	3	4	5	6	7 - übersichtlich	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

E15.

	1 - langweilig	2	3	4	5	6	7 - spannend	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

E16.

	1 - uninteressant	2	3	4	5	6	7 - interessant	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

E17.

	1 - konventionell	2	3	4	5	6	7 - originell	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

E18.

	1 - herkömmlich	2	3	4	5	6	7 - neuartig	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

Teil F: Message2

Vielen Dank.

Bitte sperren Sie das Tablet und wenden Sie sich an den Versuchsleiter für weitere Instruktionen.

LimeSurvey

Teil G: Zwischen3

Bitte beantworten Sie folgende Fragen basierend auf Ihren Eindrücken der soeben erlebten Fahrt.

G1. **Bitte geben Sie an an welchem Platz Sie gesessen haben.**

Fahrerseite - vorwärts ☐

Fahrerseite - rückwärts ☐

Beifahrerseite - vorwärts ☐

Beifahrerseite - rückwärts ☐

G2. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich habe viel darauf geachtet, was das Fahrzeug tat.	☐	☐	☐	☐	☐	☐
Ich habe viel darauf geachtet, was um das Fahrzeug herum geschah.	☐	☐	☐	☐	☐	☐
Ich habe nur wenig Zeit damit verbracht, die Umgebung zu beobachten.	☐	☐	☐	☐	☐	☐
Gedanklich war ich viel mit der Fahrt beschäftigt.	☐	☐	☐	☐	☐	☐
Ich könnte den Verlauf der Fahrt gut beschreiben.	☐	☐	☐	☐	☐	☐
Ich kann mich nicht mehr an viele bestimmte Verkehrssituationen aus der Fahrt erinnern.	☐	☐	☐	☐	☐	☐

G3. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme gar nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Ich vertraue dem automatisierten Fahrzeug während der Fahrt.	☐	☐	☐	☐	☐	☐	☐
Ich hätte die Fahrt besser gemeistert als das automatisierte Fahrzeug.	☐	☐	☐	☐	☐	☐	☐
Wenn das automatisierte Fahrzeug so arbeitet wie während der Fahrt, fällt es mir leicht etwas anderes (z.B. Lesen) zu tun.	☐	☐	☐	☐	☐	☐	☐
Diese Fahrt war riskant.	☐	☐	☐	☐	☐	☐	☐
Das automatisierte Fahrzeug hat unsichere Entscheidungen getroffen.	☐	☐	☐	☐	☐	☐	☐
Das automatisierte Fahrzeug hat angemessen auf die Umwelt reagiert.	☐	☐	☐	☐	☐	☐	☐

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G4. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich hatte das Gefühl jederzeit zu wissen in welche Richtung das Fahrzeug fährt.	☐	☐	☐	☐	☐	☐
Die Manöver des Fahrzeugs sind absehbar für mich.	☐	☐	☐	☐	☐	☐
Ich bin oft überrascht von der Fahrzeugführung.	☐	☐	☐	☐	☐	☐

G5. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich denke, dass das autonome Fahrzeug die anderen Verkehrsteilnehmer wahrnimmt.	☐	☐	☐	☐	☐	☐
Ich bin mir oft unsicher, ob das autonome Fahrzeug andere Verkehrsobjekte erkennt.	☐	☐	☐	☐	☐	☐
Ich kann abschätzen, welche Elemente des Fahrzeugumfeldes dem autonomen Fahrzeug bewusst sind.	☐	☐	☐	☐	☐	☐

G6. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Die Nutzung autonomer Fahrzeuge macht Spaß.	☐	☐	☐	☐	☐	☐	☐
Die Nutzung autonomer Fahrzeuge ist angenehm.	☐	☐	☐	☐	☐	☐	☐
Die Nutzung autonomer Fahrzeuge ist sehr unterhaltsam.	☐	☐	☐	☐	☐	☐	☐

G7. **Im Folgenden geht es um den während der Studie erlebten Fahrstil.**

	1 - sehr vorsichtig	2	3	4	5	6 - sehr sportlich
Bitte bewerten Sie den während dieser Studie erlebten Fahrstil.	☐	☐	☐	☐	☐	☐

LimeSurvey

G8. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs meine Fahrten einfacher machen kann.	☐	☐	☐	☐	☐	☐	☐
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs meine Fahrsicherheitsleistung verbessern kann.	☐	☐	☐	☐	☐	☐	☐
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs mir erlauben kann, während der Fahrt andere Dinge zu tun.	☐	☐	☐	☐	☐	☐	☐
Ich halte ein solches autonomes Fahrzeug für nützlich, wenn meine Fahrtüchtigkeit beeinträchtigt ist (z.B. bei Müdigkeit, Trunkenheit, Drogeneinfluss).	☐	☐	☐	☐	☐	☐	☐
Insgesamt halte ich ein solches autonomes Fahrzeug für nützlich.	☐	☐	☐	☐	☐	☐	☐

G9. **Würden Sie ein solches Fahrzeug nutzen, wenn...**

	Ja	Nein
...Sie entgegen der Fahrtrichtung sitzen?	☐	☐
...Sie in Fahrtrichtung sitzen?	☐	☐

G10. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu	Nicht zutreffend.
Ich habe oft auf das Display geschaut.	☐	☐	☐	☐	☐	☐	☐
Ich habe das Display nicht wahrgenommen.	☐	☐	☐	☐	☐	☐	☐

G11.

	1 - behindernd	2	3	4	5	6	7 - unterstützend	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

G12.

	1 - kompliziert	2	3	4	5	6	7 - einfach	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

G13.

	1 - ineffizient	2	3	4	5	6	7 - effizient	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

LimeSurvey

G14.

	1 - verwirrend	2	3	4	5	6	7 - übersichtlich	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

G15.

	1 - langweilig	2	3	4	5	6	7 - spannend	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

G16.

	1 - uninteressant	2	3	4	5	6	7 - interessant	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

G17.

	1 - konventionell	2	3	4	5	6	7 - originell	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

G18.

	1 - herkömmlich	2	3	4	5	6	7 - neuartig	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

Teil H: Message3

Vielen Dank.

Bitte sperren Sie das Tablet und wenden Sie sich an den Versuchsleiter für weitere Instruktionen.

Teil I: Zwischen4

Bitte beantworten Sie folgende Fragen basierend auf Ihren Eindrücken der soeben erlebten Fahrt.

I1.   Bitte geben Sie an an welchem Platz Sie gesessen haben.

Fahrerseite - vorwärts	☐
Fahrerseite - rückwärts	☐
Beifahrerseite - vorwärts	☐
Beifahrerseite - rückwärts	☐

LimeSurvey

I2. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich habe viel darauf geachtet, was das Fahrzeug tat.	☐	☐	☐	☐	☐	☐
Ich habe viel darauf geachtet, was um das Fahrzeug herum geschah.	☐	☐	☐	☐	☐	☐
Ich habe nur wenig Zeit damit verbracht, die Umgebung zu beobachten.	☐	☐	☐	☐	☐	☐
Gedanklich war ich viel mit der Fahrt beschäftigt.	☐	☐	☐	☐	☐	☐
Ich könnte den Verlauf der Fahrt gut beschreiben.	☐	☐	☐	☐	☐	☐
Ich kann mich nicht mehr an viele bestimmte Verkehrssituationen aus der Fahrt erinnern.	☐	☐	☐	☐	☐	☐

I3. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme gar nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Ich vertraue dem automatisierten Fahrzeug während der Fahrt.	☐	☐	☐	☐	☐	☐	☐
Ich hätte die Fahrt besser gemeistert als das automatisierte Fahrzeug.	☐	☐	☐	☐	☐	☐	☐
Wenn das automatisierte Fahrzeug so arbeitet wie während der Fahrt, fällt es mir leicht etwas anderes (z.B. Lesen) zu tun.	☐	☐	☐	☐	☐	☐	☐
Diese Fahrt war riskant.	☐	☐	☐	☐	☐	☐	☐
Das automatisierte Fahrzeug hat unsichere Entscheidungen getroffen.	☐	☐	☐	☐	☐	☐	☐
Das automatisierte Fahrzeug hat angemessen auf die Umwelt reagiert.	☐	☐	☐	☐	☐	☐	☐

I4. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich hatte das Gefühl jederzeit zu wissen in welche Richtung das Fahrzeug fährt.	☐	☐	☐	☐	☐	☐
Die Manöver des Fahrzeugs sind absehbar für mich.	☐	☐	☐	☐	☐	☐
Ich bin oft überrascht von der Fahrzeugführung.	☐	☐	☐	☐	☐	☐

I5. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich denke, dass das autonome Fahrzeug die anderen Verkehrsteilnehmer wahrnimmt.	☐	☐	☐	☐	☐	☐
Ich bin mir oft unsicher, ob das autonome Fahrzeug andere Verkehrsobjekte erkennt.	☐	☐	☐	☐	☐	☐
Ich kann abschätzen, welche Elemente des Fahrzeugumfeldes dem autonomen Fahrzeug bewusst sind.	☐	☐	☐	☐	☐	☐

I6. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Die Nutzung autonomer Fahrzeuge macht Spaß.	☐	☐	☐	☐	☐	☐	☐
Die Nutzung autonomer Fahrzeuge ist angenehm.	☐	☐	☐	☐	☐	☐	☐
Die Nutzung autonomer Fahrzeuge ist sehr unterhaltsam.	☐	☐	☐	☐	☐	☐	☐

I7. **Im Folgenden geht es um den während der Studie erlebten Fahrstil.**

	1 - sehr vorsichtig	2	3	4	5	6 - sehr sportlich
Bitte bewerten Sie den während dieser Studie erlebten Fahrstil.	☐	☐	☐	☐	☐	☐

I8. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs meine Fahrten einfacher machen kann.	☐	☐	☐	☐	☐	☐	☐
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs meine Fahrsicherheitsleistung verbessern kann.	☐	☐	☐	☐	☐	☐	☐
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs mir erlauben kann, während der Fahrt andere Dinge zu tun.	☐	☐	☐	☐	☐	☐	☐
Ich halte ein solches autonomes Fahrzeug für nützlich, wenn meine Fahrtüchtigkeit beeinträchtigt ist (z.B. bei Müdigkeit, Trunkenheit, Drogeneinfluss).	☐	☐	☐	☐	☐	☐	☐
Insgesamt halte ich ein solches autonomes Fahrzeug für nützlich.	☐	☐	☐	☐	☐	☐	☐

LimeSurvey

I9.   Würden Sie ein solches Fahrzeug nutzen, wenn...

	Ja	Nein
...Sie entgegen der Fahrtrichtung sitzen?	☐	☐
...Sie in Fahrtrichtung sitzen?	☐	☐

I10.   Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu	Nicht zutreffend.
Ich habe oft auf das Display geschaut.	☐	☐	☐	☐	☐	☐	☐
Ich habe das Display nicht wahrgenommen.	☐	☐	☐	☐	☐	☐	☐

I11.

	1 - behindernd	2	3	4	5	6	7 - unterstützend	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

I12.

	1 - kompliziert	2	3	4	5	6	7 - einfach	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

I13.

	1 - ineffizient	2	3	4	5	6	7 - effizient	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

I14.

	1 - verwirrend	2	3	4	5	6	7 - übersichtlich	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

I15.

	1 - langweilig	2	3	4	5	6	7 - spannend	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

I16.

	1 - uninteressant	2	3	4	5	6	7 - interessant	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

I17.

	1 - konventionell	2	3	4	5	6	7 - originell	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

LimeSurvey

I18.

	1 - herkömmlich	2	3	4	5	6	7 - neuartig	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

Teil J: Message4

Vielen Dank.

Bitte sperren Sie das Tablet und wenden Sie sich an den Versuchsleiter für weitere Instruktionen.

Teil K: Zwischen5

Bitte beantworten Sie folgende Fragen basierend auf Ihren Eindrücken der soeben erlebten Fahrt.

K1.   Bitte geben Sie an an welchem Platz Sie gesessen haben.

Fahrerseite - vorwärts	☐
Fahrerseite - rückwärts	☐
Beifahrerseite - vorwärts	☐
Beifahrerseite - rückwärts	☐

K2.   Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich habe viel darauf geachtet, was das Fahrzeug tat.	☐	☐	☐	☐	☐	☐
Ich habe viel darauf geachtet, was um das Fahrzeug herum geschah.	☐	☐	☐	☐	☐	☐
Ich habe nur wenig Zeit damit verbracht, die Umgebung zu beobachten.	☐	☐	☐	☐	☐	☐
Gedanklich war ich viel mit der Fahrt beschäftigt.	☐	☐	☐	☐	☐	☐
Ich könnte den Verlauf der Fahrt gut beschreiben.	☐	☐	☐	☐	☐	☐
Ich kann mich nicht mehr an viele bestimmte Verkehrssituationen aus der Fahrt erinnern.	☐	☐	☐	☐	☐	☐

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K3. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme gar nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Ich vertraue dem automatisierten Fahrzeug während der Fahrt.	☐	☐	☐	☐	☐	☐	☐
Ich hätte die Fahrt besser gemeistert als das automatisierte Fahrzeug.	☐	☐	☐	☐	☐	☐	☐
Wenn das automatisierte Fahrzeug so arbeitet wie während der Fahrt, fällt es mir leicht etwas anderes (z.B. Lesen) zu tun.	☐	☐	☐	☐	☐	☐	☐
Diese Fahrt war riskant.	☐	☐	☐	☐	☐	☐	☐
Das automatisierte Fahrzeug hat unsichere Entscheidungen getroffen.	☐	☐	☐	☐	☐	☐	☐
Das automatisierte Fahrzeug hat angemessen auf die Umwelt reagiert.	☐	☐	☐	☐	☐	☐	☐

K4. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich hatte das Gefühl jederzeit zu wissen in welche Richtung das Fahrzeug fährt.	☐	☐	☐	☐	☐	☐
Die Manöver des Fahrzeugs sind absehbar für mich.	☐	☐	☐	☐	☐	☐
Ich bin oft überrascht von der Fahrzeugführung.	☐	☐	☐	☐	☐	☐

K5. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich denke, dass das autonome Fahrzeug die anderen Verkehrsteilnehmer wahrnimmt.	☐	☐	☐	☐	☐	☐
Ich bin mir oft unsicher, ob das autonome Fahrzeug andere Verkehrsobjekte erkennt.	☐	☐	☐	☐	☐	☐
Ich kann abschätzen, welche Elemente des Fahrzeugumfeldes dem autonomen Fahrzeug bewusst sind.	☐	☐	☐	☐	☐	☐

K6. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Die Nutzung autonomer Fahrzeuge macht Spaß.	☐	☐	☐	☐	☐	☐	☐
Die Nutzung autonomer Fahrzeuge ist angenehm.	☐	☐	☐	☐	☐	☐	☐
Die Nutzung autonomer Fahrzeuge ist sehr unterhaltsam.	☐	☐	☐	☐	☐	☐	☐

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K7. **Im Folgenden geht es um den während der Studie erlebten Fahrstil.**

	1 - sehr vorsichtig	2	3	4	5	6 - sehr sportlich
Bitte bewerten Sie den während dieser Studie erlebten Fahrstil.	☐	☐	☐	☐	☐	☐

K8. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs meine Fahrten einfacher machen kann.	☐	☐	☐	☐	☐	☐	☐
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs meine Fahrsicherheitsleistung verbessern kann.	☐	☐	☐	☐	☐	☐	☐
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs mir erlauben kann, während der Fahrt andere Dinge zu tun.	☐	☐	☐	☐	☐	☐	☐
Ich halte ein solches autonomes Fahrzeug für nützlich, wenn meine Fahrtüchtigkeit beeinträchtigt ist (z.B. bei Müdigkeit, Trunkenheit, Drogeneinfluss).	☐	☐	☐	☐	☐	☐	☐
Insgesamt halte ich ein solches autonomes Fahrzeug für nützlich.	☐	☐	☐	☐	☐	☐	☐

K9. **Würden Sie ein solches Fahrzeug nutzen, wenn...**

	Ja	Nein
...Sie entgegen der Fahrtrichtung sitzen?	☐	☐
...Sie in Fahrtrichtung sitzen?	☐	☐

K10. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu	Nicht zutreffend.
Ich habe oft auf das Display geschaut.	☐	☐	☐	☐	☐	☐	☐
Ich habe das Display nicht wahrgenommen.	☐	☐	☐	☐	☐	☐	☐

K11.

	1 - behindernd	2	3	4	5	6	7 - unterstützend	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

K12.

	1 - kompliziert	2	3	4	5	6	7 - einfach	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

LimeSurvey

K13.

	1 - ineffizient	2	3	4	5	6	7 - effizient	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

K14.

	1 - verwirrend	2	3	4	5	6	7 - übersichtlich	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

K15.

	1 - langweilig	2	3	4	5	6	7 - spannend	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

K16.

	1 - uninteressant	2	3	4	5	6	7 - interessant	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

K17.

	1 - konventionell	2	3	4	5	6	7 - originell	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

K18.

	1 - herkömmlich	2	3	4	5	6	7 - neuartig	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

Teil L: Message5

Vielen Dank.

Bitte sperren Sie das Tablet und wenden Sie sich an den Versuchsleiter für weitere Instruktionen.

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Teil M: Zwischen6

Bitte beantworten Sie folgende Fragen basierend auf Ihren Eindrücken der soeben erlebten Fahrt.

M1. Bitte geben Sie an an welchem Platz Sie gesessen haben.

Fahrerseite - vorwärts ☐

Fahrerseite - rückwärts ☐

Beifahrerseite - vorwärts ☐

Beifahrerseite - rückwärts ☐

M2. Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich habe viel darauf geachtet, was das Fahrzeug tat.	☐	☐	☐	☐	☐	☐
Ich habe viel darauf geachtet, was um das Fahrzeug herum geschah.	☐	☐	☐	☐	☐	☐
Ich habe nur wenig Zeit damit verbracht, die Umgebung zu beobachten.	☐	☐	☐	☐	☐	☐
Gedanklich war ich viel mit der Fahrt beschäftigt.	☐	☐	☐	☐	☐	☐
Ich könnte den Verlauf der Fahrt gut beschreiben.	☐	☐	☐	☐	☐	☐
Ich kann mich nicht mehr an viele bestimmte Verkehrssituationen aus der Fahrt erinnern.	☐	☐	☐	☐	☐	☐

M3. Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.

	1 - Stimme gar nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Ich vertraue dem automatisierten Fahrzeug während der Fahrt.	☐	☐	☐	☐	☐	☐	☐
Ich hätte die Fahrt besser gemeistert als das automatisierte Fahrzeug.	☐	☐	☐	☐	☐	☐	☐
Wenn das automatisierte Fahrzeug so arbeitet wie während der Fahrt, fällt es mir leicht etwas anderes (z.B. Lesen) zu tun.	☐	☐	☐	☐	☐	☐	☐
Diese Fahrt war riskant.	☐	☐	☐	☐	☐	☐	☐
Das automatisierte Fahrzeug hat unsichere Entscheidungen getroffen.	☐	☐	☐	☐	☐	☐	☐
Das automatisierte Fahrzeug hat angemessen auf die Umwelt reagiert.	☐	☐	☐	☐	☐	☐	☐

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M4. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich hatte das Gefühl jederzeit zu wissen in welche Richtung das Fahrzeug fährt.	☐	☐	☐	☐	☐	☐
Die Manöver des Fahrzeugs sind absehbar für mich.	☐	☐	☐	☐	☐	☐
Ich bin oft überrascht von der Fahrzeugführung.	☐	☐	☐	☐	☐	☐

M5. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu
Ich denke, dass das autonome Fahrzeug die anderen Verkehrsteilnehmer wahrnimmt.	☐	☐	☐	☐	☐	☐
Ich bin mir oft unsicher, ob das autonome Fahrzeug andere Verkehrsobjekte erkennt.	☐	☐	☐	☐	☐	☐
Ich kann abschätzen, welche Elemente des Fahrzeugumfeldes dem autonomen Fahrzeug bewusst sind.	☐	☐	☐	☐	☐	☐

M6. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Die Nutzung autonomer Fahrzeuge macht Spaß.	☐	☐	☐	☐	☐	☐	☐
Die Nutzung autonomer Fahrzeuge ist angenehm.	☐	☐	☐	☐	☐	☐	☐
Die Nutzung autonomer Fahrzeuge ist sehr unterhaltsam.	☐	☐	☐	☐	☐	☐	☐

M7. **Im Folgenden geht es um den während der Studie erlebten Fahrstil.**

	1 - sehr vorsichtig	2	3	4	5	6 - sehr sportlich
Bitte bewerten Sie den während dieser Studie erlebten Fahrstil.	☐	☐	☐	☐	☐	☐

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M8. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6	7 - Stimme voll und ganz zu
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs meine Fahrten einfacher machen kann.	☐	☐	☐	☐	☐	☐	☐
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs meine Fahrsicherheitsleistung verbessern kann.	☐	☐	☐	☐	☐	☐	☐
Ich denke, dass die Nutzung eines solchen autonomen Fahrzeugs mir erlauben kann, während der Fahrt andere Dinge zu tun.	☐	☐	☐	☐	☐	☐	☐
Ich halte ein solches autonomes Fahrzeug für nützlich, wenn meine Fahrtüchtigkeit beeinträchtigt ist (z.B. bei Müdigkeit, Trunkenheit, Drogeneinfluss).	☐	☐	☐	☐	☐	☐	☐
Insgesamt halte ich ein solches autonomes Fahrzeug für nützlich.	☐	☐	☐	☐	☐	☐	☐

M9. **Würden Sie ein solches Fahrzeug nutzen, wenn...**

	Ja	Nein
...Sie entgegen der Fahrtrichtung sitzen?	☐	☐
...Sie in Fahrtrichtung sitzen?	☐	☐

M10. **Bitte geben Sie den Grad Ihrer Zustimmung zu den folgenden Aussagen an.**

	1 - Stimme überhaupt nicht zu	2	3	4	5	6 - Stimme voll und ganz zu	Nicht zutreffend.
Ich habe oft auf das Display geschaut.	☐	☐	☐	☐	☐	☐	☐
Ich habe das Display nicht wahrgenommen.	☐	☐	☐	☐	☐	☐	☐

M11.

	1 - behindernd	2	3	4	5	6	7 - unterstützend	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

M12.

	1 - kompliziert	2	3	4	5	6	7 - einfach	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

M13.

	1 - ineffizient	2	3	4	5	6	7 - effizient	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

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M14.

	1 - verwirrend	2	3	4	5	6	7 - übersichtlich	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

M15.

	1 - langweilig	2	3	4	5	6	7 - spannend	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

M16.

	1 - uninteressant	2	3	4	5	6	7 - interessant	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

M17.

	1 - konventionell	2	3	4	5	6	7 - originell
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐

M18.

	1 - herkömmlich	2	3	4	5	6	7 - neuartig	Nicht zutreffend.
Die Displaydarstellungen im Auto waren	☐	☐	☐	☐	☐	☐	☐	☐

Teil N: Abschluss

Sie haben das Ende der Studie erreicht.

Vielen Dank für Ihre Teilnahme! Mit Klick auf den Pfeil werden Ihre Antworten gespeichert.

N1. *Diese Frage bezieht sich auf alle heutigen von Ihnen erlebten Fahrten.*

Sie haben mehrfach bewertet, ob Sie ein solches Fahrzeug in vorwärtiger bzw. rückwärtiger Sitzausrichtung nutzen würden.

Sehen Sie Unterschiede in Ihrer Bewertung der Sitzausrichtung zwischen den jeweiligen Fahrten? Wie kommen diese Unterschiede zustande?

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N2. *Diese Frage bezieht sich auf <u>alle</u> heutigen von Ihnen erlebten Fahrten.*

Sie haben mehrfach die Displaydarstellungen im Auto bewertet.

Was wurde auf den Bildschirmen gezeigt?

N3. Haben Sie noch weitere Anmerkungen zu den Displaydarstellungen?
Bitte nutzen die Freifläche, um Impressionen zu notieren.

Appendix C: Visualisations of variables

Appendix C.1: Preference scales of forward and rearward facing seating orientation in transportation means based on Han et al. (1998).

Figure C.1.

Preference scale for seating orientation in transportation in geometric means divided into forward and rearward seating orientation. Note: for visibility reasons, the scale was cut and adapted.
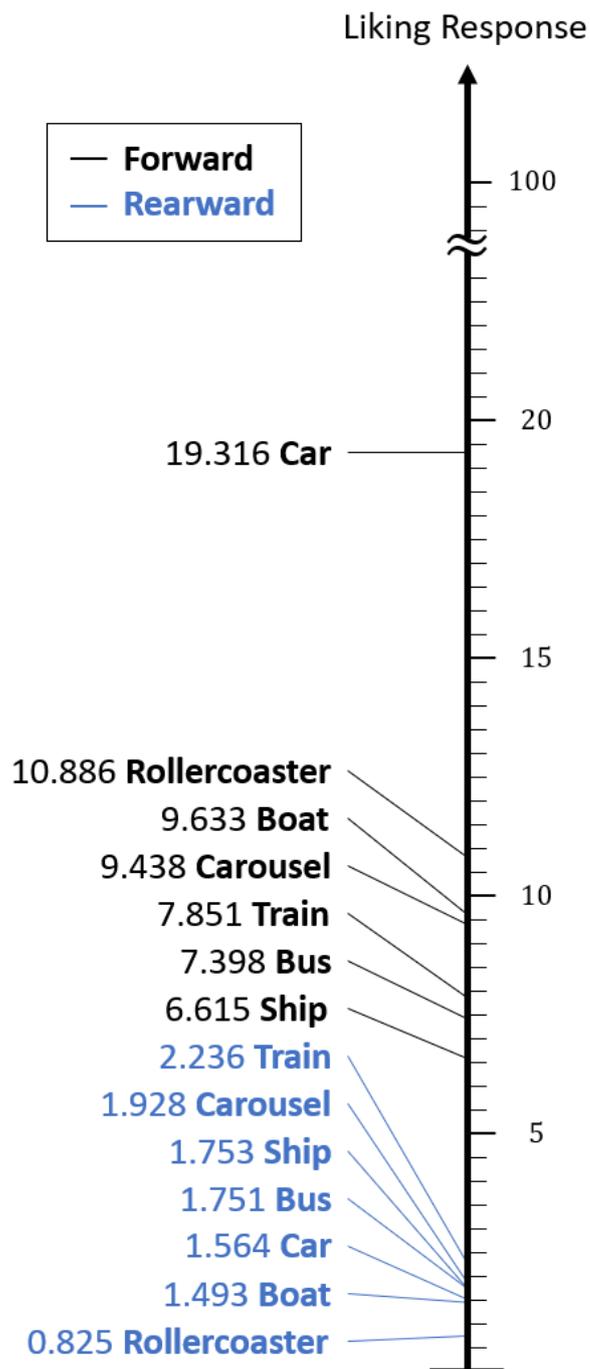
Appendix C.2: Distributions of quasi-continuous variable scores

Figure C.2.1.

Histogram of the frequency of intention transparency scores across all vehicle journeys sampled between the vehicle journeys on a scale from 1 to 6 grouped in blocks .5 points difference.
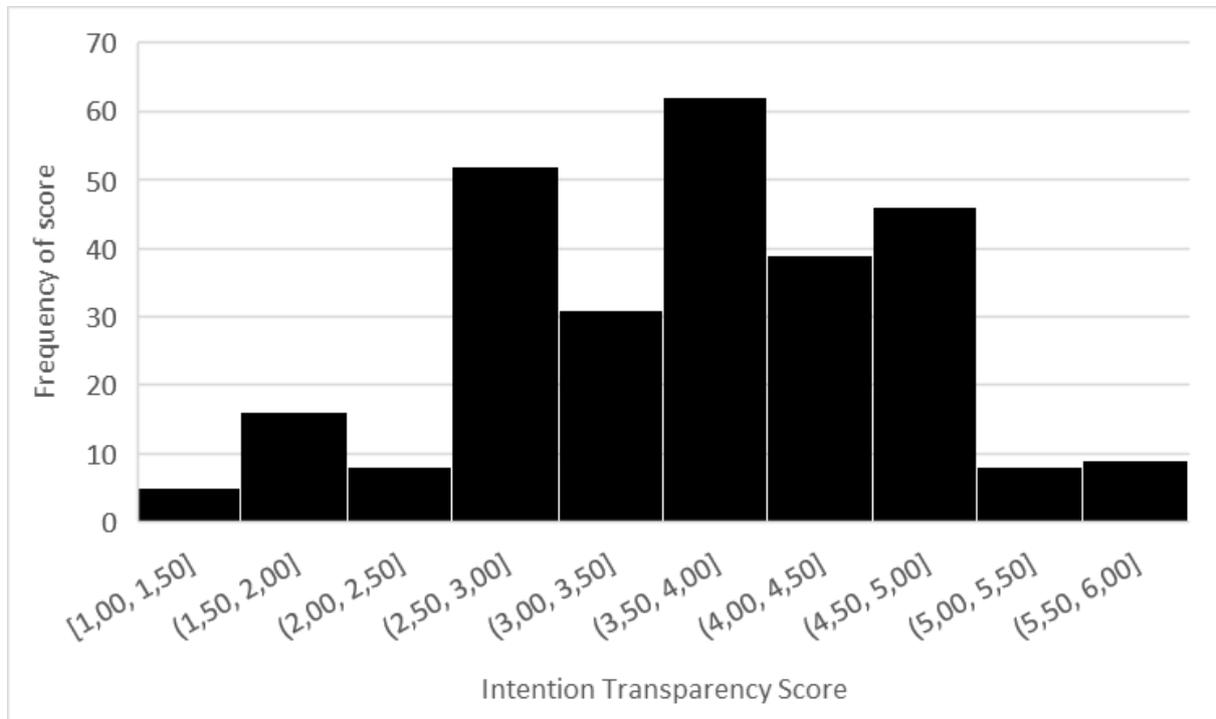
Figure C.2.2.

Histogram of the frequency of perception transparency scores across all vehicle journeys sampled between the vehicle journeys on a scale from 1 to 6 grouped in blocks .37 points difference.
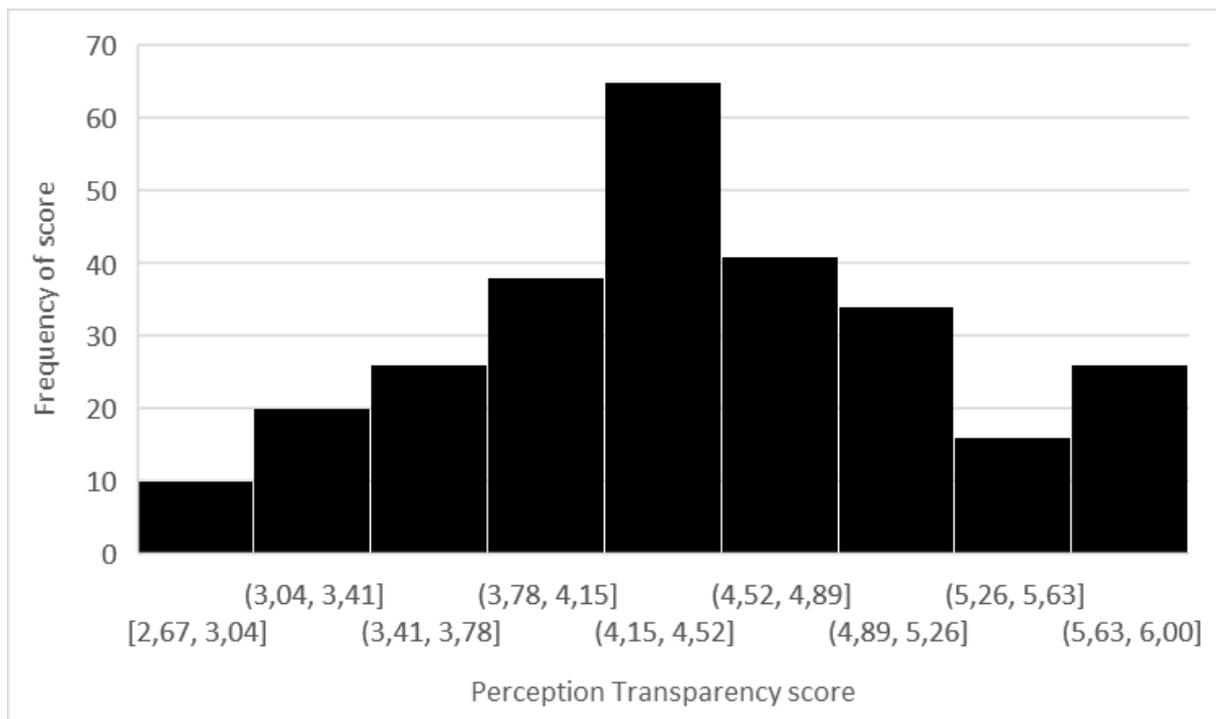
Figure C.2.3.

Histogram of the frequency of intra-journey trust scores across all vehicle journeys sampled during the vehicle journeys on a scale from 0 to 9 grouped in blocks .6 points difference.
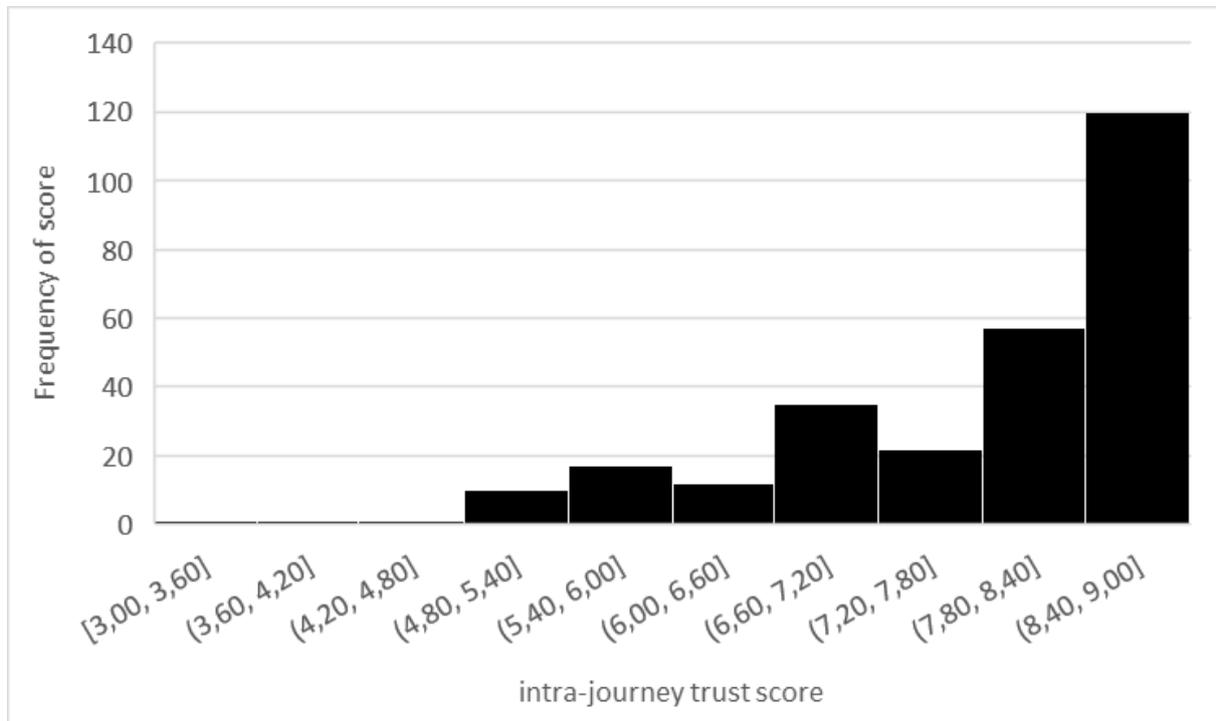
Figure C.2.4.

Histogram of the frequency of STS-AD scores across all vehicle journeys sampled between the vehicle journeys on a scale from 1 to 7 grouped in blocks .43 points difference.
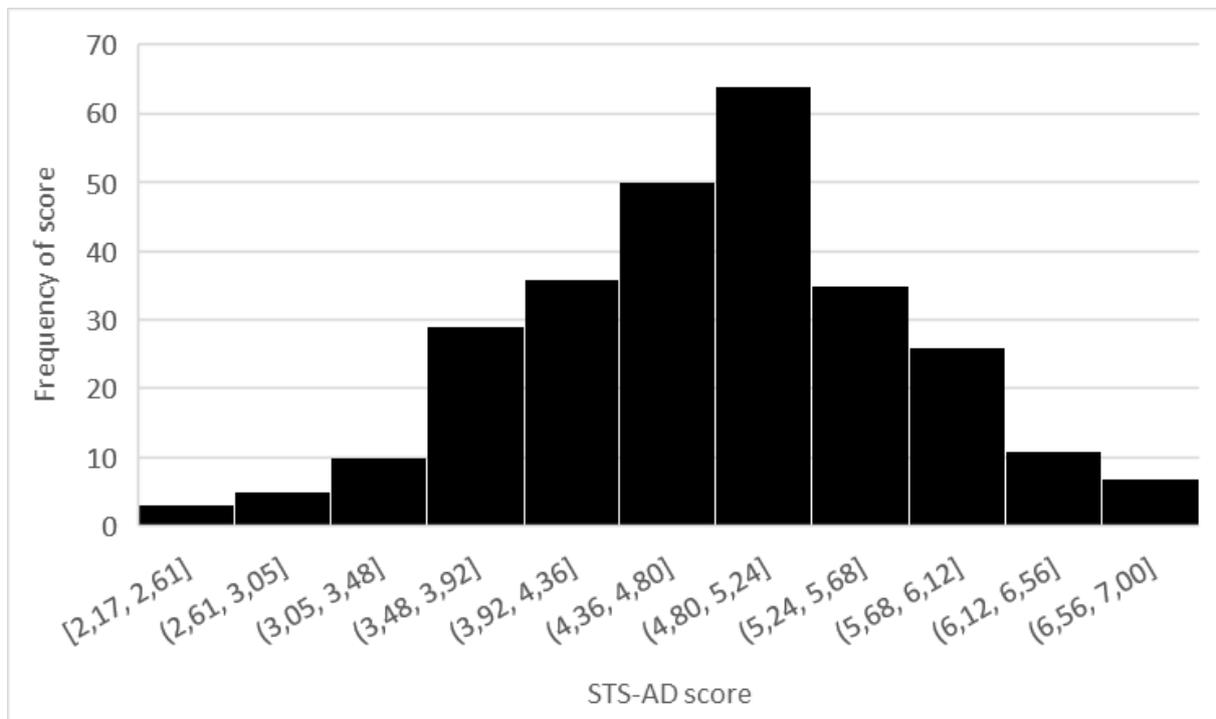
Figure C.2.5.

Histogram of the frequency of FMS scores across all vehicle journeys sampled during the vehicle journeys on a scale from 0 to 20 grouped in blocks of 1.38 points difference.
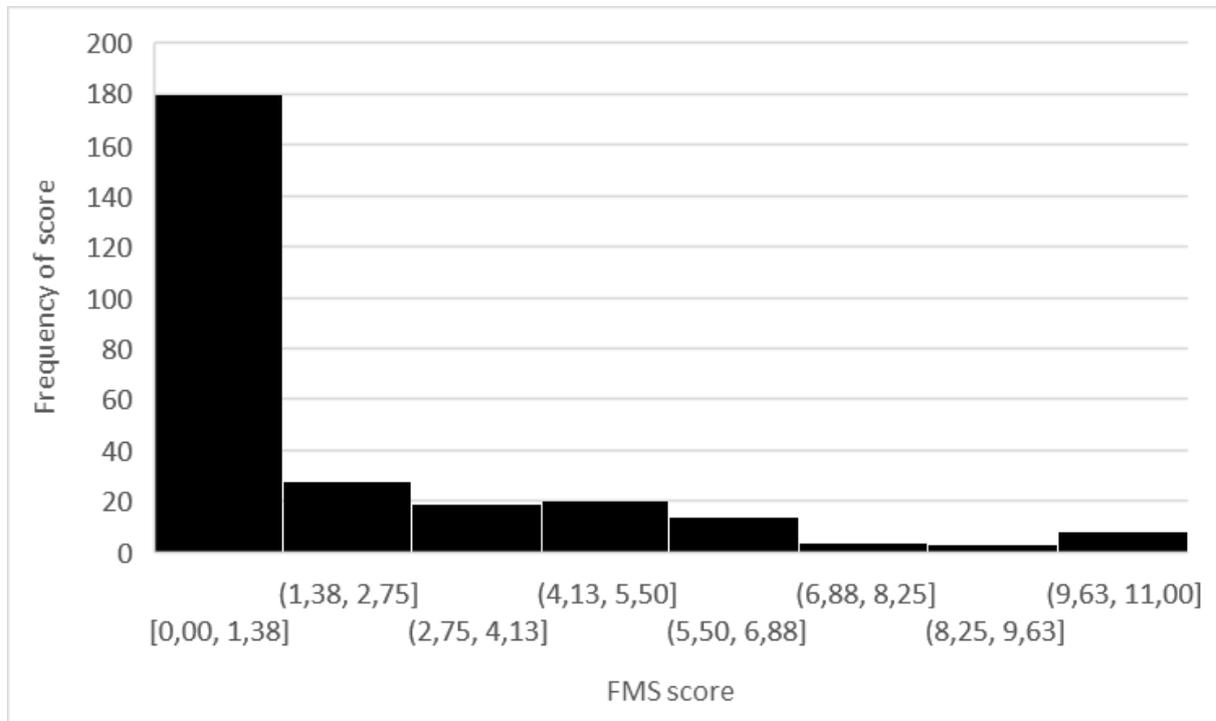
Appendix D: R analysis code

```
# Analysis

## Load dataframes

```{r}
BQ_LS_merged <- read_excel("vorOrt_LiveScale_merged.xlsx")
BQ_LS_merged_wideFahrtNo <- read_excel("vorOrt_LiveScale_mergedWideFahrtNo.xlsx")
PreQ_BQ_LS_merged_wideFahrtNo <- read_excel("PrevorOrt_LiveScale_mergedWideFahrtNo.xlsx")
```

Descriptives

```{r}
describe(BQ_LS_merged$mTrust)
hist(BQ_LS_merged$mTrust)
shapiro.test(BQ_LS_merged$mTrust)

describe(BQ_LS_merged$mFMS)
hist(BQ_LS_merged$mFMS)
shapiro.test(BQ_LS_merged$mFMS)

describe(BQ_LS_merged$mSTS_AD)
hist(BQ_LS_merged$mSTS_AD)
shapiro.test(BQ_LS_merged$mSTS_AD)

describe(BQ_LS_merged$mIT)
hist(BQ_LS_merged$mIT)
shapiro.test(BQ_LS_merged$mIT)

describe(BQ_LS_merged$mPT)
hist(BQ_LS_merged$mPT)
shapiro.test(BQ_LS_merged$mPT)

crossTabRear <- xtabs(~ BQ_LS_merged$SeatingOrientation + BQ_LS_merged$UsageIntRear)
crossTabForw <- xtabs(~ BQ_LS_merged$SeatingOrientation + BQ_LS_merged$UsageIntForw)
crossTabRear
crossTabForw
```

Seating orientation

```{r}
# Summary
BQ_LS_merged %>%
 group_by(SeatingOrientation) %>%
 get_summary_stats(mTrust, type = "mean_sd")

BQ_LS_merged %>%
 group_by(SeatingOrientation) %>%
 get_summary_stats(mSTS_AD, type = "mean_sd")
```

```
BQ_LS_merged %>%
 group_by(SeatingOrientation) %>%
 get_summary_stats(mFMS, type = "mean_sd")

BQ_LS_merged %>%
 group_by(SeatingOrientation) %>%
 get_summary_stats(mIT, type = "mean_sd")

BQ_LS_merged %>%
 group_by(SeatingOrientation) %>%
 get_summary_stats(mPT, type = "mean_sd")

# Visualize
ggboxplot(BQ_LS_merged, x = "SeatingOrientation", y = "mTrust", add = "jitter",
     ylab = "Trust", xlab = "Seating Orientation")

ggboxplot(BQ_LS_merged, x = "SeatingOrientation", y = "mSTS_AD", add = "jitter",
     ylab = "STS_AD", xlab = "Seating Orientation")

ggboxplot(BQ_LS_merged, x = "SeatingOrientation", y = "mFMS", add = "jitter",
     ylab = "Motion Sickness", xlab = "Seating Orientation")

ggboxplot(BQ_LS_merged, x = "SeatingOrientation", y = "mIT", add = "jitter",
     ylab = "Intention Transparency", xlab = "Seating Orientation")

ggboxplot(BQ_LS_merged, x = "SeatingOrientation", y = "mPT", add = "jitter",
     ylab = "Perception Transparency", xlab = "Seating Orientation")

## Assumptions were tested comparing differences between groups, outlier analysis, normality
assumption

# Computation
wilcox.test(BQ_LS_merged$mFMS ~ BQ_LS_merged$SeatingOrientation, alternative = "less", paired
= TRUE)

t.test(BQ_LS_merged$mTrust ~ BQ_LS_merged$SeatingOrientation, alternative = "greater", paired =
TRUE)

t.test(BQ_LS_merged$mSTS_AD ~ BQ_LS_merged$SeatingOrientation, alternative = "greater", paired
= TRUE)

t.test(BQ_LS_merged$mIT ~ BQ_LS_merged$SeatingOrientation, alternative = "greater", paired =
TRUE)

t.test(BQ_LS_merged$mPT ~ BQ_LS_merged$SeatingOrientation, alternative = "greater", paired =
TRUE)

# Effect sizes
cohen.d(BQ_LS_merged$mFMS, BQ_LS_merged$SeatingOrientation, paired = TRUE, within = FALSE)
cohen.d(BQ_LS_merged$mTrust, BQ_LS_merged$SeatingOrientation, paired = TRUE, within = FALSE)
```

```
cohen.d(BQ_LS_merged$mSTS_AD, BQ_LS_merged$SeatingOrientation, paired = TRUE, within =
FALSE)
cohen.d(BQ_LS_merged$mIT, BQ_LS_merged$SeatingOrientation, paired = TRUE, within = FALSE)
cohen.d(BQ_LS_merged$mPT, BQ_LS_merged$SeatingOrientation, paired = TRUE, within = FALSE)

# Descriptives
BQ_LS_merged %>%
 group_by(SeatingOrientation) %>%
 summarise(
  mean_mFMS = mean(mFMS, na.rm = TRUE),
  median_mFMS = median(mFMS, na.rm = TRUE),
  sd_mFMS = sd(mFMS, na.rm = TRUE),
  se_mFMS = sd(mFMS) / sqrt(n()),
  min_mFMS = min(mFMS, na.rm = TRUE),
  max_mFMS = max(mFMS, na.rm = TRUE)
 )
BQ_LS_merged %>%
 group_by(SeatingOrientation) %>%
 summarise(
  mean_mTrust = mean(mTrust, na.rm = TRUE),
  median_mTrust = median(mTrust, na.rm = TRUE),
  sd_mTrust = sd(mTrust, na.rm = TRUE),
  se_mTrust = sd(mTrust) / sqrt(n()),
  min_mTrust = min(mTrust, na.rm = TRUE),
  max_mTrust = max(mTrust, na.rm = TRUE)
 )
BQ_LS_merged %>%
 group_by(SeatingOrientation) %>%
 summarise(
  mean_mSTS_AD = mean(mSTS_AD, na.rm = TRUE),
  median_mSTS_AD = median(mSTS_AD, na.rm = TRUE),
  sd_mSTS_AD = sd(mSTS_AD, na.rm = TRUE),
  se_mSTS_AD = sd(mSTS_AD) / sqrt(n()),
  min_mSTS_AD = min(mSTS_AD, na.rm = TRUE),
  max_mSTS_AD = max(mSTS_AD, na.rm = TRUE)
 )
BQ_LS_merged %>%
 group_by(SeatingOrientation) %>%
 summarise(
  mean_mIT = mean(mIT, na.rm = TRUE),
  median_mIT = median(mIT, na.rm = TRUE),
  sd_mIT = sd(mIT, na.rm = TRUE),
  se_mIT = sd(mIT) / sqrt(n()),
  min_mIT = min(mIT, na.rm = TRUE),
  max_mIT = max(mIT, na.rm = TRUE)
 )
BQ_LS_merged %>%
 group_by(SeatingOrientation) %>%
 summarise(
  mean_mPT = mean(mPT, na.rm = TRUE),
  median_mPT = median(mPT, na.rm = TRUE),
```

```
    sd_mPT = sd(mPT, na.rm = TRUE),
    se_mPT = sd(mPT) / sqrt(n()),
    min_mPT = min(mPT, na.rm = TRUE),
    max_mPT = max(mPT, na.rm = TRUE)
  )
```

Manipulation check

```{r}
# Read and filter data
## Load PTonly dataset
PTcompar <- read_excel("PTcomparison.xlsx")

## Subset data for the categories of interest
subset_data <- subset(BQ_LS_merged, Condition2 %in% c("ITon", "OFF"))
subset_data2 <- subset(BQ_LS_merged, Condition2 %in% c("ITon", "LiveFeed"))
subset_data3 <- subset(BQ_LS_merged, Condition2 %in% c("LiveFeed", "OFF"))

# Summary
## PT between groups
describe(PTcompar$mPToff)
describe(PTcompar$mPTon)

## IT between conditions
BQ_LS_merged %>%
  group_by(Condition2) %>%
  get_summary_stats(mIT, type = "mean_sd")

# Visualization
## PT
### Create a new variable for display labels
BQ_LS_merged$DisplayCondition <- ifelse(BQ_LS_merged$Group == 1, "PT off", "PT on")

ggboxplot(BQ_LS_merged, x = "DisplayCondition", y = "mPT", by = "SeatingOrientation",
     ylab = "Perception Transparency score", xlab = "Group condition", color = "SeatingOrientation",
add = "jitter")

## IT
ggboxplot(BQ_LS_merged, x = "Condition2", y = "mIT", by = "SeatingOrientation",
     ylab = "Intention Transparency score", xlab = "Display Manipulation", color =
"SeatingOrientation", add = "jitter")

# Assumptions of normality, equal variances and outliers were checked

# Computation
## PT: independent samples t-test
t.test(PTcompar$mPTon, PTcompar$mPToff, var.equal = TRUE, paired = FALSE, alternative =
"two.sided", p.adjust.methods = "none")

## IT: paired t-test
```

```
t.test(subset_data$mIT ~ subset_data$Condition2, paired = TRUE, p.adjust.methods = "none")
t.test(subset_data2$mIT ~ subset_data2$Condition2, paired = TRUE, p.adjust.methods = "none")
t.test(subset_data3$mIT ~ subset_data3$Condition2, paired = TRUE, p.adjust.methods = "none")

# Further analysis
## Display use
describe(BQ_LS_merged$mDisplUse)

### t-tests
t.test(BQ_LS_merged$mDisplUse ~ BQ_LS_merged$SeatingOrientation, paired = FALSE,
p.adjust.methods = "none")
BQ_LS_merged <- ungroup(BQ_LS_merged)
BQ_LS_merged %>%
 t_test(mDisplUse ~ Condition2, paired = FALSE, p.adjust.method = "bonferroni")
t.test(BQ_LS_merged$mDisplUse ~ BQ_LS_merged$Group, paired = FALSE, p.adjust.methods =
"none")

### Descriptives
BQ_LS_merged %>%
 group_by(SeatingOrientation) %>%
 summarise(
  mean_mDisplUse = mean(mDisplUse, na.rm = TRUE),
  sd_mDisplUse = sd(mDisplUse, na.rm = TRUE),
  se_mDisplUse = sd(mDisplUse) / sqrt(n())
 )
BQ_LS_merged %>%
 group_by(Condition2) %>%
 summarise(
  mean_mDisplUse = mean(mDisplUse, na.rm = TRUE),
  sd_mDisplUse = sd(mDisplUse, na.rm = TRUE),
  se_mDisplUse = sd(mDisplUse) / sqrt(n())
 )
BQ_LS_merged %>%
 group_by(Group) %>%
 summarise(
  mean_mDisplUse = mean(mDisplUse, na.rm = TRUE),
  sd_mDisplUse = sd(mDisplUse, na.rm = TRUE),
  se_mDisplUse = sd(mDisplUse) / sqrt(n())
 )

## User Experience
### Load UEQ scale results dataset
UEQ <- read_excel("UserExperienceLong2.xlsx")

### Normality was checked

### Computation
UEQ %>% wilcox_test(UserExpDisplay1 ~ Condition2) %>% add_significance()
UEQ %>% wilcox_test(UserExpDisplay2 ~ Condition2) %>% add_significance()
UEQ %>% wilcox_test(UserExpDisplay3 ~ Condition2) %>% add_significance()
UEQ %>% wilcox_test(UserExpDisplay4 ~ Condition2) %>% add_significance()
```

```
UEQ %>% wilcox_test(UserExpDisplay5 ~ Condition2) %>% add_significance()
UEQ %>% wilcox_test(UserExpDisplay6 ~ Condition2) %>% add_significance()
UEQ %>% wilcox_test(UserExpDisplay7 ~ Condition2) %>% add_significance()
UEQ %>% wilcox_test(UserExpDisplay8 ~ Condition2) %>% add_significance()

### Descriptives
UEQ %>% group_by(Condition2) %>%
  summarise(mean_UE1 = mean(UserExpDisplay1, na.rm = TRUE),
        mean_UE2 = mean(UserExpDisplay2, na.rm = TRUE),
        mean_UE3 = mean(UserExpDisplay3, na.rm = TRUE),
        mean_UE4 = mean(UserExpDisplay4, na.rm = TRUE),
        mean_UE5 = mean(UserExpDisplay5, na.rm = TRUE),
        mean_UE6 = mean(UserExpDisplay6, na.rm = TRUE),
        mean_UE7 = mean(UserExpDisplay7, na.rm = TRUE),
        mean_UE8 = mean(UserExpDisplay8, na.rm = TRUE),
        sd_UE1 = sd(UserExpDisplay1, na.rm = TRUE),
        sd_UE2 = sd(UserExpDisplay2, na.rm = TRUE),
        sd_UE3 = sd(UserExpDisplay3, na.rm = TRUE),
        sd_UE4 = sd(UserExpDisplay4, na.rm = TRUE),
        sd_UE5 = sd(UserExpDisplay5, na.rm = TRUE),
        sd_UE6 = sd(UserExpDisplay6, na.rm = TRUE),
        sd_UE7 = sd(UserExpDisplay7, na.rm = TRUE),
        sd_UE8 = sd(UserExpDisplay8, na.rm = TRUE)
        )
```

Vehicle transparency

```{r}
# intra-vehicle trust
## Normalize DV
options(digits = 12)  # Set the number of digits to display
## Add a small positive value to avoid zeros
epsilon <- 0.0001
BQ_LS_merged$nTrust <- (BQ_LS_merged$mTrust + epsilon) / (9 + 2 * epsilon)
describe(BQ_LS_merged$nTrust)

## Pre-model testing
model_betaBase <- glmmTMB(nTrust ~ 1 + (1 | ID), data = BQ_LS_merged, family = beta_family(link = "logit"))
model_betaFahrt <- glmmTMB(nTrust ~ 1 + (FahrtNo | ID), data = BQ_LS_merged, family = beta_family(link = "logit"))
model_beta <- glmmTMB(nTrust ~ mIT + mPT + (FahrtNo | ID), data = BQ_LS_merged, family = beta_family(link = "logit"))
anova(model_betaFahrt, model_beta)

## Final model
DVmTrust <- glmmTMB(nTrust ~ mIT + mPT + (FahrtNo | ID), data = BQ_LS_merged, family = beta_family(link = "logit"))
summary(DVmTrust)
```

```
## Confidence intervals for random and fixed effects
confint(DVmTrust)

# STS-AD
## Normalize DV
options(digits = 22)  # Set the number of digits to display
## Add a small positive value to avoid zeros
epsilon <- 0.0001
BQ_LS_merged$nSTS_AD <- (BQ_LS_merged$mSTS_AD + epsilon) / (7 + 2 * epsilon)
describe(BQ_LS_merged$nSTS_AD)

## Pre-model testing
model_betaBase <- glmmTMB(nSTS_AD ~ 1 + (1 | ID), data = BQ_LS_merged, family =
beta_family(link = "logit"))
model_betaFahrt <- glmmTMB(nSTS_AD ~ 1 + (FahrtNo | ID), data = BQ_LS_merged, family =
beta_family(link = "logit"))
model_beta <- glmmTMB(nSTS_AD ~ mIT + mPT + (FahrtNo | ID), data = BQ_LS_merged, family =
beta_family(link = "logit"))
anova(model_betaBase, model_beta)

## Final model
DVmSTS <- glmmTMB(nSTS_AD ~ mIT + mPT + (FahrtNo | ID), data = BQ_LS_merged, family =
beta_family(link = "logit"))
summary(DVmSTS)

## Confidence intervals for random and fixed effects
confint(DVmSTS)

# FMS
## Normalize DV
options(digits = 12)  # Set the number of digits to display
## Add a small positive value to avoid zeros
epsilon <- 0.0001
BQ_LS_merged$nFMS <- (BQ_LS_merged$mFMS + epsilon) / (20 + 2 * epsilon)
describe(BQ_LS_merged$nFMS)

## Pre-model testing
model_betaNull <- glmmTMB(nFMS ~ 1 + (1 | ID), data = BQ_LS_merged, family = beta_family(link =
"logit"))
model_beta <- glmmTMB(nFMS ~ mIT + (FahrtNo | ID), data = BQ_LS_merged, family =
beta_family(link = "logit"))
anova(model_betaNull, model_beta)

## Final model
DVmFMS <- glmmTMB(nFMS ~ mIT + (FahrtNo | ID), data = BQ_LS_merged, family = beta_family(link
= "logit"))
summary(DVmFMS)

## Confidence intervals for random and fixed effects
confint(DVmFMS)
```
```

Behavioral intention

```{r}
# Testing the nullmodel for random effects
LgR_itself <- glm(UsageIntRear ~ 1 , data = BQ_LS_merged, family = binomial())
summary(LgR_itself)
LgR_itselfRandom <- glmer(UsageIntRear ~ 1 + (1|ID), data = BQ_LS_merged, family = binomial())
summary(LgR_itselfRandom)
LgR_itselfRandom2 <- glmer(UsageIntRear ~ 1 + (FahrtNo|ID), data = BQ_LS_merged, family =
binomial())
summary(LgR_itselfRandom2)
lrtest(LgR_itself, LgR_itselfRandom, LgR_itselfRandom2)
anova(LgR_itselfRandom, LgR_itselfRandom2)

# Each model was individually regarding random effects in advance
# Different kinds of models were compared beforehand

# Trust, STS_AD, FMS
## Final model #AIC 167.3
LgR_TrustSTSFMS <- glmer(UsageIntRear ~  mTrust + mSTS_AD + mFMS + (FahrtNo|ID), data =
BQ_LS_merged, family = binomial())
summary(LgR_TrustSTSFMS)
## Estimate the model fit compared to the null model
lrtest(LgR_itself, LgR_TrustSTSFMS)
## Extract fixed-effects coefficients
fixed_coefs <- fixef(LgR_TrustSTSFMS)
## Calculate odds ratios
odds_ratios <- exp(fixed_coefs)
odds_ratios

## Comparing the multilevel model with the normal model to assess significance of random effects
LgR_TrustSTSFMSBase <- glm(UsageIntRear ~  mTrust + mSTS_AD + mFMS, data = BQ_LS_merged,
family = binomial())
lrtest(LgR_TrustSTSFMSBase, LgR_TrustSTSFMS)

## Computation bootstrap-confidence intervals
boot_model <- bootMer(LgR_TrustSTSFMS, FUN = fixef, nsim = 1000)
boot_ci <- apply(boot_model$t, 2, function(x) quantile(x, probs = c(0.025, 0.975), na.rm = TRUE))
boot_ci

# STS-AD
## Final model #AIC 168.2
LgR_STS <- glmer(UsageIntRear ~  mSTS_AD + (FahrtNo|ID), data = BQ_LS_merged, family =
binomial())
summary(LgR_STS)
## Estimate the model fit compared to the null model
lrtest(LgR_itself, LgR_STS)
## Extract fixed-effects coefficients
fixed_coefs <- fixef(LgR_STS)
## Calculate odds ratios
```

```
odds_ratios <- exp(fixed_coefs)
## Print the odds ratios
print(odds_ratios)

## Comparing the multilevel model with the normal model to assess significance of random effects
LgR_STSBase <- glm(UsageIntRear ~ mSTS_AD, data = BQ_LS_merged, family = binomial())
lrtest(LgR_STSBase, LgR_STS)

## Computation bootstrap-confidence intervals
boot_model <- bootMer(LgR_STS, FUN = fixef, nsim = 1000)
boot_ci <- apply(boot_model$t, 2, function(x) quantile(x, probs = c(0.025, 0.975), na.rm = TRUE))
boot_ci


# STS-AD_1
BetwQSTS_AD1Live$UsageIntRear <- BQ_LS_merged$UsageIntRear

## Final model #AIC 167.3
LgR_STS_1 <- glmer(UsageIntRear ~ STS_AD + (1|ID), data = BetwQSTS_AD1Live, family = binomial())
LgR_Trust2 <- glmer(UsageIntRear ~ mTrust + (FahrtNo|ID.x), data = BetwQSTS_AD1Live, family =
binomial())
summary(LgR_STS_1)
## Estimate the model fit compared to the null model
lrt <- lrtest(LgR_itself, LgR_STS_1)
print(lrt)
## Extract fixed-effects coefficients
fixed_coefs <- fixef(LgR_STS_1)
## Calculate odds ratios
odds_ratios <- exp(fixed_coefs)
odds_ratios

## Comparing the multilevel model with the normal model to assess significance of random effects
LgR_STSBase_1 <- glm(UsageIntRear ~ STS_AD, data = BetwQSTS_AD1Live, family = binomial())
lrtest(LgR_STSBase_1, LgR_STS_1)

## Computation bootstrap-confidence intervals
boot_model <- bootMer(LgR_STS_1, FUN = fixef, nsim = 1000)
boot_ci <- apply(boot_model$t, 2, function(x) quantile(x, probs = c(0.025, 0.975), na.rm = TRUE))
boot_ci


# Trust
## Final model #AIC 163.8
LgR_Trust <- glmer(UsageIntRear ~ mTrust + (FahrtNo|ID), data = BQ_LS_merged, family =
binomial())
summary(LgR_Trust)
## Estimate the model fit compared to the null model
lrtest(LgR_itself, LgR_Trust)
## Extract fixed-effects coefficients
fixed_coefs <- fixef(LgR_Trust)
## Calculate odds ratios
```

```
odds_ratios <- exp(fixed_coefs)
## Print the odds ratios
print(odds_ratios)

## Comparing the multilevel model with the normal model to assess significance of random effects
LgR_TrustBase <- glm(UsageIntRear ~  mTrust, data = BQ_LS_merged, family = binomial())
lrtest(LgR_TrustBase, LgR_Trust)

## Computation bootstrap-confidence intervals
boot_model <- bootMer(LgR_Trust, FUN = fixef, nsim = 1000)
boot_ci <- apply(boot_model$t, 2, function(x) quantile(x, probs = c(0.025, 0.975), na.rm = TRUE))
boot_ci


# FMS
## Final model #AIC 190.1
LgR_FMS <- glmer(UsageIntRear ~  mFMS + (FahrtNo|ID), data = BQ_LS_merged, family = binomial())
summary(LgR_FMS)
## Estimate the model fit compared to the null model
lrtest(LgR_itselfRandom, LgR_FMS)
## Extract fixed-effects coefficients
fixed_coefs <- fixef(LgR_FMS)
## Calculate odds ratios
odds_ratios <- exp(fixed_coefs)
## Print the odds ratios
print(odds_ratios)

## no further testing due to non-significant results


# Seating orientation
SeatOrUsageInt <- read_excel("SeatOrUsageInt.xlsx")

## Contingency table
crossTab <- xtabs(~ SeatOrUsageInt$SeatingOrientation + SeatOrUsageInt$UsageInt)
crossTab

## Expected frequencies
n <- sum(crossTab)
expectedFreq <- outer(rowSums(crossTab), colSums(crossTab) / n)
expectedFreq

## Chi-square
chisq.test(SeatOrUsageInt$SeatingOrientation, SeatOrUsageInt$UsageInt)

## Effect size Cohen´s W
cohenW(SeatOrUsageInt$SeatingOrientation, SeatOrUsageInt$UsageInt)
cramerV(SeatOrUsageInt$SeatingOrientation, SeatOrUsageInt$UsageInt)

## Post-hoc test
chisq.test(crossTab)$stdres #standardized residuals
```

```
### alpha adjustment (bc you test the sample several times)
alpha = 0.05
alphaAdj <- alpha/(nrow(crossTab)*ncol(crossTab))
### Compute critical value
qnorm(alphaAdj/2)
```

Driving style

```{r}
# Two-tailed paired t-test
## Mean FahrstilvO
PreQ_BQ_LS_merged_wideFahrtNo$mFahrstilvO <- rowMeans(PreQ_BQ_LS_merged_wideFahrtNo[,
c("FahrstilvO_1", "FahrstilvO_2", "FahrstilvO_3", "FahrstilvO_4", "FahrstilvO_5", "FahrstilvO_6")])

## Perform paired samples t-test
t.test(PreQ_BQ_LS_merged_wideFahrtNo$mFahrstilvO,
PreQ_BQ_LS_merged_wideFahrtNo$FahrstilPrior, paired = TRUE)

describe(PreQ_BQ_LS_merged_wideFahrtNo$FahrstilPrior)
describe(PreQ_BQ_LS_merged_wideFahrtNo$mFahrstilvO)

## Effect size
cohen.d(PreQ_BQ_LS_merged_wideFahrtNo$mFahrstilvO,
PreQ_BQ_LS_merged_wideFahrtNo$FahrstilPrior)


# Correlation analyses - intra-journey trust & FMS
## Changing mFahrtstilvO into ranks
BQ_LS_merged$FahrstilvO_Ranks <- rank(BQ_LS_merged$FahrstilvO)

## Compute Kendall´s tau
cor.test(BQ_LS_merged$mTrust, BQ_LS_merged$FahrstilvO_Ranks, method="kendall")

cor.test(BQ_LS_merged$mFMS, BQ_LS_merged$FahrstilvO_Ranks, method="kendall")

# Paired t-test - Seating orientation
t.test(BQ_LS_merged$FahrstilvO ~ BQ_LS_merged$SeatingOrientation, paired = TRUE)

BQ_LS_merged %>%
  group_by(SeatingOrientation) %>%
  summarise(
    mean = mean(FahrstilvO, na.rm = TRUE),
    sd = sd(FahrstilvO, na.rm = TRUE),
    min = min(FahrstilvO, na.rm = TRUE),
    max = max(FahrstilvO, na.rm = TRUE)
  )
```

Number of vehicle journeys

````r
```{r}
# Summary
BQ_LS_merged %>%
 group_by(FahrtNo) %>%
 get_summary_stats(mTrust, type = "mean_sd")

BQ_LS_merged %>%
 group_by(FahrtNo) %>%
 get_summary_stats(mFMS, type = "mean_sd")

# Visualization
ggboxplot(BQ_LS_merged, x = "FahrtNo", y = "mTrust", add = "jitter")

ggboxplot(BQ_LS_merged, x = "FahrtNo", y = "mFMS", add = "jitter")

# Assumptions of normality, sphericity, and outliers were tested
# Extreme outliers of FMS were excluded
BQ_LS_merged_FMS <- BQ_LS_merged[-c(127, 231, 229, 231, 243, 253, 255), ]

# Friedman test - intra-journey trust
friedman.test(BQ_LS_merged$mTrust, BQ_LS_merged$FahrtNo, BQ_LS_merged$ID)

# Beta regression - FMS
## Normalize DV
options(digits = 12)  # Set the number of digits to display
## Add a small positive value to avoid zeros
epsilon <- 0.0001
BQ_LS_merged_FMS$nFMS <- (BQ_LS_merged_FMS$mFMS + epsilon) / (20 + 2 * epsilon)

## Pre-model testing
GLM_itself <- glmmTMB(nFMS ~ 1 + (1 | ID), data = BQ_LS_merged_FMS, family = beta_family(link =
"logit"))
FMSFahrtNo <- glmmTMB(nFMS ~ FahrtNo + (1 | ID), data = BQ_LS_merged_FMS, family =
beta_family(link = "logit"))
anova(GLM_itself, FMSFahrtNo)

## Final model
DVmFMSjourney <- glmmTMB(nFMS ~ FahrtNo + (1 | ID), data = BQ_LS_merged_FMS, family =
beta_family(link = "logit"))
summary(DVmFMSjourney)

## Confidence intervals for random and fixed effects
confint(DVmFMSjourney)

# Post-hoc tests
BQ_LS_merged_FMS %>%
 pairwise_t_test(
  mFMS ~ FahrtNo, paired = FALSE,
  p.adjust.method = "bonferroni"
  )
# Effect size
````

```
BQ_LS_merged_FMS %>%
 group_by(FahrtNo) %>%
 get_summary_stats(mFMS, type = "mean_sd")
mes(0.749, 2.413, 1.271, 2.912, 43, 46)
```

Correlation analyses

```{r}
# Assign ranks
BQ_LS_merged$mTrust_Ranks <- rank(BQ_LS_merged$mTrust)
BQ_LS_merged$mFMS_Ranks <- rank(BQ_LS_merged$mFMS)

# Visualization
## mTrust <-> mSTS_AD
plot(BQ_LS_merged$mTrust, BQ_LS_merged$mSTS_AD)
plot(BQ_LS_merged$mTrust_Ranks, BQ_LS_merged$mSTS_AD)

## mTrust <-> mFMS
plot(BQ_LS_merged$mTrust, BQ_LS_merged$mFMS)
plot(BQ_LS_merged$mTrust_Ranks, BQ_LS_merged$mFMS)

## mFMS <-> mSTS_AD
plot(BQ_LS_merged$mFMS, BQ_LS_merged$mSTS_AD)
plot(BQ_LS_merged$mFMS_Ranks, BQ_LS_merged$mSTS_AD)

## mTrust <-> STS-AD_1
plot(BetwQSTS_AD1Live$mTrust, BetwQSTS_AD1Live$STS_AD)

## mIT <-> mPT
plot(BQ_LS_merged$mIT, BQ_LS_merged$mPT)

# Computation
cor.test(BQ_LS_merged$mTrust_Ranks, BQ_LS_merged$mSTS_AD, method="kendall", conf.level =
0.95)

cor.test(BQ_LS_merged$mTrust_Ranks, BQ_LS_merged$mFMS, method="kendall", conf.level = 0.95)

cor.test(BQ_LS_merged$mFMS_Ranks, BQ_LS_merged$mSTS_AD, method="kendall", conf.level =
0.95)

cor.test(BQ_LS_merged$mTrust_Ranks, BQ_LS_merged$mSTS_AD, method="kendall", conf.level =
0.95)

cor.test(BQ_LS_merged$mTrust_Ranks, BetwQSTS_AD1Live$STS_AD, method = "kendall", conf.level
= 0.95)

cor.test(BQ_LS_merged$mIT, BQ_LS_merged$mPT, method = "kendall", conf.level = 0.95)
```