6th DGPs Human Factors Summer School

Program

August 26 – 28, 2024

The Organizing Team:

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I. General Information

Welcome

We are happy to welcome you all to the 6th DGPs Summer School for Human Factors 2024. The DGPs German Human Factors Summer School is the successor of the Berlin Summer School of Human Factors which was initiated and organized from 2014-2018 by the Department of Psychology and Ergonomics, TU Berlin. The Summer School is an annual postgraduate event that is supported by the Section of Engineering Psychology of the German Psychological Society (DGPs).

The intention is to provide an interactive platform that promotes the transfer and communication of interdisciplinary skills relevant to Human Factors research. Successful postgraduate applicants (Ph.D., M.Sc., and candidates) have the opportunity to present their research interests and/or current projects for critical discussion. Prominent researchers are invited to teach advanced methods and communicate state-of-the-art research from their laboratories.

The 6th DGPs Summer School for Human Factors is hosted by the German Aerospace Center (DLR), Institute of Transportation Systems from August 26 to 28, 2024. We are looking forward to inspiring talks and discussions.

If you want to get in touch with the organizers, please contact us via e-mail (andreas.schrank@dlr.de).

Target audience

The target audience is Ph.D. students working in Human Factors, irrespective of whether they have just started or almost finished their Ph.D. The objective of the Summer School of Human Factors is to offer a space for Ph.D. students to connect and help each other with the empirical parts and handling of other issues concerning the Ph.D. Also, the summer school will be attended by invited senior researchers and guests, further facilitating the discussions.

Venue

The Summer School will take place in Braunschweig, Germany, at the German Aerospace Center (DLR) Campus (Lilienthalplatz 7, 38108 Braunschweig) near the Braunschweig Research Airport. Aeronautics and transport research are the two main

areas of focus at DLR's Braunschweig site: High-performance road and flight test vehicles as well as flying simulators, air traffic simulation facilities, road and flight simulators, a railway laboratory, wind tunnels, mobile rotor test rigs and test rigs for materials and noise research are available for experimental investigations.

There are two public bus lines (413 and 436) that connect the city and the venue. Check the BSVG website for more information on public transport in Braunschweig.

In order to enter the premises, please show your ID card or passport to the officers at the main gate. When you receive a visitor’s badge, please wear it visibly at all times.

Information for Presenters

At this year’s summer school participants will present their research projects in three different formats: talks, forums and posters.

Each **talk** will be scheduled for 30 minutes. During the talk, the contributor has the opportunity to initialize and lead a discussion about his/her current project. On this account, contributors can give a short introduction to their current project and use the rest of the time for an intense discussion with the audience.

Each **forum** will be scheduled for 45 minutes. A forum is sought to be an opportunity to organize an interactive group discussion of the presenter’s research program to address issues such as technical challenges and previous work. This year, there will be two forums which will be held in parallel on Tuesday (August 27, 11:00 am – 11:45 am) in different rooms. Participants can chose which one they want to attend.

All **posters** will be presented in a poster session on Tuesday afternoon (August 27, 3:30 pm – 5:00 pm). Please print your poster beforehand (DIN A1, portrait format) and bring it with you to the event. There is no need to use a specific template or to send the digital file in advance.

Schedule

The location is building 118.6, room A.015 on the ground floor unless indicated otherwise.

Day 1: Monday, August 26

2:00 pm	**Arrival**
2:30 pm – 5:30 pm	**Tour of the laboratories and simulators** at the DLR Institutes of Transport Systems and Flight Guidance *Group allocation is displayed in the foyer*
8:00 pm	**Dinner** (self-payed) and get-together at “EAT Grill & Bar”, Kohlmarkt 2, 38100 Braunschweig *(pre-registration required)*

Day 2: Tuesday, August 27

9:30 am – 10:30 am	**Welcome, introduction, and keynote** *Welcome*: Dr. Michael Oehl, DLR *Greeting:* Prof. Dr. Linda Onnasch, DGPs and TU Berlin *Keynote*: Prof. Dr. Martin Baumann, Ulm University
	Coffee break
11:00 am – 11:45 am	**Interactive forums (in parallel)** **Andreas Schrank, Thorben Brandt** Development of an Adaptive and User-centered HMI for Connected and Automated Vehicles *Building 118.6, room A.015* **Miriam Schäffer** Human-Vehicle Interaction: Factors Influencing Human Take-Over after Sleep in Automated Driving *Building 118.6, room A.130 on the first upper floor*
	Coffee break
12:00 – 12:30 pm	**Leonhard Rottmann** Talk: Towards the Acceptance of Facing Rearward in Autonomous Vehicles
	Lunch break
1:30 pm – 2:00 pm	**Dr. Patrick Weis** Talk: Primacy effects during performance monitoring of environment-based cognitive strategies

2:00 pm – 2:30 pm	**Eva Goesswein** Talk: Executive Functions and Human Adaptation to New Technologies: Insights from an ongoing PhD Project
2:30 pm – 3:00 pm	**Anna Christopoulou** Talk: Advancing Human-Robot Collaboration: Exploring Fit for Enhanced Employee Well-being and Performance in Industry 5.0
	Break
3:30 pm – 5:00 pm	**Poster session** **Thorben Brandt** System Transparency of Visual AI in Remote Operation Interfaces for Highly Automated Vehicles **Alejandro Díaz Rosales** Overcoming Challenges in Human Factors Studies with Limited Test Users **Jana-Sophie Effert** Beyond Standards and Automated Testing: Exploring User-Involvement in Human-Centered Design for Accessible Enterprise Software and B2B Solutions **Luise Haehn** Engage to educate – Can game immersion be used to boost learning success and attitude changes in serious games? **Silvio Hess** Rearward Countdown Timers as External HMIs for Displaying the Departure of Highly Automated Shuttle Buses **Yijun Li** Virtual Reality Group Intervention as a Meaningful Activity for Older Adults in Nursing Homes: Acceptance, Mental Capabilities, Well-being, and Side Effects **Alexandra Nick** Teleoperation of Automated Vehicles - Spotlight on the Remote Operator

	Fabian Schlichtherle Measures to increase passenger security in the interior of shared automated vehicles - Research framework for a PhD project **Luljeta Sinani** Extended Reality Interfaces for Enhanced Situational Awareness in UAV Operations **Thirumanikandan Subramanian** Mixed Reality Methods to simulate and evaluate Autonomous Vehicle Interior
8:00 pm	**Dinner** (self-payed) and get-together at “Vielharmonie”, Bankplatz 7, 38100 Braunschweig *(pre-registration required)*

Day 3: Wednesday, August 28

9:15 am – 9:45 am	**Maike Ramrath** Talk: Impact of mental workload and situation awareness on trust and performance during the surveillance of autonomous systems
9:45 am – 10:15 am	**Raquel Salcedo Gil** Talk: Are you ready to work with robots? The effect of a socio-cognitive theory-based training intervention on robot use self-efficacy and attitudes toward robots.
	Coffee Break
10:30 am – 11:00 am	**Jennifer Klütsch** Talk: In-between privacy and cybersecurity decisions: From investigating young adults’ vulnerabilities towards supporting informed and conscious decisions online - A PhD Outline
11:00 am – 11:30 am	**Beatrice Schmieder, Dorothea Liehr** Talk: Teleoperated Train Driving: Performance and Preferences of Remote Operators with Different Alert Systems
	Coffee Break
11:50 am – 12:20 pm	**Gina Schnücker** Talk: Bridging the gap between occupational satisfaction and technology acceptance
12:20 pm – 12:50 pm	**Leonie Terfurth** Talk: AR Troubled Water: Exploring Immersive Intervention Technology for Enhancing Flood Protection Behavior

12:50 pm – 1:20 pm	**Melina Bergen** Talk: Towards Realistic Pedestrian Simulation: A Comparative Analysis of Training Methods for an Omnidirectional Pedestrian Simulator
1:20 pm – 1:30 pm	**Closing of summer school** Dr. Michael Oehl, DLR Andreas Schrank, DLR

II. Abstracts

Towards Realistic Pedestrian Simulation: A Comparative Analysis of Training Methods for an Omnidirectional Pedestrian Simulator

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Understanding the behavior of pedestrians is an important part of traffic research. Simulators, like the Omnideck, an omnidirectional pedestrian simulator, offer a unique opportunity to study pedestrian behavior in a controlled yet realistic setting. However, the realism and naturalness of participants' behavior is dependent on their familiarity and comfort with the simulator interface. This study aims to explore the effectiveness of different training modalities in preparing participants for walking in a pedestrian simulator, ensuring their movements through the virtual environment reflect their natural walking behavior. In a mini-study, we compared two training conditions: a structured condition, in which participants were guided through the training with specific gamified tasks, and an unstructured condition, in which participants received an unstructured, free exploration training. The structured program was designed to include tasks such as navigating turns and interacting with virtual objects, whereas, the unstructured condition allowed participants to freely move and practice within a virtual room without any specific instructions. To assess the effectiveness of these training approaches, participants were subsequently tasked with completing a test course under time pressure, designed to include slalom paths and turns of varying radii. The two training approaches were evaluated by comparing the performance on the test course, with respect to speed, accuracy and step patterns, as well as by comparing subjective ratings on presence, simulator sickness, motivation and performance. First results indicate that participants in the structured training condition were able to complete the test course slightly faster and with less deviation from the ideal path. The preliminary results indicate that participants might

show an enhanced walking performance after they experienced a structured training compared to an unstructured training. This study can provide important implications for traffic research, highlighting the importance of appropriate simulator training to elicit natural pedestrian behavior. The findings could contribute to the development of training protocols for pedestrian simulators, ensuring that participants' behavior in virtual environments accurately reflects their real-world pedestrian behavior.

Advancing Human-Robot Collaboration: Exploring Fit for Enhanced Employee Well-being and Performance in Industry 5.0

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Background: As robots are increasingly used in the workplace, human-robot collaboration (HRC) promises improved employee well-being and task performance. However, prior research indicates challenges in achieving effective collaboration between humans and robots, including negative affective and performance outcomes. Industry 5.0 emphasizes how technologies should customize the work according to human needs, advocating for systems that adapt to employees rather than requiring continuous adaptation by employees to evolving technology. Despite this, the research in human-robot collaboration remains fragmented and predominately focused on technological aspects. In this study, we address this shortcoming by exploring specific human-, robot-, and task characteristics that hinder and promote HRC and how different combinations of the identified characteristics affect HRC from the perspective of employees. We build on the fit model to leverage literature from work and organizational psychology, where there has been extensive exploration of employee well-being and performance. Fit refers to the alignment and compatibility between the capabilities, and requirements of humans, robots, and the tasks they perform collaboratively, and a fit is thought to facilitate HRC, which, in turn, will enhance task performance, and employee well-being.

Method: We conducted semi-structured interviews with 19 operators working in 4 European manufacturing companies where robots will be implemented. The data are currently being analyzed using an abductive thematic analysis approach (Thompson, 2022). The fit model was used to interpret the findings (ref).

Results: We identified 3 themes, namely the perceived fit between the 1) human and task, 2) human and robot, and 3) human-robot-task. We found that employees’ needs and capabilities, task requirements, and robot characteristics, such as reliability, all impact employees’ expectations about their performance and well-being. They reported varying impacts on performance and well-being based on different combinations of human, robot, and task characteristics. The results revealed that perceived fit between the employee capabilities and task requirements increases employees' well-being and task performance. Conversely, the perceived misfit between human needs and robot capabilities negatively affects employees' expectations regarding task performance and well-being. Finally, the perceived fit between human capabilities, robot capabilities, and task requirements is necessary for positive employee expectations regarding task performance and well-being. *Conclusion:* This study expands the fit model by emphasizing the role of humans beyond aligning task requirements with system characteristics and extends its application in HRC. It highlights the necessity of considering the fit between humans, robots, and tasks before implementing robots in the workplace to maintain employee well-being and performance. Robot introduction can negatively affect employees, as they might feel threatened by the robot or unable to perform their tasks. The study provides design and implementation guidelines to assist industries in effectively integrating robots into the workplace.

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Overcoming Challenges in Human Factors Studies with Limited Test Users

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At the European Organization for Nuclear Research (CERN), teleoperated robots are used for maintenance and inspection tasks around the different accelerators and experimental areas that are considered hazardous for humans (Di Castro et al., 2017; Di Castro et al., 2018). The team responsible for these activities develops and manufactures these robotic systems and the interfaces to control them. There is one full-time robot operator, but other team members can assist if there is a high demand for tasks. These operators play a critical role in configuring the robotic system for specific tasks, using various human-robot interface options and positioning cameras for optimal execution of robot activities (Szczurek et al., 2022). When developing products and systems, constant testing and several iterations are required along the design process. In places such as this one, the final goal of the product (robot and interface) is for people to use and interact with it, therefore user testing becomes part of the process.

One of the main challenges with these tests is determining the appropriate sample size. Many companies attempt to determine the optimal number of subjects, considering time constraints, budget, and the reliability of results. At CERN, the challenge is that the pool of potential users is limited, and they have a very high degree of specialization, concerns, and behaviors that are not common among people without that experience. Conducting user testing with people outside of this group might not be as meaningful, but such group can have less than 5 members, making it very difficult to get a good sample size with valid results. A test like this may limit

our understanding of the user experience. It can overlook diversity, and common patterns, potentially leading to biased improvements.

Our approach for such situations involves working closely with the expert operators to be the first subject of the user tests and establish the parameters and ground truth. Allowing operators to modify the experiment setup according to their preferences provides valuable insights into task dynamics and interface usability. For example, an operator’s feedback may lead to changes in the placement of objects or cameras, resulting in improved performance and usability, not caused by the system that is being tested.

After establishing a strong experimental setup with input from experts, trials can be carried out with less experienced users to increase the sample size for more meaningful results. It’s crucial to ensure that the system is configured as it would be for a real end user. Involving expert operators helps to closely mirror real-world use, leading to practical results and valuable insights into task dynamics and interface usability. However, their influence may skew the results, making them less representative of a broader user base. This raises the question of which is the best approach for conducting user testing when the end users are very specialized and there are less than 5?

To validate this approach, we began testing a newly developed augmented reality interface for teleoperating robots using a specific control method known as variable impedance control. So far, we’ve conducted a preliminary user study with CERN’s primary robot operator, gathering valuable feedback (Díaz Rosales et al., 2024). We are now starting to validate these insights with a broader audience after refining the setup configuration.

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Beyond Standards and Automated Testing: Exploring User-Involvement in Human-Centered Design for Accessible Enterprise Software and B2B Solutions

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According to the UN Convention on the Rights of Persons with Disabilities, inclusive sociotechnical work systems can be seen as one of the central components for inclusive societies (United Nations, 2006). Designing accessible enterprise software is a decisive, yet often overlooked part of providing opportunities for labour market participation for people with disabilities. While the accessibility of specific software solutions such as Microsoft Teams (Khomik et al., 2021) or collaborative document editing tools (Lee et al., 2022) have been subject of previous studies, the current accessibility status of enterprise software in general can only be estimated. The latest figures for accessibility of websites in general, however, highlight substantial room for improvement: In 2023, 96,3% of the one million most visited websites globally did not fully meet the Web Content Accessibility Guidelines criteria (WCAG) (WebAIM, 2023). With legislation changes (BFSG, 2021; Directive 2019/882), the requirements of web and software accessibility are for the first time put on the agenda for stakeholders from the private sector – in Germany from June 2025, underlining the timeliness of this research.

With my PhD project I will focus on neurodiversity, encompassing not only autism, ADHD or dyslexia, with the aim to research how disabled and neurodivergent people can be integrated into the software development process from the beginning. Concepts of developing accessible software and websites currently center around widespread standards, such as the WCAG (WCAG 2.0., 2008), and using automation or artificial intelligence in accessibility implementation (Egger et al., 2022) and testing (Macakoglu & Peker, 2022). Those concepts are lacking perspectives of

neurodivergent people (Wessel et al., 2021) and do not ensure truly accessible and usable software solutions (Power et al., 2012).

To ensure accessibility and usability, user-involvement in the design process is necessary. Therefore, adjustments of methods in technology design processes need to be addressed to involve people with disabilities and neurodivergent people. In research projects these adaptions, such as performing thinking-aloud-protocols with blind people (Strain et al., 2007) are already analyzed in individual cases but need to be translated to companies with a focus on feasibility and efficiency to secure the possible integration in current workflows. This is especially important, as not all design approaches are applicable to small and medium sized enterprises (SMEs) but mostly stem from larger companies (Gulari & Fremantle, 2015).

Within this research project, views on accessibility (scope, target groups and tools) together with opportunities for the involvement of real users with disabilities and neurodivergent people will first be studied with a focus on feasibility and efficiency from enterprise-software-producing SMEs’ point of view. These findings will then be complemented by life and work realities of people with different disabilities and neurodivergent people. Together with affected people, motivators, concerns and barriers to be included in human-centered software development processes in a variety of enterprise-IT-companies, will be elaborated with participatory approaches.

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Executive Functions and Human Adaptation to New Technologies: Insights from an ongoing PhD Project

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Given the pervasive integration of technology into everyday life, an understanding of human adaptation and preceding cognitive abilities remains highly relevant. This contribution provides an overview of the contents of my PhD on the critical role of executive functions (EFs) in the adaptation to new technologies. Executive functions are defined as "a set of cognitive processes that guide action and behaviors essential to aspects of learning and everyday human performance tasks" (Baggetta & Alexander, 2016) and are understood as a multidimensional model with three core EFs: working memory, inhibitory control, and cognitive flexibility (Diamond, 2013).

The basis of my dissertation project is formed by a pre-registered, systematic review of the topic (Gößwein & Liebherr, under Review). Results of the eligible n = 11 publications suggest an enhancing influence of EFs on the adaptation to new technologies, although findings are partially mixed. Possible co-variables influencing the relation between EFs and adaptation emerge in the discussion and should be considered in future studies. Inconsistent results and the risk of bias assessment furthermore point toward a need for further high-quality research.

To meet this challenge, empirical insights gained from an online study on the possible adaptation of an app supporting sustainable driving behavior are presented. Apart from a simple gamification approach, the study considered cognitive flexibility as an EF and further factors, such as affinity for technology interaction, technology trust, and environmental awareness. Based on a sample of N = 183 (82 women, 100 men, 1 diverse person) aged between 20 and 72 years (M = 31.6 years, SD = 11.03), a hierarchical regression and a mediation analysis were conducted. The final regression model explained R^2 (adj) = 54.2 % of the variance in the intention to use

the eco-driving app (F (7,175) = 31.7, p < .001), but also proved that cognitive flexibility is not a valid predictor (β = .050, p = .361). Looking into possible co-variables between cognitive flexibility and intention to use (IU), the mediation model introduced perceived ease of use (PEU) as a technological factor. After entering the mediator into the model, cognitive flexibility predicted the mediator PEU significantly (B = 0.288, p = .005), which in turn predicted IU (B = 0.511, p > .001). We found the relationship between cognitive flexibility and IU to be fully mediated by PEU (B = 0.147, p = .012). These findings provide valuable insights into the relationship between EFs and adaptation: cognitive flexibility was found to enhance adaptation, but its influence was fully mediated by how easy the participants perceived the eco-driving app to be.

Overall, my contribution discusses the understanding of the adaptation to new technologies, provides an overview of the current research on the influence that EFs have on the adaptation of new technologies, and gives first empirical insights on the indirect influence that one EF (cognitive flexibility) has on the adaptation to a new mobility technology.

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Engage to educate – Can game immersion be used to boost learning success and attitude changes in serious games?

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Video games have become a crucial part of our modern society. More than half the German population play video games at least occasionally (Statista, 2024) with entertainment as their primary goal. Another form of video games stems from the direction of gamification and game-based learning: serious games, which are by definition designed for a primary purpose other than pure entertainment – namely, education and learning. This kind of education and video game, respectively, have garnered more attention in recent years (e.g., Gentry et al., 2010; Zadeja & Bushati, 2017). This dissertation aims to investigate whether and how aspects that boost the game experience in entertainment games can be exploited to push learning success in serious games. In fact, when considering entertainment games, these also have certain goals that the player wants to accomplish and is generally highly involved in achieving. Such goals include social contacts and team-building (e.g., multiplayer online games), high behavioral performance (e.g., dexterity games, first-person-shooter games) or cognitive performance like solving problems or strategy development and roll-out (e.g., strategy games). A player’s involvement in the game is usually dependent on the video game experience. Here, various potentially interrelated factors are crucial, such as fun during gaming, the identification one feels with the avatar, and especially the subjective experience of ‘being there’. In particular, the latter feeling of immersion (often also described as presence, absorption etc.) and the resulting escape from the surrounding reality were found to be important motivations for players (Yee, 2006). This could be particularly helpful to increase the usage of serious games, as immersion might aid in the players' intention to continue playing a game or picking it up again. To boost the experienced immersion, the auditory background of a video game such as background music, ambient sounds or

character sounds, seems highly important: Background music has been found to lead to increased immersion in video games (e.g., Gallacher, 2013; Gormanley, 2013; Zhang & Fu, 2015) and hypothesized to assist with immersion and healing in medical serious games (Stingel-Voigt, 2019). However, little is known about the influence of the other types of sounds on the game experience. My first PhD study therefore investigated, in two laboratory experiments, whether ambient and character sounds influence the game experience. Significant effects of sound on fun, avatar identification, as well as experienced immersion were observed (Haehn et al., 2024). This suggests that immersion in video games can indeed be influenced by different types of sounds, which presents a promising approach for the manipulation of immersion in serious games. One next step is to investigate whether immersion affects a player’s learning success or even leads to attitude changes through serious games. Afterwards, it should be examined whether the player’s learning success can be increased by manipulating the player’s immersion. This would offer meaningful insights for the design of serious games, a field which is today more relevant than ever.

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Rearward Countdown Timers as External HMIs for Displaying the Departure of Highly Automated Shuttle Buses

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The use of highly automated shuttle buses (HASBs; SAE Level 4) represents a promising solution for ensuring broad access to flexible, safe, and sustainable mobility in the future, for example, as a supplement to the current public transport system to cover the first or last mile (Beiker, 2016). However, for implementation, the number of bus stops would have to be expanded to include many decentralized, most likely on-demand stops curbside. If a HASB has stopped at a curbside stop, it interacts in particular with the (motorized) traffic behind it, which, depending on the traffic situation, either can pass the HASB or is required to wait for the HASB's departure. Currently, established signals such as the left turn indicator are used to signal departure from bus stops, but merely immediately prior to departure, which may be inadequate for the time-critical assessment of following traffic to decide whether it would be feasible to overtake the HASB in a comfortable, safe manner. This short period during which the departure is announced is comparable to the dilemma zone, in which drivers have difficulty deciding whether to stop or continue after the traffic light has changed from 'green' to 'yellow' (Moore & Hurwitz, 2013). In the context of traffic lights, it has been shown that digital countdown timers (CDTs) increase the probability of drivers making comfortable stops in the dilemma zone (e.g., Islam et al., 2017). Hence, using CDTs via LED displays at the rear of HASBs as external HMI (eHMI) may also be beneficial to indicate the departure of HASBs more transparently. To gain first insights into the potential of CDTs to signal a HASB's prospective departure from a curbside stop, an online study (N = 148) based on repeated measurements with video sequences was conducted. In each video, participants

virtually drove a car approaching the stopping bus that departed from the stop in the course of the video. As independent variable, eHMI design ('no CDT' as baseline condition comprising the currently established signals left turn indicator and the vehicle's braking lights, 'CDT with accompanied icon', or 'CDT with accompanied text') was applied. Participants evaluated the eHMI designs with questionnaires, such as understanding/predictability, a dimension of trust in automation (Körber, 2019), and acceptance (Van Der Laan et al., 1997). Regarding ratings on understanding/predictability of the HASB's departure, the ANOVA revealed a significant effect for eHMI design, $F(1.74, 255.05) = 254.56$, $p < .001$, $\eta_p^2 = .634$. The large effect size mainly resulted from the significantly higher ratings of both conditions including the CDT compared to the 'no CDT' condition. However, 'CDT with accompanied text' was also rated significantly higher than 'CDT with accompanied icon'. Similar findings resulted for acceptance of the CDTs. Both conditions that included the CDT were highly accepted, depicting scores above 1.0, based on the underlying rating scale ranging from –2 to +2 (Van Der Laan et al., 1997). Overall, results support a prospective implementation of CDT eHMIs on HASBs. Validation in more realistic test environments should be aspired.

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In-between privacy and cybersecurity decisions: From investigating young adults’ vulnerabilities towards supporting informed and conscious decisions online - A PhD Outline

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Social media and apps are perceived almost indispensable to their users. However, the use of these digital services is associated with increased privacy and cybersecurity risks, for example, through providers who collect and analyze users’ data for profiling purposes (Ali et al., 2018) or through novel cyber threats such as social media phishing (Frauenstein & Flowerday, 2020). Young adults (approximately 16–29 years old, Sawyer et al., 2018) seem particularly vulnerable towards these risks as they tend to disclose more personal data through their increased use of social media (We Are Social, 2023) and experience an increased fear of missing out online (Przybylski et al., 2013). Similarly, they are characterized by their pursuit of age-related developmental tasks such as belonging to their peer group or finding their first employment (Seiffge-Krenke, 2015). Understanding how these user-specific characteristics affect young adults’ privacy and cybersecurity decisions is therefore a first step to develop interventions towards informed and conscious privacy and cybersecurity decisions online.

My dissertation research aims to gain insight into young adults’ privacy and cybersecurity decisions, considering both their developmental and social vulnerabilities by examining (1) young adults’ privacy decisions at the app download stage and (2) their susceptibility towards social media phishing. As a methodological basis, experimental online vignette studies were conducted. With vignettes, it is referred to short, carefully constructed descriptions of privacy and cybersecurity related situations through text-based scenarios with visualized app store and social

media screens (cp. Atzmüller & Steiner, 2010). To gain insight into young adults’ privacy decisions, it was examined how friends’ recommendations and developmentally related apps influence young adults’ download probability of low- and high-privacy-rated apps. Based on this study, it was investigated whether (social) nudges as one intervention approach could motivate users in general to more informed privacy decisions in the app download stage. To gain insights into young adults’ susceptibility towards social media phishing, it was examined how Fear of Missing Out, developmentally related messages as well as messages from followers or supposed friends affect young adults’ susceptibility in two studies on social media phishing.

The results highlight that young adults’ privacy decisions and phishing susceptibility are influenced by social and developmental aspects. For example, friends’ recommendation increased young adults’ probability to download an app both in high- but also for low-privacy-rated apps. In the studies on social media phishing, young adults’ suspicion was reduced, among others, by their general Fear of Missing Out on rewarding experiences. Additionally, their susceptibility increased when phishing messages invited to an upcoming event and were received from followers or supposed friends. Based on these studies, my dissertation research aims to derive implications for future privacy and phishing awareness campaigns to support young adults in informed and conscious decisions online.

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Virtual Reality Group Intervention as a Meaningful Activity for Older Adults in Nursing Homes: Acceptance, Mental Capabilities, Well-being, and Side Effects

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Loneliness and a lack of meaningful activities negatively affect the physical and mental health of senior residents in nursing homes (Brownie & Horstmanshof, 2011; Leigh-Hunt et al., 2017; Pitkala, 2016; Wu, 2020). Virtual Reality (VR) interventions offer a potential solution, providing safety, presence, and immersive experiences for older adults in long-term geriatric rehabilitation (Dascal et al., 2017; Huygelier et al., 2019; Li, Wilke, et al., 2024). We conducted a longitudinal study applying VR interventions once a week for four consecutive weeks in nursing homes. These sessions gave older adults the opportunity to engage in activities, such as baking pizza, that are otherwise impossible for them in a nursing home setting. During the VR sessions, participants were grouped together to discuss their experiences afterward. Two psychologists measured acceptance, side effects, and impacts on capability and well-being before, during, and after the VR interventions. The results shows that acceptance varied based on personal factors (Li, Shiyanov, & Muschalla, 2024). Mental capabilities, such as group interaction and proactivity, showed significant statistical improvement (Li, Wilke, et al., 2024). The well-being of the older adults remained high (Li, Wilke, et al., 2024). However, further experimental design is needed to test the effectiveness of VR intervention comprehensively.

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Teleoperation of Automated Vehicles – Spotlight on the Remote Operator

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Automated Vehicles (AVs) currently, and for the foreseeable future, lack the capability to handle every possible situation in everyday traffic. Teleoperation, supported by academia and industry, is a promising approach to addressing the related issues (Bundesanstalt für Straßenwesen, 2023; Mutzenich et al., 2021; Tener & Lanir, 2022). The focus lies on remote assistance, which can be described as the system receiving help from a remote operator, while the responsibility for driving (e.g., lateral and longitudinal control) rests with the system (Majstorovic et al., 2022). Remote assistance requires high-level interpretation skills and problem-solving abilities from a remote operator (Bogdoll et al., 2022; Majstorovic et al., 2022).

The proposed research explores how general cognitive abilities correlate with operator performance and perceived workload, which information is needed in the current situation, and how performance can be measured objectively. We plan to assess participants’ cognitive abilities regarding continuous attention, peripheral vision, spatial orientation and rotation abilities, and rapid detection skills with Schuhfried tests (Schuhfried, 2024). In a subsequent session, participants will be remote operators in our control room. The selected information and the control room are developed by published research findings and ergonomic standards (Biletska et al., 2021; Gafert et al., 2023). For this study, we will use pre-recorded videos from a training course where we staged various scenarios that an AV might find challenging to resolve independently. The scenarios are based on previously published edge cases and situations outside the AV’s operational design domain (Kettwich et al., 2022; Tener & Lanir, 2024). We will only consider situations where the AV is stuck, and the remote operator needs to provide clearance, set waypoints, or draw a new trajectory. During the trials, we measured reaction times, the appropriateness of posed solutions,

visual attention, situational awareness, and perceived complexity. Afterward, mental workload, usability, the importance of features, and general feedback are evaluated.

The results will contribute to addressing open human factors questions related to tele- operation. It will provide one of the first studies examining the actual interaction behavior of the remote operator in high-level decision-making. Furthermore, the results can serve as a starting point for identifying suitable remote operators based on cognitive abilities. The setup can be expanded and improved so that driving simulators or real vehicles can be assisted in the future.

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Impact of mental workload and situation awareness on trust and performance during the surveillance of autonomous systems

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In domains characterized by inherent risks to both individuals and the environment, such as aviation, road traffic, and maritime shipping, human error remains a prominent contributor to accidents (Chauvin et al., 2013; Wiegmann & Shappell, 2017). To mitigate these risks, there is a growing trend towards the automation of various processes through technology. This paradigm shift requires the establishment of new roles wherein automated systems are monitored remotely, with human intervention reserved for critical situations. Effective operation alongside autonomous teammates relies significantly upon the operator's trust in the technology (Bertino et al., 2020; Dawson et al., 2015). Inadequate trust levels may lead to prolonged independent verification of system outputs, while excessive trust can cause a false sense of security (Basañez & Suárez, 2009; Lee & Moray, 1992). Moreover, the cognitive constructs of mental workload and situational awareness have significant influence on performance during control transitions (Parasuraman et al., 2008). Automation may induce periods of low mental workload (Basañez & Suárez, 2009), potentially resulting in suboptimal performance due to underload. Similarly, high task demands can induce elevated mental workload, resulting in delayed responses and diminished situational awareness (Neubauer et al., 2012; Saxby et al., 2013). Given the ubiquity of automation across diverse sectors, it is crucial to assess individuals' capacity to adapt and perform proficiently when transitioning from manual tasks to monitoring roles. The current study plans to explore the interplay between mental workload, situational awareness, trust, and performance during surveillance tasks. Additionally, the study will explore the roles of working

memory and perceived usability characteristics—namely, usefulness and ease of use. The study will recruit 100 participants (determined according to a G*Power analysis) aged 16 years and above, who will engage in a simulated ship monitoring scenario supposedly driven by autonomous systems. Mental workload and situational awareness will be quantified utilizing eye-tracking methodologies, while performance metrics will encompass reaction times to auditory stimuli. Working memory assessments will be conducted employing the Test Battery for Attention Testing. Additionally, subjective evaluations of mental workload, situational awareness, trust, perceived usefulness, perceived ease of use, and technology affinity will be solicited through structured questionnaires, the latter serving as a control variable in the analysis of a structural equation model. This study will contribute to a deeper understanding of the complex dynamics involved in human-automation interaction, particularly in surveillance tasks. By illuminating the interplay between mental workload, situational awareness, trust, and performance, it will provide valuable insights for the design and implementation of effective human-machine systems. Furthermore, the investigation into the roles of working memory and perceived usability characteristics will offer practical recommendations for optimizing system usability and user experience in real-world operational settings.

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Towards the Acceptance of Facing Rearward in Autonomous Vehicles

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As the development of autonomous vehicles (AVs) progresses, new seating arrangements are emerging. Face-to-face seating is common in SAE L4 AV concepts and is intended to facilitate social interaction during autonomous driving, enabling previously unfeasible non-driving related tasks (NDRTs). However, this is countered by the unpopularity of seat orientation against the direction of travel, which is particularly pronounced in cars. In order to develop countermeasures to address this unpopularity, a deeper understanding of the underlying mechanisms is required. This study validates a model for predicting the acceptance of AVs that takes into account the seat orientation of the occupants. To this end, a subject study with 46 participants was conducted to investigate the influence of seat orientation on AV acceptance and related factors such as trust and motion sickness. To achieve a realistic implementation of a fully functional SAE L4 AV, a test vehicle equipped with a steering and pedaling robot was realized on a test track. In addition, potential means to increase trust and mitigate motion sickness for rear-facing passengers were evaluated in the form of internal human machine interfaces (iHMIs). These iHMIs provided information about upcoming maneuvers and detected road users. While engaged in a group-based NDRT, participants experienced a total of six journeys that varied in seat orientation and iHMI visualization. Most of the relationships in the model were confirmed, but some were not. Rear-facing passengers showed lower levels of confidence and higher levels of motion sickness than front-facing passengers. However, the iHMIs had no effect on acceptance or related factors. Based on these findings, an updated version of the model is proposed, showing that rearward facing passengers in autonomous

vehicles pose a particular challenge for trust calibration and motion sickness mitigation. In fully autonomous vehicles, information that benefits from continuous transmission should not rely on the attention of the passenger, as this interferes with NDRTs. Implications for future research and design of iHMIs to address this challenge are discussed.

Are you ready to work with robots? The effect of a socio-cognitive theory-based training intervention on robot use self-efficacy and attitudes toward robots.

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Key to the willingness to commit oneself to a highly demanding undertaking is the "belief in one's capabilities to organize and execute the course of action required to produce given attainments," that is, self-efficacy (Bandura, 1997, p.3). In the technology context, self-efficacy has been linked to attitudes toward technology, perceived usefulness, or ease of use (Karsten et al., 2012). In addition, individuals with higher levels of self-efficacy reported lower stress and anxiety levels when first using technology (Shu et al., 2011). However, besides its demonstrated importance, self-efficacy beliefs have been explored yet only sporadically within the context of robot adoption. In the robotization context, robot use self-efficacy (i.e., beliefs in one's capabilities to use and interact with robots) has been identified as a separate construct from general self-efficacy beliefs (Turja et al., 2019) and is associated with higher acceptance of robots (Latikka et al., 2019), trust toward robots (Oksanen et al., 2020), and more positive attitudes toward robots (Latikka et al., 2021). These initial findings underscore the importance of focusing on self-efficacy in the context of robotization.

Recognizing its importance, a handful of studies have developed self-efficacy interventions (i.e., training) for employees to enhance their self-efficacy beliefs in various domains (e.g., Eden & Aviram, 1993; Gist et al., 1989; Shantz & Latham, 2012). However, to date, little evidence is available on the effectiveness of training for enhancing robot use self-efficacy and the impact of this training on attitudes toward robots and willingness to work with robots. Recognizing this important research gap, we propose that integrating well-established theories such as Bandura's Socio-Cognitive Theory into robotics training holds promise for enhancing employee's

self-efficacy as they adapt to working alongside robots. Thus, we developed a training intervention to increase an individual’s self-efficacy beliefs for robot use.

This is a two-study design. First, a pilot study (i.e., pre-post design with no control group) will explore how self-efficacy, attitudes toward robots, and robot acceptance change before and after an online training intervention. Second, based on Study 1, a laboratory experiment will assess 1) how training impacts interaction with a robot during a collaborative task and 2) whether the learning curve differs between people with and without training. This study is currently in the design and conceptualization stage, so no data is available.

This research contributes to existing literature on human-robot collaboration by offering insights into ways to facilitate employee adaptation to working with robots. Our focus lies particularly on the frequently overlooked pre-implementation stages (i.e., prior to the introduction of robots). In terms of practical implications, our findings offer valuable guidance for companies aiming to better equip their employees for this transition.

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Human-Vehicle Interaction: Factors Influencing Human Take-Over after Sleep in Automated Driving

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From a legal perspective, automated driving allows the driver, for the first time, to withdraw from the driving task and engage in non-driving related activities (NDRA). In highly automated driving (SAE-Level 3, Society of Automotive Engineers), the driver must still be ready to take over control of the vehicle within a defined time window when the system reaches its limits. Therefore, the OEM will only allow NDRA that the driver can easily interrupt, such as reading. An SAE-Level 4 automated vehicle can handle all situations independently, but only within a defined Operational Design Domain (ODD). When the automated vehicle leaves the ODD, the SAE-Level 4 system will also require take-overs. Since the system allows the driver a complete and continuous devotion from the driving task, take-overs in SAE-Level 4 will be more complex and extensive. However, the increased range of system functions gives the driver more time to prepare for the driving task. Still, as in SAE-Level 3 take-over scenarios, aspects such as the time required to prepare for the driving task, as well as the safety during this transition process and the perceived comfort are becoming increasingly important.

Take-over time, take-over quality and perceived comfort, among other factors, while taking over after different NDRA have been recently examined (Jarosch, 2020; Radlmayr et al., 2019). Current research focuses mainly on the cognitive/mental absence of the driver (i.a. Kim et al., 2022). Furthermore, it is widely assumed that both the driver and the vehicle interior are in a drivable state at the time of a take-over request. Since the customer will request interior adjustments and the use of items to perform the NDRA, such as a reclined seat or a tablet, the transition and adaptation of both the driver and the interior in physical terms should also be considered. Several

aspects of NDRA that may limit the ability to take-over an automated vehicle have already been defined (Schäffer et al., 2024; Naujoks et al., 2018).

In the adaptation process of the human during the transition from an NDRA state to a manual driving state, good support and cooperation between the human and the vehicle is important. To increase safety and comfort, it is necessary to identify possible scenarios of this transition in order to adapt the support to the actual situation. To design these scenarios, an overview of the factors leading to different scenarios is required. Based on a literature review, factors influencing take-over time and take-over quality, among other factors, were identified. These factors include personal characteristics, like experience with automated functions, knowledge of the system limitations, anthropometric data, and situational factors such as posture and readiness to drive. The occupation with NDRA, including the NDRA modalities, activity load, use of handheld devices and location of the NDRA in the interior, appears to play the most significant role. In addition, the cognitive load and the complexity of the take-over situation as well as the time available influence this transition.

As human factors play a crucial role while taking over, experience, knowledge exchange and expert opinion in the context of an open discussion in the field of human factors seems to be very beneficial. The aim is to discuss what steps and actions are required to enable the driver to resume the driving task after various NDRA, including readjustments of the interior and the stowage of items used, such as handheld devices. This will be followed by an examination of how the vehicle interior can support the fast, safe and comfortable resumption of driving and how these aspects are related to each other.

The results of the literature review and the discussion will then be used to design a study in a driving simulator. The identified factors and the results of the discussion will be varied and the effects on the take-over procedure will be examined in order to develop possible take-over scenarios after an NDRA.

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Interior Adaptations to Increase Passenger Security in Shared Automated Vehicles – Research Framework for a PhD Project

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Automated driving is currently one of the most researched technologies in the mobility sector. However, simply automating private vehicles will not be enough to sustainably reduce traffic, especially in urban areas. What is also needed is the shared use of automated vehicles, for example, as part of ride pooling services, which could position themselves as a new type of mobility concept between private and public transport. This concept can only contribute to more sustainable mobility if it represents a functional alternative, especially to the use of private cars (Krueger et al., 2016). However, this is not even fully the case with established public transportation services today. For example, harassment and assaults of various kinds in shared transportation have a strongly detrimental effect on passengers’ perception of security. This already causes certain user groups to avoid these mobility alternatives, with women being particularly affected (Colliard et al., 2018; Weinstein Agrawal et al., 2020). The imminent elimination of the driver in shared automated vehicles (SAVs) as part of automation, and thus the lack of a controlling authority could represent a further loss of security and therefore create a usage barrier for potential passengers. Consequently, this could make security not only a central user experience factor for SAVs but also a determining variable for the participation in social life of entire population groups.

The aim of this doctoral project is to identify effective interior adaptations to increase security in SAVs. Due to a lack of relevant literature, the first step was to identify security features that could potentially be implemented in shared vehicle interiors. These were determined via a questionnaire as part of a mixed reality (MR)

experiment in which *n* = 42 participants took part. The test subjects experienced the interior of an SAV without any security features and subsequently indicated on a five-point Likert scale if and how much their perception of security would change as a result of a certain feature (Schlichtherle et al., 2024). The features identified as most effective were then implemented in a 3D SAV model. This vehicle model will form the basis for further research in this project. Specifically, the next step is to validate the developed features in another MR study, by assessing and comparing participants’ perceived security via the PSSAV questionnaire (Schuß et al., 2023). Subsequently, as part of a follow-up study, alternatives will be developed for the most promising solutions to exploit their potential in greater depth.

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Teleoperated Train Driving: Performance and Preferences of Remote Operators with Different Alert Systems

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Teleoperated and automated trains (GoA 3) can represent an important step toward future highly automated train connections (GoA4) as a fallback solution and for technical supervision (Grippenkoven, 2020). Remote operators are train drivers who monitor or drive a train via mobile connection, sharing tasks with an on-board train assistance system (Pacaux-Lemoine et al., 2020). In a current use case, an automated train encounters a signal disruption and transmits a takeover request to the remote operator, who then guides the train to a safe location. This driving on sight condition for a certain time can cause fatigue in remote operators and leading to longer reaction times when making decisions (Brandenburger et al., 2017). Worst case scenarios shortly after the takeover can also lead to lower reactions times because of updating the situation awareness (Endsley, 1996). Human- machine interfaces with warning systems such as acoustic alerts can help to solve these problems (Horberry et al., 2022), but no performance measures have been examined yet. The study aims to identify the characteristics that a remote workplace needs to improve human operator performance and to show their preferences. In addition to the effect of acoustic warnings, we also test how performance changes when monitoring the system the whole time vs. monitoring only in predefined cases.

The present study examines sensitivity d’ and reaction times of detecting an object on the track as a measurement of vigilance. N = 45 participants successfully completed teleoperated train simulations with object detection tasks. Reaction times, sensitivity (d’) and preferences were analyzed in a within-subjects design varying acoustic alerts and display modes (display always on vs. display after takeover).

Acoustic alerts showed a high effect on detecting objects and lead to faster reactions. With an acoustic alert, there was no longer any difference in reaction time between monitoring the system the whole time or only after takeover. Without an alert system, object detection was faster after a takeover than with continuous monitoring. Sensitivity was high in all conditions. Participants preferred an acoustic alert for detecting objects and monitoring the system only in predefined cases.

Industry partners also want remote control for dangerous maneuvers such as slow shunting and as fallback solutions for highly automated trains. Acoustic alerts could help the remote operator monitoring a train also in dangerous situations after takeover. Further warning systems, such as acoustic signals or HMIs with highlighting methods will be discussed in the talk. Teleoperation train systems can give the future remote operator the best options for decision-making and the passenger the highest standard for a pleasant and fast journey.

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Bridging the gap between occupational satisfaction and technology acceptance

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The European Commission aims to achieve a 90% reduction in transport-related greenhouse gas emissions by 2050. Digitalization and automation in rail operations are among the main pillars to achieve this goal. This has significant consequences for railway staff, as new technologies change tasks and work environments, especially for train drivers. While safety and performance-related aspects of automation in rail operations have been investigated, there is currently very limited understanding of how new technologies in the driver cabin change job characteristics and if and how drivers integrate these technologies into their driving. In my PhD project, I therefore investigate how job characteristics and occupational satisfaction change due to the introduction of a driver assistance system (DAS) and what influence these changes have on the way train drivers adopt the system and interact with it. First results from a field study investigating the impacts of a DAS in a German railway company on train drivers’ job characteristics and work-related attitudes, and their compliance with the system, are discussed. Findings from this study will enhance our understanding of technology acceptance and use. Additionally, it will have consequences beyond system design and provide insights into organizing tasks between technologies and operators and how new technology can be successfully integrated into existing work environments.

Development of an Adaptive and User-centered HMI for Connected and Automated Vehicles

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Highly automated vehicles (HAVs; SAE level of automation 4) are likely to be an essential element of future mobility solutions. However, even with advanced automated driving systems (ADS), human intervention and support will be required for safe, reliable and inclusive driving operations. One approach to integrate a human into the system is the remote assistance of HAVs. A remote assistant supports the HAV from a distance, e.g., a remote operations center, by being displayed key information from the HAV and the surrounding traffic environment. When a need for assistance emerges, e.g., in the event of reaching ODD limits, edge, or corner cases, the remote assistant is notified and asked to aid the HAV by reviewing the situation and providing input to the ADS without executing the dynamic driving task. To interact with the ADS, the remote assistant uses a suitable human-machine interface (HMI). Moreover, an in-vehicle HMI is required to keep passengers on board of the HAV up to date on the remote assistant’s intervention. One way to meet user needs in designing these HMIs is to apply user-centered design methods. The presenters’ PhD projects follow the user-centered design process to develop and evaluate solutions for HMIs in the event of remote assistance, for both the remote assistant in a control center and for the passengers of remotely assisted HAVs. Focusing on the HMI for the remote assistant, a comprehensive prototype of a remote assistance workstation was initially introduced and evaluated from a Human Factors perspective. This baseline prototype yielded good results regarding performance, workload, and situation awareness (Schrank et al., 2024a). While the initial HMI design predominantly relied on video streams to provide situational information, a second PhD study explored the potential of augmenting the video stream with additional sensor data. These data were visualized to make road users that were difficult to

perceive more salient, particular in situations with poor visibility such as fog. The augmentation helped to significantly reduce the number of collisions overall but especially in foggy conditions (Schrank et al., 2024b). The augmentation applied in the study was the output of an assumed adaptive system: It was only displayed for road users an interaction was likely with. Thus, the augmentation was adapted to likelihood for interaction in the foreseeable future. Focusing on the HMI for passengers of remotely assisted HAVs, an In-vehicle HMI for passengers was investigated. Results provided evidence that providing information about the remote assistance resolution process improved passengers’ understanding and experience significantly (Brandt et al., 2024a). In a follow-up study, design principles for presenting this information were investigated, utilizing media-richness as a vehicle to improve user experience of passengers of remotely assisted vehicles further (Brandt et al., 2024b). In this forum session, the presenters intend to explore together with participants and experts how to extend their research on both adaptive HMIs for remote assistance and multimodal in-vehicle HMIs for passenger communication in their following PhD studies. In particular, they want to brainstorm ideas on the further refinement of the perception-based HMI for remote assistance from previous studies and conceptualizations for adaptive HMIs beyond that, including, but not limited to, intention-based HMIs. Additionally, possibilities to provide more information about the system according to passengers’ needs will be brainstormed. Implications of Human Factors research for these HMI solutions will be discussed.

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Mixed Reality Methods to simulate and evaluate Autonomous Vehicle Interiors

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Automated Mobility is considered one of the pillars of future mobility solutions. User-centric development is essential to these mobility solutions (Subramanian et al., 2023; Schlichtherle et al., 2023). Having mentioned that, in automated vehicles, understanding the user needs is highly essential in the vehicle interiors since most of the time is spent here. Understanding user needs, especially in automated vehicle interiors, is one of the biggest challenges that research institutions and the mobility sector face currently. The demand for evaluations, that analyze not just the interior design, but also aspects such as user interactions, user safety, and user accessibility in the automated vehicle interior are increasing (Etminani-Ghasrodashti, et al., 2022). Such demands can be met by Virtual Prototyping techniques, where a group of participants can also be included in the automated vehicle interior simulations using Mixed Reality (MR) Immersion, which not only helps to simulate but also to evaluate aspects involving the user and their acceptance. Gamification can be used here as a Virtual prototyping technique, where the simulations of the automated vehicle interior, the environment, and traffic can be developed using game engines like Unreal Engine (UE). The participants can use high-end MR glass like Varjo-XR 3 to visualize and interact in the virtual environment. This creates a platform, where several scenario-based evaluations, to analyze user-centric aspects. Having said that, each and every user-centric aspect to be evaluated in an automated vehicle interior is unique, and immersing the participants in the virtual environment, is not enough to cater to each degree of evaluation. This is why additional layers such as the type of mixed reality technique, and the type of

interaction device and trackers are necessary to carry out a particular evaluation (Subramanian, et al., 2024). This Doctoral Project aims to develop MR methods to simulate and evaluate automated vehicle interiors to analyze aspects such as interior design, equipment, and features, user safety, user interaction, HMI, user acceptance, comfort level, and to understand and frame requirements for assistance systems by simulating necessary scenarios. Methods such as the Human-in loop approach to integrate real individuals and physical prototypes into a virtual environment using Green Screens were developed and evaluated which was the base for this research (Unreal Chroma keying API 2022; Subramanian et al., 2023). Following this, a workflow to facilitate the implementation of further mixed reality techniques like depth occlusion and masking was constructed (Subramanian, et al., 2024). The next step is to map the suitable mixed reality technique, interaction device, and trackers, and the scenario, to the corresponding aspect of evaluation. This multi-dimensional mapping matrix will help the scientific world to identify the necessary method to carry out automated vehicle interior evaluation when a particular aspect has to be evaluated. The ways in which the mixed reality methods and aspects list can be mapped, and the ongoing research on mixed reality methods to simulate and evaluate vehicle interiors, are the two lines of research that run parallel in this doctoral project.

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AR Troubled Water: Exploring Immersive Intervention Technology for Enhancing Flood Protection Behavior

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The resilience of a society is a fundamental component of a country's ability to cope with crises and disasters. Individual prevention and self-protection must complement government action (Bundesministerium des Innern und für Heimat, 2022). Yet, past events have revealed lacking individual disaster preparedness, partially caused by perceived distance from disasters and a perceived lack of and control. Research indicates that prior disaster experience is one of the strongest predictors of preventive behavior, highlighting the importance of experience-based learning.

Immersive technologies, such as augmented reality (AR) and virtual reality (VR), enable users to experience elements of a disaster scenarios and interactively explore effects of their actions without exposure to real-world risks. Hence, it may have the potential to decrease barriers that inhibit prevention and support behavior change towards a more disaster-prepared society. To explore these possibilities, research evaluating their effectiveness is needed.

The developed iOS-based application AR Troubled Water targets the improvement of protection behavior regarding flooding as an extreme weather event that can lead to health impairments, fatalities, and massive financial losses. In a flood simulation, a rising water level enhances the users' immediate environment to visualize potential disaster and support risk awareness. It is accompanied by short texts on the effects of flooding. We aim to reduce perceived temporal and spatial distance to flood events and anticipate an enhancement in risk awareness. In the interaction component, users explore the room and interact with virtual objects to

learn about flood emergency preparedness. Here, we aim to increase the availability and attractiveness of information.

In an ongoing experiment, scheduled to finish fall 2024 with 120 participants (currently $N = 86$) at Technische Universität Braunschweig, we examine the effects of simulation and interaction in comparison with a control group. Based on the protection motivation theory (Rogers et al., 1983), we analyze effects on threat and coping appraisal and changes in protection intentions and behaviors. We use a pre-post design evaluation with a follow-up online survey two weeks after the experiment to take into account immediate and medium-term effects.

Preliminary analysis implies potential for the flood simulation to enhance threat appraisal, while the interaction seems to positively influence coping appraisal. Regarding protection intention and behavior, we found a descriptive tendency towards higher values in the intervention groups.

With our findings, we aim to inform the development of future immersive intervention technology tailored to various types of natural disasters. Given the increasing accessibility of immersive technology, we thus aim to contribute to a more resilient society.

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Primacy effects during performance monitoring of environment-based cognitive strategies

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Humans frequently make use of their environment when acquiring and processing information. For example, humans retrieve factual knowledge not only from their own organic memory but also from their handwritten notes, sometimes from their colleagues, from the books they studied the facts with in the first place, from search engines, and so on. Clearly, it is a challenge to proficiently navigate the plethora of cognitive strategies available in today’s technologized world. Here, we took a look at a mechanism that contributes to such proficiency: performance monitoring. Specifically, we took a look at the time course of speed monitoring. Is speed monitored consistently across all encounters with a cognitive strategy? To answer this question, we subtly manipulated the time it took two algorithms to find the solution to Trivia questions in a forced-choice observation block and subsequently asked participants to use the algorithm they prefer in a free-choice block. Crucially, some algorithms performed faster at the beginning and some at the end of the forced-choice observation block. Across a series of experiments, our results clearly show a preference for algorithms that performed fast in the beginning of the observation block. Results showed no preference for algorithms that performed fast at the end of the observation block. Thus, we found evidence for a primacy but no evidence for a recency effect. In other words, performance monitoring might be focused on initial encounters of novel cognitive strategies and be less pronounced thereafter.