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Star Visit: Exploring Soma Design Approach to Multisensory In-car AR Wellness Experiences for Electric Vehicles

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This thesis investigates the design and evaluation of an in-car leisure experience to enhance user wellness during electric vehicle (EV) charging. Amidst the rapid transformation of the EV market, driven by technological advancements such as Extended Reality (XR) and biosensors, the project seeks to create engaging in-car experiences that transcend traditional transportation. Using soma design principles within a Research-through-Design (RtD) framework, the study introduces a multisensory strategy to foster wellness, leveraging the benefits of Virtual Restorative Environments (VRE) and deep breathing. Designed within the context of Polestar, a luxury EV brand, a final design concept, aptly named 'Star Visit', integrates visual, auditory, and tactile stimulation. During the final evaluation conducted with 10 participants, the design revealed profound somatic sensations centered on deep relaxation and escapism, with harmonious multisensory elements enhancing these experiences. Additionally, the study identified the limitations of VR and the potential of AR for in-car applications, along with user expectations and enthusiasm for integrating the system into Polestar vehicles. Key findings underscore the efficacy of the soma design method, the design's potential to contribute to the "Coping Self" dimension of wellness through bringing benefits of VREs and deep breathing, and the necessity for personalization and adaptability in multisensory systems to accommodate diverse user preferences and environmental variations. By embracing these insights, the research sets the stage for future advancements in in-car wellness experiences, enriching the overall user experience in electric vehicles.

SAMMANFATTNING

Denna avhandling undersöker design och utvärdering av en in-car fritidsupplevelse för att förbättra användarens välbefinnande under laddning av elfordon (EV). Mitt i den snabba omvandlingen av EV-marknaden, driven av teknologiska framsteg som Extended Reality (XR) och biosensorer, syftar projektet till att skapa engagerande in-car upplevelser som går bortom traditionell transport. Genom att använda soma designprinciper inom en Research-through-Design (RtD) ramverk, introducerar studien en multisensorisk strategi för att främja välbefinnande, utnyttjande fördelarna med Virtuella Restorativa Miljöer (VRE) och djupandning. Designad inom ramen för Polestar, ett lyxmärke för elfordon, integrerar ett slutgiltigt designkoncept, lämpligt namngivet 'Star Visit', visuell, auditiv och taktil stimulans. Under den slutliga utvärderingen genomförd med 10 deltagare, visade designen djupa kroppsliga sensationer centrerade på djup avslappning och eskapism, med harmoniska multisensoriska element som förstärkte dessa upplevelser. Dessutom identifierade studien begränsningarna av VR och potentialen hos AR för in-car applikationer, tillsammans med användarnas förväntningar och entusiasm för att integrera systemet i Polestar-fordon. Viktiga fynd understryker effektiviteten av soma designmetoden, designens potential att bidra till dimensionen "Coping Self" av välbefinnande genom att erbjuda fördelarna med VREs och djupandning, samt nödvändigheten av personalisering och anpassningsbarhet i multisensoriska system för att tillgodose olika användarpreferenser

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och miljövariationer. Genom att omfamna dessa insikter, banar forskningen väg för framtida framsteg inom in-car välbefinnandeupplevelser, vilket berikar den övergripande användarupplevelsen i elfordon.

CCS Concepts: • **Human-centered computing** → **Empirical studies in HCI**; *Empirical studies in interaction design*.

Keywords: in-car leisure experience, wellness, multisensory, augmented reality, soma design

Nyckelord: bilbaserad fritidsupplevelse, välbefinnande, multisensorisk, förstärkt verklighet, soma design

1 INTRODUCTION

The rapid transformation of the electric vehicle (EV) market, driven by technological advancements like Extended Reality (XR) and biosensors, is pushing the boundaries of in-car experiences. This shift goes beyond simply getting from point A to point B, redefining cars as versatile living spaces [49]. As a result, the focus is shifting towards innovating leisure experiences within the car, offering new opportunities for novel user behaviors and interactions. For example, affective automotive interfaces that respond to the affective states of drivers and occupants have been extensively researched, leveraging the various sensing and actuating modalities available in vehicles [10, 30]. Additionally, companies like Audi and in-car VR content provider Holoride have introduced XR entertainment in cars by integrating XR content with real-time vehicle data, creating "hyper-immersive" experiences [13].

Moreover, as vehicles include increasingly more autonomous driving features, so too are increasing opportunities to promote driver health and wellness. Recent examples of development in this area include Ford's 2011 collaboration with WellDoc to create an in-car health and wellness system specifically designed for individuals with conditions like diabetes and asthma, which aimed to provide timely care, ensuring not only the safety of the driver but also that of others on the road [39]. This trend has continued, with Hyundai Mobis recently developing the M.VICS system, an integrated cockpit element as part of their smart cabin concept, which actively monitors users' bio-signals and responds accordingly to promote their wellness. Furthermore, previous research that surveyed 2500 consumers about their expectations for future cars [46], highlights the demand for relaxation and wellness features within vehicle interiors, reinforcing the need for innovations in this area.

Targeting EVs that are expected to enter the market in the next 5-10 years, this degree project aims to explore and design in-car leisure experiences that focus on promoting user wellness. Using Polestar, a luxury EV company, as a context, the project includes an exploration of the design space, the development of a final design concept, and an evaluation of the concept.

Furthermore, building on previous research that has demonstrated the effectiveness of a multisensory approach for wellness experiences [20, 22, 37, 52], this project aims to unlock a deeper level of user engagement and relaxation within the car environment. By adopting a multisensory approach that transcends conventional visual stimulation - typically delivered through a centrally positioned screen in vehicles - this project investigates the potential of contemporary and emerging automotive technologies, alongside interaction designs enabled by these advancements. The resulting designs engage a broader range of human senses, fostering a more holistic and enriching in-car experience.

This project proposes a design concept titled "Star Visit," a prototype of the in-car relaxation system specifically designed for EVs to enhance user wellness during the often-overlooked moment of EV charging. Leveraging the principles of soma design, the prototype is developed to offer a multimodal sensory experience tailored to promote relaxation and stress management, thereby transforming the EV charging process into a rejuvenating and enjoyable activity. "Star Visit" aims to represent a holistic integration of somatic experiences intricately woven with cutting-edge technologies, ultimately fostering a sense of wellness aligned with Polestar's brand identity.

The evaluation process of the "Star Visit," involved a comprehensive user study focusing on participants' somatic experiences before, during, and after interacting with the prototype. Thematic analysis of participant data revealed

three key themes: deep relaxation, escapism from reality, and harmonious multisensory experiences through audio, visual, and tactile integration. The findings highlighted how participants transitioned from feelings of stress to relaxation, characterized by deeper breathing and a meditative state. Participants also experienced a sense of being transported away from their immediate environment, enhancing their overall relaxation and sense of personal space. Additionally, the study identified limitations in VR technology, particularly regarding visual fidelity and hardware weight, suggesting a preference for AR integration to enhance visual quality and user comfort. Notably, participants expressed strong enthusiasm for the concept's potential integration into Polestar vehicles, highlighting its potential to enrich the in-car experience and contribute to wellness in the automotive context.

In essence, this thesis endeavors to contribute to the growing body of knowledge around in-car wellness experiences [5, 15, 65]. By embracing a multisensory approach and leveraging emerging technologies, this research provides valuable insights into designing leisure experiences that promote user wellness, paving the way for a more engaging and fulfilling in-car journey for EVs.

2 BACKGROUND

2.1 Wellness: Enhancing the Coping Self

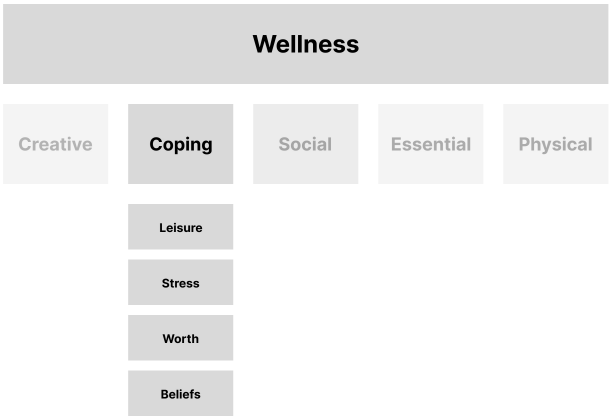


Figure 1: Graphic demonstrating five primary factors of wellness revealed by Hattie et al. [24]. Recreated by the author.

In today's fast-paced world, the concept of wellness has transcended its historical focus on simply avoiding illness. It has been integrated into various aspects of our lives, from everyday routines to infrastructure and development of technologies, to promote overall quality of life. This widespread integration reflects a shift towards prioritizing proactive health management and a preventive approach to overall wellness.

The concept of wellness, though widely discussed today, has a relatively short history in terms of its formal definition. In 1947, the World Health Organization (WHO) established a definition of health as a "condition of overall physical, mental, and social well-being, rather than simply the absence of illness or weakness" [62]. This broader definition laid the groundwork for the understanding of wellness as a multidimensional concept. Building upon this foundation, Halbert L. Dunn, often regarded as the "father of the wellness movement," described wellness as "a comprehensive approach to functioning that aims to optimize an individual's full potential." [18].

The Wheel of Wellness model, extensively analyzed and refined by psychologists over the years, offers a comprehensive theoretical framework for understanding wellness [24, 61]. Through factor analysis, Hattie et al. confirmed the original 17 dimensions, leading to the identification of five higher-order dimensions: Creative Self, Coping Self,

Social Self, Essential Self, and Physical Self [24] (Figure 1). Defined by the model's author as a lifestyle focused on achieving optimal health and well-being by integrating the mind, body, and spirit, wellness is deeply influenced by each of these dimensions [24, 61]. Specifically, the Creative Self pertains to interpreting the world, while the Coping Self reflects the ability to manage internal and external challenges, emphasizing the role of leisure activities in enhancing coping mechanisms [24]. The Social Self concerns relationships, the Essential Self focuses on spirituality and self-identity, and the Physical Self relates to attributes such as exercise and nutrition [24].

Within the Wheel of Wellness framework, the concept of "Coping Self" holds particular relevance for this project's focus on in-car leisure experiences designed to promote wellness. In-car environments inherently prioritize safety, necessitating a robust Coping Self – the ability to manage internal and external challenges. This dimension encompasses skills like maintaining realistic beliefs, a healthy sense of self-worth, and effective stress management, as outlined in the framework [24]. The intimate connection between leisure activities and the Coping Self underscores the importance of exploring this aspect of wellness in the context of in-car environments, providing a solid foundation for understanding how enhancing coping mechanisms and managing stress through leisure activities can contribute to the overall well-being and safety of individuals within the vehicle.

2.2 Multisensory Technologies for Wellness

2.2.1 Virtual Restorative Environment (VRE). The concept of Virtual Restorative Environments (VREs) has emerged as a potentially powerful tool for promoting relaxation and stress management. Decades of research have documented the restorative effects of nature exposure, including reduced stress, decreased sympathetic nervous system activity, diminished cognitive fatigue, and increased focus, which also translates to improvements in psychological and physiological health [9, 23, 55, 56]. Notably, these restorative effects are evident even when exposure comes from artificial representations of nature, such as photos and videos [57, 68].

The advent of Virtual Reality (VR) technology has further fueled research into the potential of VREs. Studies have shown that immersive experiences within VR-simulated natural environments can yield restorative effects comparable to those observed in real nature settings [50, 57, 68]. For example, Valtchanov et al. [57] demonstrated that participants exposed to a virtual natural environment recovered more effectively from a stress-inducing task than those exposed to an environment with abstract paintings. Building on the findings, Schutte et al. [50] further explored the impact of VREs on psychological well-being. Their study compared the effects of experiencing a 360° VR natural environment with those of a VR urban environment, focusing on measures of affective states and restorativeness. Consistent with prior findings, their results indicated that exposure to the natural environment in VR led to significantly more positive affect and a heightened sense of restorativeness compared to the urban VR experience. Ünal et al. [68] found that exposure to both real natural environments and virtual ones led to similar stress reduction following a stressful task, supporting the potential of VREs to improve well-being.

2.2.2 Intervention for Breathing. Multiple studies have established that intentional slow breathing activates the parasympathetic nervous system, leading to reduced physiological arousal and heart rate [12, 31, 38, 40]. This activation translates to improved stress tolerance, ultimately contributing to enhanced mood and overall well-being [12]. Recognizing these well-documented benefits, Human-Computer Interaction (HCI) research has increasingly explored breathing exercises as a potential tool for stress management. This focus has led to the study of interventions using various actuation methods to simulate breathing exercises and harness their benefits on wellness.

For example, Ghanderharioun and Picard [20] developed BrightBeat, a system that utilizes visual and auditory feedback to promote slower breathing. Participants in the study engaged in tasks like relaxation, reading, and quizzes while receiving visual and auditory cues when their breathing rate exceeded a predefined threshold. The results showed significant effectiveness in influencing participants to slow their breathing, leading to increased calmness

and focus [20]. Further supporting this application, Papadopoulou et al. [41] explored the use of tactile intervention to promote relaxation and lower breathing rate. Their study employed a sleeve equipped with shape memory alloy cuffs that applied pressure and thermal variations to the palm and forearm area. Both the physiological data and the self-reported measures showed that this tactile intervention had a beneficial effect on participants' breathing rate and their sense of calmness. [41]. These studies demonstrate the HCI community's interest in designing and researching effective breathing interventions across various modalities.

2.3 Promoting Wellness in Cars

The growing concern for driver performance and safety has led to an increasing focus on the "Coping Self" dimension of wellness as a critical aspect of the in-car experience. This focus is evident in the AwareCar concept proposed by Coughlin et al., which promotes user wellness through monitoring, management, and optimization [15]. The approach, inspired by the Yerkes-Dodson Law [63], aims to maintain an optimal driver state by reducing stress during a high workload and mitigating fatigue during a low workload. Their research demonstrated the effectiveness of biometric monitoring and active feedback (e.g., visualizing biofeedback) in improving wellness in cars. Furthermore, Bai et al. focus on in-vehicle healthcare systems, identifying mental well-being and sensory experience as key areas [5]. The co-design process highlighted the importance of features like "stress-relieving mode" with soothing environments and meditation guides, acknowledging the enclosed space of the car and the potential for promoting mindful activities [5]. Their result recognizes stress and loneliness as concerns and identifies factors affecting comfort like vibration, noise, odor, and lighting, along with muscle fatigue [5].

2.3.1 VRE. Given the increasing popularity of VR technology and its demonstrated potential for mindfulness practices (e.g., [1, 2, 58]), researchers have explored the feasibility of adapting it for wellness in cars as well [35, 36, 42]. Paredes et al. designed a dynamic VR experience that synchronized car movement with a calming underwater diving environment [42]. Importantly, participants reported the experience as highly relaxing, mindful, and even entertaining with no signs of motion sickness observed, suggesting the potential effectiveness of dynamic VR content synchronized with car movements for in-car relaxation. Building on this finding, Li et al. investigated the effectiveness of immersive Virtual Restorative Environments (VRE) in cars, proposing them as a tool for "active relaxation," particularly during short breaks [36]. However, in their follow-up study, which utilized a static virtual beach environment with tactile feedback (simulating sand) instead of a dynamic content, the result showed an increase in participants' heart rate, suggesting limited relaxation effects [35]. This contrasting outcome underscores the importance of exploring varying levels of interactivity with VRE to optimize relaxation outcomes in the context of in-car wellness experiences.

2.3.2 Intervention for Breathing. Recognizing the potential of breathing exercises, researchers has been exploring ways to integrate them into the car environment [7, 14, 34, 44]. In particular, Choi et al. investigated the feasibility of integrating breathing exercises for passengers in the car in the commuting scenario by designing "aSpire," a mobile device that guides users through breathing exercises using personalized haptic feedback patterns [14]. The study employed self-reported stress levels and bio-sensors to measure heart rate and electrodermal activity. Results showed that "aSpire" successfully reduced the average breathing rate by 24.8% for 80% of participants; moreover, 93% of participants reported potential benefits for stress relief and meditation.

However, mixed results have emerged from studies exploring the use of in-car breathing interventions for drivers behind the wheel. Lee et al.investigated the use of multi-sensory feedback (auditory, visual, and tactile) as ambient breathing guides for calming drivers in the simulated environment [34]. While participants readily engaged with the breathing exercises, the study did not find significant calming effects. On the other hand, other previous research has

shown promise for in-car breathing interventions. Paredes et al. found that these interventions, delivered through a vibrotactile haptic seat or voice guidance in a simulated commute environment, reduced both breathing rate and physiological arousal [44]. They further demonstrated that haptic guidance was more effective and long-lasting compared to voice guidance. Similarly, Balters et al. (2020) utilized a similar haptic seat for in-car breathing guidance during the actual driving situation [7]. Their study achieved a significant 25% reduction in participants' breathing rates and received positive user feedback, suggesting the potential of this approach in real-world scenarios.

2.3.3 Movement Interventions. In the context of mindful in-car experiences, some studies explored movement interventions to promote wellness [29, 43]. Paredres et al. developed a haptic guidance system to prompt relaxing movements, inspired by yogic breathing, Feldenkrais practice, and the Alexander technique [43]. Similar to their previous study on breathing guidance [44], the researchers utilized non-intrusive vibrotactile feedback embedded in the seat to guide participants. Subtle movements emerged as the most preferred and relaxing movement in cars, while those obstructing vision or interfering with hand/foot movement (e.g., on pedals and steering wheel) were less favored. In addition, recognizing the challenges of driver fatigue and boredom in congested city commutes, Jang et al. designed a heads-up display (HUD) infotainment system that suggests simple 30-60 second body stretches [29]. While participants reported the system helpful in reducing drowsiness, they also noted its greater potential for long drives rather than commuting. However, safety concerns emerged, with participants expressing discomfort at taking their hands off the wheel and losing focus on the road, even momentarily. Within the industry, Ford has announced a mindfulness concept car with features like yoga and meditation guides [19]. The company provided a mobile app that includes guides for light yoga exercises with meditation, aimed to use while the car is stopped or parked. Jaguar Land Rover introduced "morphable seats" as another approach to address movement intervention. The seat aimed at promoting wellness on long journeys by simulating walking movements through subtle seat adjustments, thereby mitigating muscle discomfort [28]. Unlike other research and designs, it aimed for a passive movement to promote wellness through movements.

2.3.4 Olfactory Stimulation. Recent research has explored the potential of odor-based interventions to promote wellness in cars. Dmitrijs et al. conducted four laboratory studies investigating the use of subtle scents for emotion regulation in drivers [16]. Their findings suggest that pleasant scents like rose and peppermint can relax drivers and potentially lead to safer driving. However, the study also highlights the importance of individual preferences in scent perception, as the effectiveness of these interventions can vary significantly across individuals. Moving forward, another study has investigated the use of scents for mitigating motion sickness and promoting passenger wellness [48]. While some scents, like ginger and lavender, were intended to alleviate these issues, the results showed no significant difference between the two scents and even indicated that both scents might worsen motion sickness for participants. These findings emphasize the crucial role of personalization in utilizing scent-based interventions and avoiding potential negative effects.

2.3.5 Interactive In-Car Wellness Systems. The automotive industry is experiencing growth in the development of fully interactive in-car wellness systems, which reflects a growing desire for personalized and dynamic experiences that enhance individual wellness in cars. Several carmakers are leading the charge in this space. Hyundai Mobis' M.VICS concept, for example, monitors biosignals and adjusts lighting, aroma, and climate control to promote comfort and reduce stress [59]. Similarly, Audi integrates features like massage seats, soundscapes, breathing exercises, and meditation aids based on biodata from wearables into their vehicles [4, 33, 64]. Likewise, Mercedes-Benz's "Energizing" package and BMW's "Caring Car" program personalize the driving experience by adjusting climate, seat functions, and ambient lighting based on driver preferences and biodata [17, 47].

However, despite the increasing number of in-car wellness systems being developed, a crucial gap exists. These features are often implemented as standalone additions rather than part of a cohesive, holistic system. While they may draw from popular wellness behaviors or technologies outside the car, they have not been thoroughly researched and adapted for the specific context of in-car use, which raises important questions about the effectiveness of these systems. Further research is necessary to rigorously explore the potential benefits of multisensory stimulation in vehicles and to design these systems in a more sophisticated manner that genuinely enhances the wellness of drivers and occupants.

3 METHODOLOGY

To effectively explore the challenge of in-car experience design, this project employs the soma design method through a Research through Design (RtD) approach. This choice is particularly well-suited for several reasons. Firstly, the RtD process provides the flexibility needed to thoroughly explore novel design spaces, accommodating the iterative and dynamic nature of design research more effectively than traditional methods [67]. Secondly, the use of soma design is particularly pertinent to this project, as it deeply investigates the felt dimensions of experience—an essential aspect given the multimodal environment of car interiors and the diverse sensory aspects available. As soma design emphasizes the importance of bodily sensations and emotions in shaping experiences, it offers a unique and valuable perspective for investigating and enhancing user interactions and well-being within car spaces, which has not been extensively researched in this context before [27]. By integrating soma design with RtD, the project aims to create user-centered, sensory-rich in-car experiences that align intending to promote wellness and enhance the overall quality of life for drivers and passengers.

3.1 Soma Design

Soma design is a contemporary approach focused on enriching experiences by deepening sensory perception and fostering self-awareness, rooted in the fusion of pragmatics and somaesthetics by Richard Shusterman [25, 27]. This method explores the intricate connections between sensation, emotion, understanding, and values, aiming to facilitate a more fulfilling life [25]. By viewing the soma as an integrated entity that transcends the traditional body-mind distinction, soma design emphasizes the importance of sensory experience and appreciation within a holistic framework [27].

Central to soma design is the "felt dimension," which stresses first-person engagement and an autobiographical design process to uncover the aesthetic essence of the soma [25]. This approach acknowledges the subjective nature of felt experiences, allowing designers to deeply reflect and iterate on these experiences [25]. Unlike conventional design processes that systematically identify and solve user needs, soma design delves into the aesthetic and sensory nuances of felt experiences. This approach expands designers' creative perspectives, leading to richer and more holistic design outcomes that address user problems and enhance overall sensory experiences [27].

By integrating soma with aesthetics, soma design aims to deepen the comprehension of sensory experiences, crafting enriching experiences that foster somatic awareness [60]. Ultimately, by merging somaesthetics and pragmatic principles, soma design offers a pathway to a better life by fostering deeper connections with oneself, others, and the world [60]. This approach is particularly relevant for enhancing the Coping Self aspect of wellness, as it focuses on the holistic integration of sensory and emotional experiences.

Soma design has demonstrated efficacy in promoting wellness and therapeutic experiences in designs, as evidenced by its application in projects aimed at fostering awareness of the soma's aesthetic [32, 51–53]. Initiatives such as the Soma Mat and the Breathing Light, exemplify the great potential of soma design in cultivating mindfulness and relaxation [52]. The Soma Mat employs heat modality to facilitate body scanning, while the Breathing Light utilizes

light to visualize users' breath as a form of biofeedback, resulting in reported outcomes of enhanced relaxation, smoother movements, and heightened self-awareness [52].

Within the design process that is detailed later, tools like Soma Bits, body maps, and soma trajectories facilitate exploration and reflection [3, 54, 60]. To be specific, Soma Bits aid sketching and brainstorming in the design process, enhancing tactile engagement through actuating with heat, vibration, and shape-shifting materials [60]. Body maps serve as a visual representation of somatic experiences, facilitating deeper reflection beyond the limitations of verbal communication and enabling a more nuanced articulation of these experiences [3]. Soma trajectories are employed to track participants' emotional and sensory transitions throughout the experience, enabling the effective capture and articulation of the temporal nuances of somatic experiences [54].

3.2 Research through Design (RtD)

RtD involves creation of prototypes or products that address 'Wicked Problems' - complex issues that are challenging to solve, and enables researchers to contribute to the community by generating knowledge not only through the end result of the project but also throughout the design process [67]. Therefore, Zimmerman emphasizes that the design process is critical for evaluating the quality of research employing this approach [67]. Researchers must provide sufficient detail about the design process, including the rationale behind their methodological choices and decision-making throughout the research [66]. The RtD approach inherently acknowledges the non-linear nature of the design process, allowing for more flexible iterations throughout.

The RtD process commenced with expert interviews to explore the design space of in-car technologies and EVs, hearing directly from technical and design experts from Polestar. Following this, I organized an ideation workshop to foster collaborative efforts, both within and outside the company, bringing in diverse perspectives for idea generation and development. The project then advanced by selecting one idea for further development, storyboarding the user journey, and designing the felt experience through an autobiographical process. A prototype, capable of being tested through a VR car simulator, was subsequently developed. To further reflect on and analyze the felt experience generated by the prototype, I conducted a qualitative user study. The results of this study were then analyzed using methods that will be elaborated on in subsequent sections.

3.2.1 Exploring the Design Space. Semi-structured interviews, each lasting approximately 30 minutes, were conducted with seventeen Polestar experts from diverse departments, including UX, Connected Experience, Advanced Engineering, and Interior Design, to uncover the design space. These interviews aimed to gain industry insights and explore design opportunities specific to EVs, with a particular focus on promoting wellness within the car. To be specific, the discussions with the experts covered current trends in in-car experience design, design opportunities specific to EVs that could enhance driver and passenger wellness, perspectives of experts on in-car leisure experiences (both in general and for Polestar cars), expert visions for future cars and in-car experiences that consider promoting wellness, and currently feasible sensor and actuator technologies that can be integrated into EVs.

3.2.2 Generating Inspirations and Ideas. Ideas and inspirations were generated through collaborative efforts during the ideation workshop (Figure 2). The workshop was held at two locations: internally at Polestar with UX design and EV experts that has experience driving EVs, and externally at KTH Royal Institute of Technology with second-year interaction design students. A total of 10 participants attended, with 5 participants at each location. All participants possessed design experience, having practical knowledge in the field. In terms of soma design experience, the Polestar UX design experts came in fresh, while the KTH participants all had prior experience with practicing soma design. To mitigate gender bias during the ideation process, 5 males participated in the workshop at Polestar, while 5 females took part in the workshop at KTH.

Figure 2: Workshop setup and process photos in time order

After outlining the aim of the ideation workshop and providing an overview of current trends in in-car technologies, the workshops began with a sensitizing activity, comprising three parts. First, participants engaged in an 8-minute body scan meditation, followed by a 16-minute exploration of somatic experiences, including breathing exercise, self-accupressure, and Feldenkrais exercise. Both activities ended with documenting their sensations on body maps. For the body scan meditation, participants from Polestar conducted the exercise while seated in a Polestar vehicle, while all other sessions in both workshops were carried out in a room dedicated to the workshop. The final sensitizing activity involved participants using Soma Bits [60] and various materials to stimulate different senses and inspire their ideation process. These included Soma Bits delivering tactile stimulation through heat and vibration, candle and aroma oils offering a range of scents, and textural materials like clays, memory foam, and objects with varying shapes. Following a brief break, three ideation rounds were facilitated. The first round focused on participants' favorite senses during the sensitizing activities. In the second round, they generated solutions to enhance the experience of a fictional character, Eric, who was stressed from a long drive and needed activities during a 30-minute car recharge. The last round involved refining and merging the most promising ideas.

After the workshop, collected ideas underwent analysis through affinity diagramming [8], resulting in the generation of six initial concepts. These concepts were assessed based on user experience, brand identity, wellness promotion, and feasibility, with a prioritization matrix [21] used for clearer analysis. The chosen multisensory concept's complexity was addressed through the development of a storyboard, facilitating a comprehensive understanding of the user journey.

3.2.3 Autobiographical Design. Autobiographical exploration and evaluation guided the development of the chosen concept. The process began with exploring the visualization of a virtual restorative environment, where space travel videos and visualizations designed to encourage deep breathing were utilized. Based on continuous

first-person evaluations, the design was iteratively developed and refined, which involved identifying specific body parts whose actuation could enhance the experience's relaxation and stress management aspects. Accordingly, tactile senses were explored and developed, progressing from initial material exploration to explorations of form, behavior, and integration with potential actuation points on the body to enhance relaxation. Then, to further engage the user's peripheral senses and assess its potential to enhance the experience, the investigation of integrating the car's built-in technologies (audio systems, interior ambient lighting, and climate controls) was undertaken. Throughout the process, I documented the data and reflections through diary entries and photographs.

3.2.4 Evaluating the Concept. To evaluate the concept based on the felt experience it brings to different somas, a high-fidelity prototype was specifically developed for user testing within a VR car simulator. Although the final concept was intended to use AR for visual stimulation, it was decided to test it within a VR simulator due to the project's time constraints and the easier accessibility of developing VR within a short timeframe. This approach also ensured ecological validity by replicating the target environment as closely as possible, allowing users to interact with the prototype in a reliable, yet realistic setting. The prototype itself was crafted to provide a multisensory experience, incorporating a mobile neck pillow designed to deliver targeted tactile stimulation to the user's neck area through pneumatic actuation. Additionally, the auditory system complemented the visual experience, and the interior ambient lighting was dynamically adjusted to match the colors of the visualization, ensuring cohesive sensory actuation.

The user study involved 10 participants, consisting of an equal number of male and female full-time employees from Polestar. They were randomly recruited from the company's internal user testing pool, with consideration given to their availability for the study's scheduled activities. To ensure their suitability, participants were screened for their experience with VR headsets and susceptibility to motion sickness; eight had tried VR and found it acceptable, while two had never tried VR but rarely experienced motion sickness. The age distribution included seven participants aged 25-34, two aged 35-44, and one aged 45-54. All participants had prior experience driving an electric car.

3.2.5 Data Collection and Analysis. Four different types of data were collected for this study. First, the body map was used to effectively compare the self-reported state of the participant's soma before and after the experience. Second, soma trajectory data was collected to effectively capture and articulate the temporal nuances of soma experiences throughout the experience. Third, video recordings were made during the main experience to observe and analyze the subtle responses and body movements of the participants. Notes were taken based on the video recordings after the study for the analysis. Fourth, audio recordings were taken during the semi-structured interviews and were transcribed into text using Microsoft Word's audio transcribe feature. All collected data were analyzed using a thematic analysis approach with inductive coding, a method employed to exploratively identify themes or patterns as well as relationships between different kinds of data sets [11]. Notably, body map and soma trajectory data from two participants were excluded because they could only experience 70% of the experiment due to a technical problem (participant g, h).

4 DESIGN PROCESS

4.1 Exploring the Design Space

Informed by a comprehensive literature review on trends and existing research in EV design, semi-structured interviews were conducted with EV experts in Polestar. This approach provided valuable insights into the needs and perspectives of EV specialists across various domains.

The interviews identified charging time as a significant opportunity for enhancing leisure experiences within EVs. Currently, charging is an unavoidable aspect of EV ownership, often perceived as an unproductive waiting

period. Re-framing this period as a chance to prioritize driver and occupant wellness emerged as a significant insight, shaping the focus of the design exploration towards maximizing the value of charging time within the user journey.

The interviews also highlighted a gap between the acknowledged importance of driver stress management and research on user responses to in-car sensory actuation. While previous studies have focused on driver emotion sensing, little is known about the effectiveness and user comfort levels associated with various types of in-car sensory actuation. This gap underscores the need for further research to develop evidence-based practices for optimizing user wellness through sensory stimulation in vehicles.

Furthermore, the interviews revealed an intriguing trend in the automotive industry's approach to integrating emerging technologies within car experiences. While technologies like XR (encompassing VR and AR) and AI offer exciting possibilities, there is a risk of prioritizing novelty over user-centered design principles, potentially relegating these advancements to mere gimmicks. This underscores the importance of designing experiences that genuinely enhance, rather than complicate, the in-car environment and user experience.

Additionally, the interviews identified existing sensors and actuators within Polestar vehicles that could be leveraged to enhance user wellness. These include a fatigue detection system that works mainly with eye blink sensors, reclining seats, climate control systems, and massage functions aimed at relaxation. Another noteworthy case within Polestar was the internally developed breathing application, accessible through the vehicle's built-in central display, which guides users through breathing exercises using visual stimuli. These findings emphasize a significant opportunity to infuse new in-car leisure experiences, leveraging the brand's distinctive design language and the existing technological infrastructure within the vehicle space, which harbors ample potential to cultivate substantial value through in-car leisure experiences that focus on promoting user wellness.

Specific to Polestar's brand identity, the interviews underscored the brand's emphasis on performance, shaping the narrative and design decisions throughout the project. Aligning the design with Polestar's performance-focused ethos while incorporating a novel wellness theme presents a unique design opportunity.

In summary, the interviews with experts provided valuable insights into the design space. Charging time emerged as a promising context for in-car leisure experiences, offering an opportunity to promote wellness and provide novel value to Polestar users. Additionally, the interviews identified a gap in understanding user responses to in-car sensory actuation, emphasizing the need for evidence-based design practices to enhance user wellness in EVs. Building upon this point, technology trends should be wisely adopted in cars to truly bring value to users, rather than merely being integrated to follow trends. Therefore, designs should focus on leveraging Polestar's existing technological infrastructure and incorporating new technologies like XR and AI to create user-centered experiences that enhance wellness while staying aligned with the brand's performance-focused ethos.

4.2 Generating Inspirations and Ideas

This section explores the ideation process employed to generate inspiration and ideas about designing an in-car leisure experience focusing on promoting wellness. The process culminated in a hands-on ideation workshop with designers, which resulted in a rich set of inspirations and ideas. The ideas underwent thematic analysis, and based on the identified themes, 6 ideas were refined. Although the workshop was initially planned to emphasize somatic ideations during brainstorming sessions, participants preferred conventional methods such as leaving notes and verbal explanations. To prioritize the quantity of ideas in this exploratory workshop, it was facilitated to generate ideas in this familiar manner.

4.2.1 The Impact of Sensitizing Activities. By engaging in sensitizing activities, participants heightened their sensory awareness. This process not only encouraged further ideation to incorporate sensory aspects during but also

revealed three key themes, offering valuable insights into how people's experiences change after a series of effective wellness exercises. These themes, identified from the body maps, are as follows:

- **Shifting Balance:** Participants initially reported feeling unbalanced, but after the activities, they described a sense of balance, often concentrated in specific areas like hands or the torso.
- **Lighter Sensations:** A recurring theme was the transition from feeling heavy to lighter after the experience. Some participants specifically mentioned a shift in head weight that spread to the entire body, creating overall lightness.
- **Warmth and Relaxation:** Despite no environmental changes, participants reported feeling warmer throughout their bodies. This could be attributed to the movements themselves or the association of warmth with relaxation.

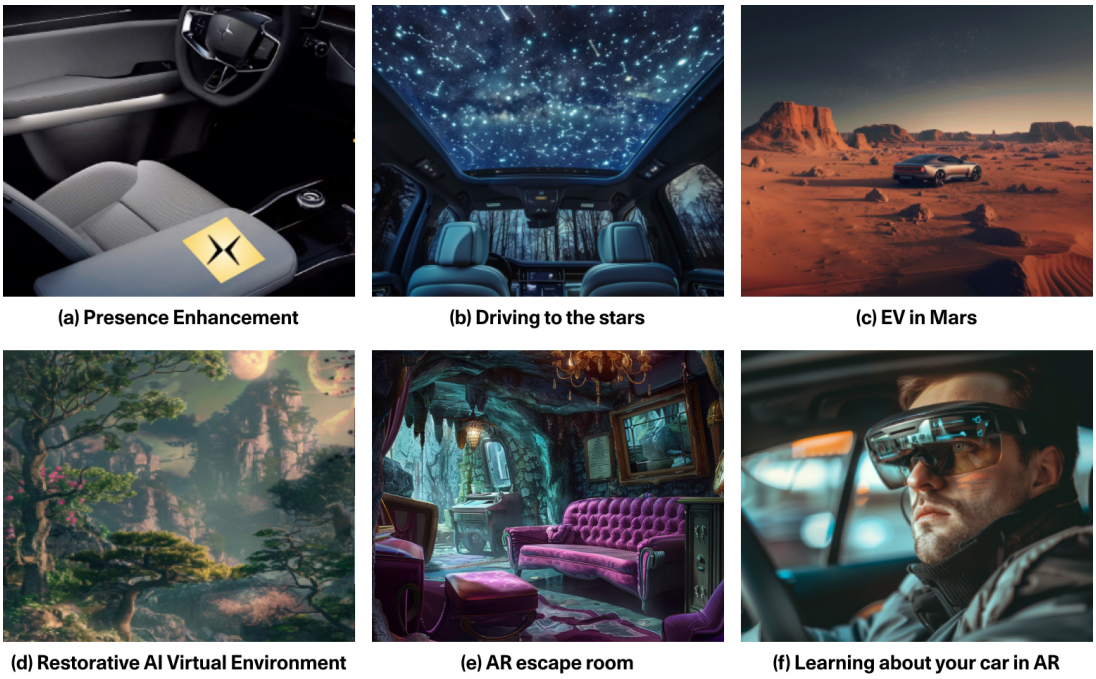


Figure 3: Polished ideas from the ideation workshop. (a) figure created by the author. (b)-(f) figure created by Generative AI tool, Midjourney

4.2.2 Thematic Analysis of Ideas. Thematic analysis of the ideas generated during the workshop revealed eight distinct themes. These themes encompassed a wide range of concepts, including conventional media entertainment, mindfulness practices, beauty care, journey planning, emphasis on personal space and me-time, educational pursuits, gaming and gamification, and the integration of music.

Of particular note within the context of leisure experiences within the car, there was a prevalent perception of the car as a sanctuary, often referred to as "my space." This perception inspired numerous ideas aimed at enhancing the car environment, such as providing a space for escapism or creating an effective refuge from external disturbances. Similarly, many ideas emphasized the importance of me-time within the car.

Furthermore, mindfulness practices emerged as a recurring theme, with activities such as light yoga, breathwork, and quick power naps being prominently featured. The potential for educational experiences within the car was also highlighted, with suggestions ranging from providing learning opportunities for families during travel time to

fostering personal enrichment through leisure learning activities. These insights underscored the diverse range of ideas generated during the workshop, each demonstrating significant potential value for further development.

4.2.3 Idea Development and Selection. Based on the analysis, six refined ideas reflecting the identified themes were developed. Particularly, these concepts aimed to embrace the aspect of relaxation, entertainment, education, and social interaction within the car environment.

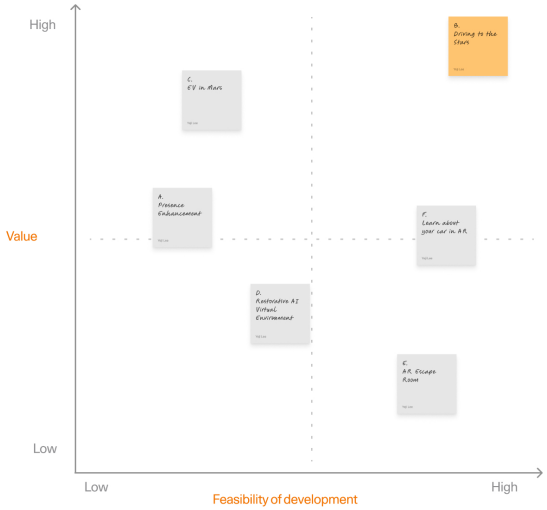


Figure 4: Evaluation on ideas using Prioritization Matrix

- **Presence Enhancement (Figure 3a):** This concept focuses on enriching social interactions and entertainment opportunities within the car by integrating haptic technology. Haptic devices would facilitate activities like social calls, interactive gaming, and even remote massage experiences, fostering a more connected and engaging in-car atmosphere.
- **Driving to the Stars (Figure 3b):** Leveraging AR, this concept envisions transforming Polestar vehicles into simulated spaceships through projecting a space travel on the roof of the car. Inspired by Virtual Restorative Environments and deep breathing practices, users embark on immersive journeys to a star they want to visit. The experience incorporates starry sky and outer space as a virtual restorative environment, personalized actuation based on detected stress levels, and educational content about constellations, catering to a leisure experience for not only relaxation but also gaining new knowledge.
- **EV in Mars (Figure 3c):** This concept involves simulating a driving experience on Mars. Through dynamic driving simulations and haptic feedback, users experience a novel and engaging environment. Additionally, the concept aims to alleviate stress and educate users about the vehicle's capabilities.
- **Restorative AI Virtual Environment (Figure 3d):** This idea harnesses AI to generate personalized virtual environments based on user-selected nature themes, accessible through XR. These immersive environments offer opportunities for relaxation and learning, tailored to the user's preferences and surroundings.
- **AR Escape Room (Figure 3e):** This concept transforms the car interior into an interactive escape room experience using AR technology. By engaging users in solving puzzles and challenges, this concept aims to provide stimulating entertainment and potentially foster cognitive skills development.

- **Learn About Your Car in AR (Figure 3f):** This concept leverages AR technology to empower users with knowledge about their car's functionality. By visualizing various car components through AR glasses, users gain a deeper understanding of their vehicle's operation, fostering a sense of control and confidence.

Each idea was then rigorously evaluated using a prioritization matrix, as visualized in Figure 4. The evaluation considered the project's intended deployment within the next 5-10 years and assessed each concept's strengths and weaknesses, particularly in terms of enhancing the "Coping Self" aspect of wellness and its value to the brand. This process identified *Driving to the Stars* (Figure 3b) as the most promising candidate for further exploration.

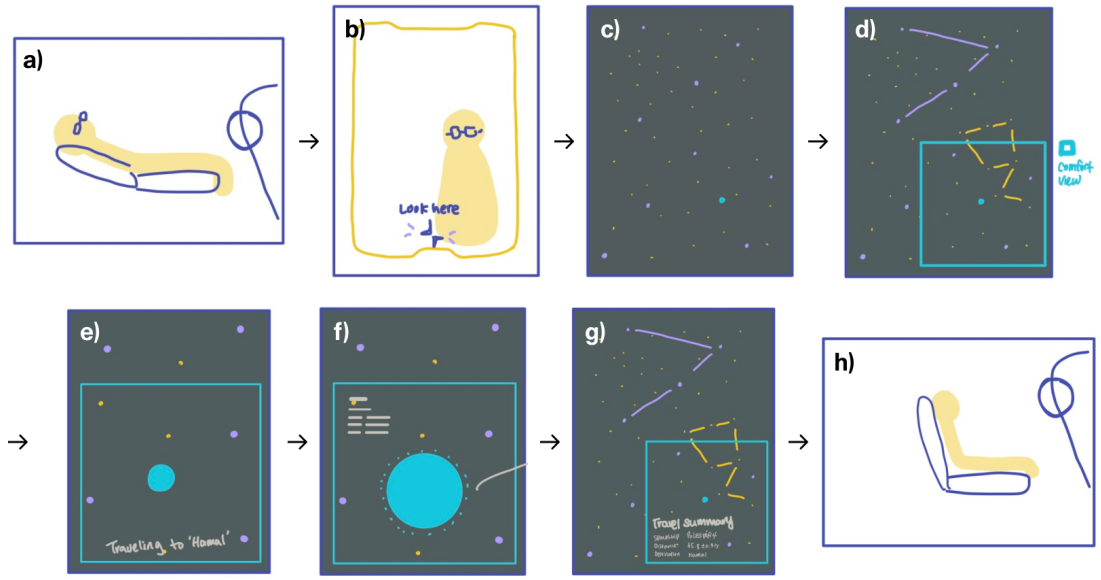


Figure 5: Final storyboard of the user journey

4.2.4 Storyboard of the User Journey. The user journey depicted in the storyboard relies on several technological assumptions (Figure 5). These include the presence of AR glasses within the vehicle, the ability to recline the car seat, a built-in panoramic roof, readily available ambient interior lighting, and smart cabin functionality capable of detecting and learning about the user's stress level.

The user journey unfolds as follows: After plugging the car into a charging station, the user returns to their seat, reclines it, and puts on the AR glasses (Figure 5a). A visual prompt then appears on the panoramic roof, emanating from the Polestar logo and instructing the user to "look here" (Figure 5b). This logo functions as an AR marker, a crucial element for calibrating the AR experience. Upon successful calibration, real-time data of the constellations above the user is displayed through the AR glasses, showcasing a virtual night sky (Figure 5c). A designated star is then selected, prompting the commencement of a virtual journey (Figure 4d). During this journey, the visualization, centered within the user's comfortable viewing field, simulates travel through the cosmos, ultimately arriving at the chosen star (Figure 5e). The chosen star initiates a gradual dimming and brightening visualization, accompanied by tactile actuation that gently nudges the user toward deep breathing (Figure 5f). The rhythm of the prompts personalizes to the user's stress level, as detected by the car's system. As the car finishes charging, the virtual journey returns the user to Earth, signifying the completion of the charging process (Figure 5g). Finally, the user sits up, removes the AR glasses, and exits the car to disconnect it from the charging station (Figure 5h).

4.3 Autobiographical Design

This section details the iterative design process undertaken. The approach involved a series of self-experiments focused on recreating a sense of interstellar travel that aims for promoting wellness within the vehicle.

4.3.1 Initial Exploration on Visualization. The journey began with a simple observation: watching a star travel video while reclined, mimicking a potential car seat position. The video, played on a 11-inch tablet pc positioned on the top of my head, depicted a journey from Earth, past stars and planets, offering a glimpse into the vastness of space. This is part of my diary notes after trying it for the first time:

> *"Surprisingly, it actually felt like flying and was more mesmerising than watching while sitting at a table. As I gazed at the countless stars passing by, I couldn't help but ponder the vastness of the universe and my own insignificance within it. Yet, amidst this vastness, I found myself appreciating the complexity of our world and society, being reminded from the outer universe [...]"*

Subsequent trials involved replicating the setup in an actual Polestar vehicle, using a tablet affixed to the roof. The confined space of the car enhanced the immersive quality, further reinforcing the concept of a spaceship journey. Importantly, the experience consistently evoked feelings of relaxation and self-awareness as found in the notes after trying it in the car setup:

> *"Compared to the initial trial, there were fewer surprises throughout, but a heightened sense of self-awareness and self-acceptance emerged. For instance, I felt gratitude for being part of a planet like Earth, abundant with resources amidst the vastness of space, and because of the nature of the car space being separated from the external, it made the experience to be more relaxing and meditative [...]"*

These initial experiments confirmed the potential of the virtual environment, which involves gazing at and traveling through the stars while reclined, to foster feelings of relaxation and self-awareness similar to the effects observed in Virtual Restorative Environments (VREs). The experiments highlighted this visualization's potential to evoke a sense of wonder and introspection within a car environment.

Building upon the established effectiveness of the virtual environment, the design process then focused on incorporating user interaction to further enhance relaxation. A simple scene was created in Figma featuring a prominent star that dimmed and brightened rhythmically for four seconds each over eight minutes. This cycle mirrored the pattern of box breathing, a recognized stress management technique utilized even in the U.S. military [6]. Self-experimentation within a car environment observed a distinct shift towards a more relaxed state as I focused on the pulsating star. The rhythmic dimming served as a subtle cue for deep breathing, resulting in a calming effect akin to the pre-sleep or meditative state. Interestingly, a sensation of warmth arose even though the car's temperature remained constant. Furthermore, I could feel the thoughts gradually transitioned away from earthly concerns, replaced by a heightened sense of focus on the internal experience. This experiment confirmed the potential of the designed visualization for promoting relaxation and deeper breathing.

However, these experiments revealed several areas that need refinement. The absence of sound effects emerged as a significant shortcoming, diminishing the immersive quality of the experience and making it challenging to focus and fully engage. Synchronized background audio that enhances the immersive experience and fosters a sense of leisure seemed to be beneficial, enabling users to feel present in the simulated environment rather than their actual surroundings. Moreover, without any form of guidance, the transitions between scenes felt abrupt and distracting, coupled with the lack of cues about the remaining duration of the scene. To address this, incorporating voice prompts to guide users through the journey seemed beneficial in mitigating this distraction. Additionally, a major discomfort was the neck strain I experienced from looking at the roof, even with the seat reclined. This physical

strain underscored the importance of exploring support and tactile stimulation for the neck, a topic elaborated upon in the later sections.

4.3.2 Integrating Multi-Sensory Elements. The next phase of the design process focused on incorporating tactile elements to enhance the relaxation experience. Initial exploration involved experimenting with various materials, including air-dry clay, air cushions, soft rubber balls, and bouncy balls (Figure 6). Actuation on different body areas was investigated, beginning with the back. However, actuation on the back proved to be less effective due to the need for stronger forces to overcome body weight and achieve a noticeable effect.

Figure 6: Material Exploration

Shifting the focus to the neck region, the design rationale considered the natural movement of the neck during deep breathing and the potential for acupressure to induce relaxation. This concept aligned with findings from the ideation workshop, where participants reported acupressure as a technique that aided relaxation. Experimentation involved manual actuation on various neck locations while in a similar set up in the car while watching the designed visuals from the tablet PC attached to the car roof. The upper neck region, specifically the curve before the head, emerged as the most effective area for promoting deeper breathing and relaxation. Subsequently, the exploration transitioned towards actuated objects. Soft and bouncy balls proved unsuitable due to their inability to conform to individual neck shapes and provide consistent pressure. Air-dry clay, however, offered more flexibility in shaping, leading to the development of "breathing in/out" shapes for the neck – one slightly thicker than the other – designed to fit the user's neck and provide a sense of gentle support during inhalation and exhalation (Figure 7a). Nonetheless, recognizing the limitations of a personalized clay design, particularly the difficulty in finding a shape that fits different individual's necks, inflatable air pillows were explored as a more adaptable solution.

Initial experiments with the inflatable air pillows involved mechanical actuation through manual manipulation, pushing the pillow up and down. While this approach provided a sense of neck support, it revealed limitations in air distribution within the pillow, resulting in a weaker sensation of support and relaxation around the neck. Further refinement involved pneumatically stimulating the neck by concentrating air in the central region to replicate an "embracing" sensation. This iteration successfully linked air movement with the concept of nudging for deep breathing, creating the feeling that the pillow was breathing together with the user.

Having identified an optimal neck actuation method, the design process focused on creating a low-fidelity prototype using air pillows. Exploration involved connecting 2 strings to a partially inflated pillow and pulling them to concentrate air in the center (Figure 7b). While this approach stimulated the neck with nice and gentle touch, limitations in size and actuation force became apparent due to the pillow being pushed by the head region,

(a) Exploration on forms (b) Initial prototype (c) Prototype with linear actuator

Figure 7: Exploration on forms and prototypes

which added weight to the pillow. Subsequently, the exploration shifted towards a single-sided push mechanism utilizing a 3d printed linear actuator driven by a servo motor and Arduino [45] with a smaller-sized pillow (Figure 7c). However, this prototype generated significant noise during operation due to friction within the actuator, disrupting the relaxation experience, despite the size and actuation method being optimal. To prioritize testing the felt experience over complex mechanics within the scope of this thesis project, a "Wizard-of-Oz" approach was decided to be adopted for later user study on tactile stimulation. This method focused on the user's felt experience of the pneumatic pillow rather than the intricacies of the actuation mechanism.

Leveraging the exploration of tactile elements, the design process investigated the potential of integrating other available senses such as auditory and ambient cues to further enhance the relaxation experience. Reflecting on the initial experimentation, which highlighted how the absence of audio detracted from the immersive experience of the interstellar travel visualization, synchronized background audios were added for further experiment. This included the sound of an engine starting as the scene transitioned into spaceflight, accompanied by low-volume machine noises replicating a spaceship's operation. As expected, these subtle additions heightened the immersion within the environment, potentially enhancing the relaxation effects of Virtual Restorative Environments (VRE) during the star-traveling experience.

Furthermore, during the scene where the spaceship arrives at the star and facilitates interaction with it, aiming to induce deeper relaxation, I noticed that the soothing, meditative audio could be used to enhance immersion into a deeper state of relaxation rather than the realistic background sounds used during the star travel. Consequently, I incorporated recordings of sound bowls, also known as gong sounds, commonly utilized in yoga and meditation practices. Using the same setup within the Polestar vehicle as in previous experiments, I experimented with this iteration with the complete experience incorporating the visuals and the tactile stimulation on the neck. Through this experiment, I found that it effectively facilitated a more rapid transition into a relaxed state. Especially when combined with the tactile stimulation on the neck and the visualization of the star, the scene encouraged me to focus more on myself and the calming environment. The gong sounds also nudged me into deeper breathing, as they harmonized well with the deep breathing sound I was producing. Additionally, recalling the need for audio guidance to mitigate distractions arising from not knowing what's going on, I integrated a narrative voice using VoiceMod, an AI text-to-speech tool, to offer general context throughout the interstellar journey. This enhancement significantly improved the understanding of the experience's context.

Finally, taking into account the ambient interior lighting available in current Polestar vehicles, I explored integrating Polestar's existing ambient lighting within the design concept. Considering the peripheral vision offered by AR glasses, I envisioned the car's interior lights synchronizing with the visuals playing overhead. Unlike prior experiments, this concept was evaluated within a VR simulator, as the prototype was developed enough to be tested. Within

the immersive environment in the simulator, the synchronized lighting pulsed and flowed in harmony with the visualizations of the panoramic roof, fostering a powerful sense of connection between myself, the car, and the interactive experience. It transcended a mere add-on; instead, it felt seamlessly integrated, enhancing the overall interaction without any intrusive or distracting elements. This visceral experience solidified the decision to incorporate synchronized ambient lighting into the final design.

5 FINAL DESIGN

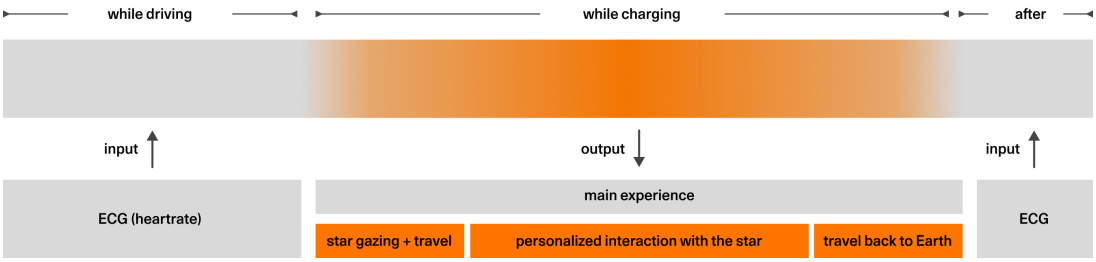
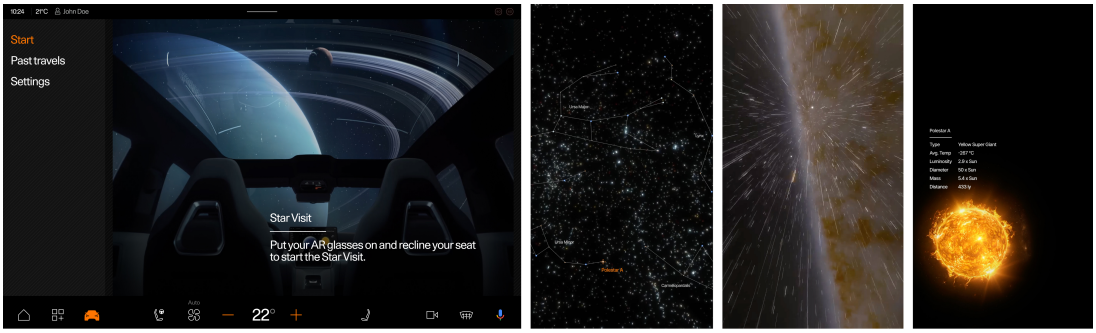


Figure 8: System diagram of Star Visit

The final design concept is 'Star Visit,' a wellness system designed to enhance the car charging experience by transforming this typically mundane task into an opportunity for taking care of user wellness, encapsulated by the concept of "Charge yourself while the car charges" (Figure 8). As illustrated in Figure 8, the system begins by recognizing the user's stress level through either the car's built-in ECG (Electrocardiography or heartrate) sensor or a connected wearable device that measures ECG while the car is in motion. When the car requires charging, and the user plugs in the vehicle at the charging station, the central display in the car suggests initiating the 'Star Visit' program once the user returns to their seat.



(a) Start screen in the central display (b) Star gazing scene (c) Star traveling scene (d) Scene at the star

Figure 9: Start screen and screenshots from the main experience

Upon the user's selection to begin, the system prompts them to put on AR glasses and recline, initiating the user journey of the main experience detailed in Section 4.2.4 (Figure 9a). During the main experience, the user sees a projection of the real-time starry night sky as demonstrated in Figure 9b on the panoramic roof through the AR glasses (Figure 10). Then, the system designates a star directly above the user as the destination, accompanied by a voice prompt: "Your travel to [Star Name] will start soon. Relax and enjoy the travel." This is followed by the sound of a spaceship engine starting. The virtual journey to the star lasts approximately three minutes, as depicted in

Figure 9c. Upon arrival, the system announces, "We arrived at [Star Name]," followed by a calming gong sound typically used in yoga sessions. The star then appears closer, providing basic information such as its name, type, average temperature, luminosity, diameter, mass, and distance from Earth, initiating the interaction phase (Figure 9d). The star rotates slowly, synchronizing its light intensity with the pneumatic stimulation in the user's neck, implicitly encouraging slower breathing. This rhythm is tailored based on the stress and fatigue data collected by the smart cabin system, and the duration of this phase is aligned with the car's charging time. As the charging process nears completion, the system notifies the user with, "We will travel back to Earth soon". The return journey mirrors the initial travel experience, lasting another three minutes with the same audiovisual elements. Finally, the system concludes with, "We are back on Earth now. Your car has finished charging," signaling the end of both the virtual journey and the car charging process.

Figure 10: Main experience simulation in VR

6 USER STUDY

6.1 Prototype & Apparatus

(a) VR environment **(b) Set up with car simulator and Meta Quest 3**

Figure 11: User study setup

The user study focused on evaluating the main part of the experience, where the user had already plugged in the car and returned to their seat. For this study, a prototype was adjusted to simulate the experience for 20 minutes. Since the emphasis was on assessing somatic sensations during the experience, certain elements such as AR marker recognition and travel summary display were excluded. Additionally, instead of personalizing the rhythm of the

visual-tactile stimulation to prompt slower breathing based on individual stress levels, as would be done in the final design concept, a standardized sequence of 4-second inhalations and exhalations was used for a duration of 12 minutes while interacting with the star. The pneumatic neck pillow was manually actuated by the researcher in a wizard-of-oz manner. The VR car simulator was utilized to simulate visualizations on AR and mimic the interior and ambient lighting of the vehicle. Within the virtual environment of the VR simulator, the interior of a Polestar 4 was depicted, and the car was simulated to be parked in a parking lot after sunset (Figure 11a). The study was conducted in an XR room located at Polestar Design HQ, using the Meta Quest 3 for the VR experience (Figure 11b).

6.2 Procedure

Upon arrival, participants were provided with a brief overview of the study. They were introduced to the study procedures, their rights, and the option to withdraw from the study at any time. Participants were also informed that they would be testing an AR experience using a VR simulator and were asked to imagine wearing AR glasses instead of the VR headset. Subsequently, participants filled out a baseline body map, reflecting their current physical and emotional state.

The researcher then assisted participants in VR setup, ensuring proper seating, VR headset fitting, and optimal environment adjustment. Participants verified the VR experience quality by reading text on the central display and reclined comfortably for an 18-minute immersive journey projected onto the car's panoramic roof. As the journey progressed, the researcher manually adjusted a neck pillow in sync with visual cues.

Post-experience, participants completed a body map and soma trajectory to document their sensations after the experience and relaxation-stress trajectory. Then, a semi-structured interview explored their experience, focusing on body maps, soma trajectories, multi-sensory experiences, and potential distractions. Participants then shared additional comments before concluding the study.

6.3 Result

The thematic analysis of participant data, which included body maps, soma trajectories, coded video data on physical responses, and transcribed interview recordings, provided insights into the subjective experiences and somatic sensations elicited by the designed in-car wellness system. As the study aimed to promote wellness through enhanced coping mechanisms, the following results explore how participants managed stress and achieved relaxation during the experience. Therefore, this section delves into the felt experience and resulting somatic sensations, ultimately revealing three key themes that emerged from the analysis: sensation of deep relaxation, traveling away from reality, and harmony of multisensory elements. Moreover, the analysis revealed participants' reflections on AR and VR technology, as well as their enthusiasm for the design itself. These findings will be explored in detail in the following sections.

6.3.1 Sensation of Deep Relaxation. The dominant theme identified through participant data was the experience of deep relaxation. This finding is particularly evident in the body map data, where most participants explicitly reported feeling more relaxed after the VR experience compared to before. Soma trajectory data corroborates this, indicating a general trend of participants feeling more relaxed at the end compared to the beginning, despite variations in the reported levels of relaxation. In particular, the body map data showed a pre-intervention trend of "heavy," "stressed/tired," and "asymmetric" feelings, shifting to "light," "relaxed," and "symmetrical" post-intervention. Additionally, video analysis highlighted the recurring theme of participants achieving deeper and slower breaths, particularly when prompted to focus on the star with the neck touch, calming audio, and star visualization.

Participants described a progressive relaxation of their bodies, with specific mentions of tension dissolving in legs and neck. Participant B exemplifies this sentiment, stating:

> *“I was really enjoying that I could feel my legs relaxing more and more and then at some point also my arms got more relaxed overtime. So it slowly went from a more stressed position, keeping everything straight like tightening the core, but then especially while at the star you come to relax a lot more and it’s like you can feel you’re becoming more mellow and then you melt down in the seat. And that was particularly on my legs. And then with the pillow, it made me more and more relaxed in the neck.”*

This relaxation extended beyond the physical body, with participants reporting a sense of letting go of thoughts and worries. Participant H described it as *"Leaving all other thoughts outside and just be in the moment in, in that space"*, while Participant A referred to it as entering a *"meditative bubble"* or achieving a meditative state, fostering a sense of presence in the moment.

The intervention also facilitated deep relaxation through nudges for deeper breathing. Video analysis revealed a consistent pattern among participants who experienced the system without technical difficulties. Initially, they were curious, looking around during the traveling phase. However, as the gong sound resonated with tactile stimulation on the neck, the mood became calmer, and the participants took deeper breaths during the ten-minute immersion in the star’s presence. Specifically, participant I elaborated on this experience while walking through their soma trajectory:

> *"At the star I felt more and more relaxed. It felt sort of like a meditation practice together with the music. Also with the touch feeling, that was really nice. It got me breathing deeper and space out a bit [. . .] The touch nudged me into breathing in the same pattern as the lighting and dimming of the star, so I really enjoyed that. I think that added a lot to the experience actually, and the relaxation experience."*

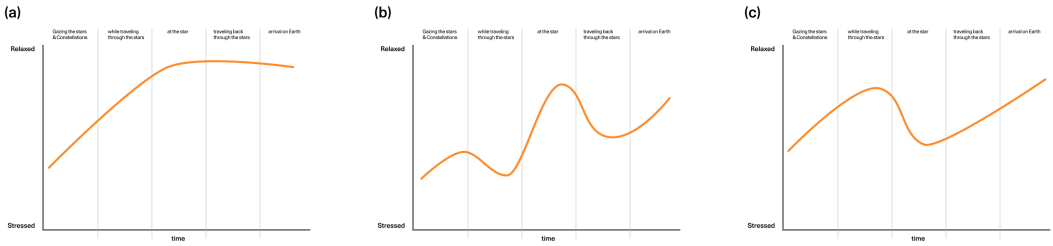


Figure 12: Three trends of soma trajectory

The specific moment of deepest relaxation during the intervention varied between participants, with the "while traveling" and "at the star" phases emerging as the most common points. Three distinct trends were identified through soma trajectory data (Figure 12).

Six out of eight participants reported feeling the deepest relaxation during the "at the star" phase, with four participants mostly maintaining this feeling of relaxation until the end of the main experience (Figure 12a). However, two participants indicated feeling less relaxed while traveling (Figure 12b), attributing it to the pixeled VR visualization.

Two other participants identified the "while traveling phase" as more relaxing than other phases (Figure 12c). Both found the "at the star" phase to be more stressful, citing the audio as being too loud, particularly the long gong sound, and expressing boredom with staying focused on one star and its visualization for an extended period. Despite their preference for the traveling phase, notes taken from video recordings revealed that these participants also achieved slower and more relaxed breathing patterns compared to the beginning of the experience, aligning with the general trend observed in other participants.

6.3.2 Traveling Away from Reality. Another prominent theme that emerged was the immersive travel experience and its contribution to feelings of escape from reality and the creation of a personal space. Participants consistently reported a feeling of being transported to a different location, removed from their immediate surroundings. This escape was perceived positively as a means of disconnecting from daily pressures, as exemplified by Participant C:

> *"I think it made you feel like you were somewhere else right away,[...] I would say it did actually feel like you went away somewhere you didn't feel like you were on Earth in a way, instead, you felt like you were traveling through space and then looking at a big star, which is also quite positive because you kind of take yourself away from everything so that was nice."*

Similarly, Participant H emphasized the positive aspects of escape, describing it as *"I liked the relaxing feeling the most, the overall relaxing feeling that I had was just to be like you are in your bubble"*

By amplifying the sense of escape from reality and fostering the creation of personal space, the intervention also notably condensed perceived time. Participants reported feeling as if the experience was shorter than the actual duration due to the sensation of traveling during the charging period. Participant I elaborated on this phenomenon:

> *"The traveling made it feel like the time was shorter. I would think that if I was actually charging a car and sitting there, I would feel that the time would feel shorter which nicely added to the experience that we actually traveled somewhere."*

6.3.3 Harmony of Multisensory Elements. Another common thread emerging from the analysis was the significant contribution of harmonious multisensory integration (audio, visual, and tactile) to the positive user experience. When directly asked if any elements were distracting, all participants reported a sense of well-balanced design.

Visual Immersion. The visual component was generally well-received for its immersive qualities, directly conveying the in-car experience. Participants, however, expressed a preference for seeing the main travel animation from their own perspective, rather than a central viewpoint, which aligns with ergonomic comfort during the simulated journey. Participant B exemplifies this sentiment:

> *"I had the feeling like I wanted to lower my seat even more or lay completely flat so that I could see the whole scene. I didn't have the view all the way in the back, but I felt that a lot of the action was happening there so that bothered me in the travel parts."*

Tactile Integration. The tactile stimulation on the neck through an inflating neck pillow generally received positive feedback, with some participants even mentioning it as one of the most enjoyable aspects of the experience. Participants described it as complementing the overall experience, adding to comfort, and enhancing relaxation through a massaging sensation. Participant C elaborates on this point:

> *"The neck support actually felt quite nice. It felt really relaxing and felt like a massage. Especially the deflating and inflating made you just feel very very relaxed and chilled out, which felt good."*

Participant H further highlights how the neck touch contributed to a relaxing narrative within the experience:

> *"When you have that (the pillow on the neck), and when you are focused on the star, you arrive in the almost asleep phase because you have this feeling of,' You are concentrating on something,' but at the same time it's this relaxing feeling. So it felt relaxed with inflation. Also, you are feeling like you're in space, but at the same time, it stimulates your nerves. And while that's happening, you are focused on trying to understand what's happening and try to build your own story in your mind, and at the same time you have this feeling in the neck, which helps to make the story in your head."*

However, some participants desired a stronger intensity and a larger neck pillow for better support when looking upwards. Participant A states, *"I would like some more support in the neck to complement watching straight to the roof and making my neck stiff."* Moreover, participant B adds, *"It could have been a bit more stronger, but the location was great [...] But for me, the inflation of the cushion could have been a bit bigger so that I felt it more intense in the pressure."*

Audio Stimulation. The participants generally found the audio elements to enhance relaxation during the experience. The gong sounds used during the "staying in the star" phase, however, elicited mixed reactions. Some participants, like Participant A, found it enhanced relaxation:

> *"For me with the sounds, it's like you completely forget that you're in the car where you are, which is super good, I think. It creates this kind of mental bubble [...] There were also people talking in the hallway, but because of the sounds, it blurred that out. I could perceive they were there, but it was far enough away to enter more into this meditation bubble. so, I really liked the gong sounds."*

However, others reported feeling anxious and stressed by the length and volume of the gong sound, as mentioned by Participant E, *"[I disliked] the sound of the gong that was too long and loud. Shorter sounds were fine."* Participant F echoed this sentiment, *"The sound made me feel a bit anxious and sick like you just want to turn it off."*

6.3.4 *Limitation of VR and Potential of AR.*

While the study focused on an augmented reality (AR) system, the testing environment within a virtual reality (VR) headset introduced a distinct theme within participant feedback. When directly asked about any negative aspects of the experience, the most common concern centered on VR quality. Specifically, participants reported jitteriness in some scenes due to the VR headset's lower resolution. These instances, as Participant D describes, detracted from the relaxing experience:

> *"When you're going fast, it was so jittery, so I was starting to feel dizzy. I was feeling like I am at the sea [...] And then the pictures were like, yeah, maybe if it's in a future product [...] The quality of the image was making me kind of dizzy, reducing the relaxation level."*

However, when considering the potential integration of AR technology within Polestar vehicles, participants expressed positive sentiments and envisioned it adding significant value. This positivity is particularly noteworthy given the existing in-car technologies like 3D audio headrests and massage seats since the participants perceived AR as an enhancement when integrated with these existing features. Participant G elaborates on this point:

> *"I think the future is not the complete virtual reality, but a blend in the physical world with digital components. So I feel it's also a good solution for in-car experiences, especially with this kind of program [the Star Visit]. It really goes along with our HMI [Human-Machine Interface], with the different planet light, and ambient lighting as well. And I also think it goes well with the brand concept of Polestar."*

However, the social aspect of AR integration also emerged as a consideration. While participants saw the potential for relaxation during solo charging, they envisioned sharing the experience with others in the car. Participant E particularly highlighted this point:

> *"Instead of using AR or VR, if you can project it directly on the roof, you can enjoy it with other people in the car. I wish the system considered the social aspect of enjoying it with family because we travel together. But otherwise, I think it's a perfect use case for the one individual to have it during the charging time."*

6.3.5 Enthusiasm for Integration. During the semi-structured interview, participants expressed considerable enthusiasm for integrating the designed experience into Polestar vehicles. When prompted for additional comments, their responses echoed this sentiment. Participant I highlighted the potential for a unique and valuable addition:

> *"I think that would be a really nice addition to the car and something very unique. I also think that focusing more on mindfulness is quite important nowadays, also to remind yourself of breathing. And perhaps also adding something more in terms of entertainment using this system would be nice."*

Similar eagerness was expressed by Participant C:

> *"I would like to have it in my car, so I could relax."*

Participant F echoed the desire to see the concept realized:

> *"I am curious to see if it will become reality and what will become reality. It's really cool."*

Finally, Participant G summarized the overall sentiment with a wish for implementation:

> *"I wish this comes to reality."*

7 DISCUSSION

This project explored the design of in-car leisure experiences, with a particular emphasis on wellness, tailored for EVs. Specifically, the project focused on designing with a focus on felt experiences and evaluating the felt experiences facilitated by the final design concept. The comprehensive design process and subsequent user study demonstrated the significant potential of incorporating soma design methods to design felt experiences that promote wellness, especially within the automotive context. The thematic analysis revealed positive themes regarding sensations, with participants reporting experiences of deep relaxation, a sense of escape from reality, and the harmony of multisensory elements enhancing these sensations. These findings indicate that 'Star Visit' has the potential to add value to EVs by contributing to the "Coping Self" dimension of wellness, fostering stress management, and promoting relaxation during what can be a stressful or monotonous experience - charging the vehicle.

7.1 The Role of Soma Design in Creating In-Car Wellness Experiences

Throughout the design and evaluation process, soma design was integral, employing methods such as autobiographical design, body mapping, Soma Bits, and soma trajectories. One key challenge encountered was making soma design, which emphasizes subjective felt experiences, understandable within the automotive industry. Felt experiences are often overlooked in this context, where production and utility-centered approaches dominate. Nonetheless, the use of soma design tools helped bridge this gap by rendering the method more concrete and generating valuable data throughout the design process. This section discusses how these methods contributed to effectively and practically designing and evaluating the user experience.

Firstly, engaging in autobiographical design underscored the importance of capturing subjective felt experiences as a source for iterative design. While individual felt experiences varied, the autobiographical design provided a clear direction for the felt experience, such as offering different forms of relaxation that stimulated various feelings in the somas. All these experiences aimed at effective coping during the limited time available while charging the car. This aligns with previous studies and designs created through first-person perspective design, particularly focusing on early design concepts, demonstrating its effectiveness as a method [26].

Secondly, the body map proved to be an effective tool for sensitizing participants. By requiring individuals to reflect on their body parts and mental states, participants became more attuned to their soma and sensations throughout the workshop and the user study. For instance, during the workshop, participants were encouraged to ideate on how they might feel, focusing on the felt experience in a multi-dimensional way rather than merely brainstorming practicalities,

which is common in traditional ideation workshops. Additionally, the body map facilitated the expression of feelings. Although many initially found it challenging to draw and express their sensations, the exercise prompted deeper reflection on their overall soma. The process of walking through and explaining their body maps provided a visual representation that made it easier for participants to elaborate on their feelings, aligning with previous studies on body maps [3].

Thirdly, although soma bits were not utilized for prototyping in this project, they demonstrated their capacity to ignite creativity across various sensory modalities during the ideation phase. As proposed in the study by Windlin et al. [60], soma bits played a crucial role in enhancing tactile engagement, particularly during the collaborative ideation phase. Imagining physical interactions such as heat pads or vibrotactile stimulation with varying strengths and rhythms can be difficult without direct experience. Soma bits allowed participants to easily experiment and engage with different sensations, facilitating the development of ideas involving multiple senses, particularly those offered by the soma bits.

Lastly, soma trajectories enabled participants in the user study to articulate their felt sensations effectively. The simple visualization method of drawing a line graph to represent their feelings during each phase of the experience allowed for detailed communication of their felt experience. This method proved useful for analyzing data without losing nuance and meaning, which can be challenging to capture merely through verbal expressions as suggested in the previous study [54].

7.2 Enhancing 'Coping Self' with VRE and Deep Breathing Nudges through Multisensory Experiences

The dominant theme of deep relaxation and escapism from reality suggests that the system successfully triggered coping mechanisms, ultimately enhancing the 'Coping Self' aspect of wellness. This aligns with previous studies on VREs that have demonstrated how natural environments in virtual settings can reduce stress and yield psychological benefits [36, 42, 50, 57, 68]. Expanding upon these previous investigations, which primarily concentrated on physiological responses such as heart rate and breath rate, this study employed a multifaceted approach to assess the restorative potential of the designed experience. This included qualitative methods such as body mapping, soma trajectory recordings, video observation, and follow-up interviews, with results strongly suggesting that the experience likely induced relaxation, consistent with previous VRE research. Recalling some results, body map data revealed a clear trend: participants shifted from reporting feeling of heaviness, stress, and asymmetry on their soma to sensations of lightness, relaxation, and symmetry. Soma trajectories further supported this, demonstrably showing participants' relaxation deepening throughout the experience.

Unlike previous studies [35, 36, 42] that examined the effects of VREs in cars while the cars were moving—introducing variables such as car sickness, which can mitigate restorative effects—this study focused on the stationary car environment during charging. This context is particularly relevant for EVs, offering an ideal scenario for integrating VRE benefits that has not been explored previously. Furthermore, although the design concept was evaluated using a VR simulator, it also explored AR technology for delivering the restorative effects of VREs, thereby extending the application of VREs to AR. Although it is premature to conclude that AR can match VR in its effectiveness, the findings indicate positive potential for AR in this context.

The study also highlights the significant potential of multisensory systems like 'Star Visit' to promote deeper and slower breathing, supporting previous research [7, 14, 20, 41, 44]. Thus, it is evident that the positive effects of 'Star Visit' to promote deep breathing indeed contribute to the 'Coping self', since activation of deep breathing enhances stress tolerance with both psychological and physiological effects [12]. Although the specific interaction and contribution of each multisensory aspect to the observed calmer breathing remain unclear, insights from past

studies provide valuable context. For example, the BrightBeat system, utilizing visual and audio stimulation, was found to promote slower breathing [20], while the aSpire system, designed as a pneumatic tactile stimulation device for car users, was observed to have a positive impact on breathing patterns [14]. Therefore, it can be inferred that in 'Star Visit,' the brightness of the star and the meditative audio served as implicit cues to synchronize breathing with the visualization, while the neck pillow provided pneumatic stimulation, effectively engaging their tactile senses to enhance the relaxation experience. As a result, the combination of these elements, particularly with 'Star Visit' incorporating more harmonious modalities than in previous research, likely facilitated slower and calmer breathing throughout the experience.

7.3 Importance of Personalization and Adaptability in In-car Multisensory Systems

The research findings emphasize the importance of accommodating individual preferences in multisensory experiences. While the majority of participants found the sound of bowls, referred to as 'gong sounds,' relaxing, some reported experiencing anxiety. This highlights the need for personalization options within the system, allowing users to adjust audio elements to suit their preferences. Similarly, the tactile stimulation provided by the neck pillow was generally perceived as relaxing, but variations in body shapes and preferences for stimulation intensity revealed the necessity for personalization. This variability can significantly impact comfort and effectiveness. Additionally, individual preferences regarding the duration of engagement with specific stars varied, with some participants expressing boredom after prolonged exposure, while others found the experience relaxing and pleasant. This indicates the importance of offering users the freedom to explore different experiences within the same timeframe.

Furthermore, the study unveiled the possibility of variations in individual environments, emphasizing the need for system adaptability. Whether charging occurs at night in dark surroundings or during the day in bright conditions, an adaptable system is essential to optimize user experiences across diverse environmental contexts. Therefore, integrating personalization and adaptability features is crucial in designing an in-car multisensory experience to effectively assist stress management and alleviate boredom during the typically mundane EV charging process.

7.4 Ethical Consideration

While soma design strives for a better life for all somas, its application to certain domains, such as the automotive industry, could open up ethical tensions that require further discussion. The automotive industry has been deeply associated with environmental degradation and social inequity. This study focused on EVs as a more sustainable alternative to traditional petrol or diesel vehicles due to their lower emissions and potential for renewable energy integration. Yet, it is worth touching upon the tensions arising from applying soma design method for an EV car brand striving for a high-end luxury driving experience.

Therefore, research and design efforts should aim to bridge the gap between the principles of soma design and the realities of the automotive industry, exploring how soma design can contribute to more sustainable and equitable transportation solutions. One potential approach could be to collaborate with individuals from diverse backgrounds, accommodating different somas and felt experiences throughout the design process. This approach can be beneficial in enriching the in-car experience for individual users while taking into consideration the interpersonal and environmental relations that they are embedded in. For instance, both during the ideation workshop and evaluation part of the design process sought to incorporate this approach by involving more women participants to ensure the gender diversity. This helped consider more diverse perspectives and insights based on individual experiences.

8 LIMITATIONS & FUTURE WORK

Notable limitation of the study arises from the use of VR simulator to replicate AR experiences, posing challenges due to the disparity in visual fidelity between VR headsets and AR glasses, as well as inherent discrepancies in user experience stemming from the hardware itself. Notably, discomfort reported by several participants while wearing the VR headsets may have influenced their overall felt experience during the study, while limitations inherent in VR technology could have impacted visualization quality, potentially diminishing participants' immersion in the simulated environment. Moving forward, a more authentic assessment of the holistic felt experience could be achieved by evaluating the system with AR glasses in real-world in-car scenarios, providing a more accurate representation of the system's performance, including its interaction with actual car systems such as the audio system and ambient lighting.

Furthermore, participant feedback emphasized the importance of considering the social aspect of AR integration in in-car experiences, urging future iterations to focus particularly on scenarios where multiple individuals are engaging with the concept within the vehicle. Developing AR experiences that foster shared enjoyment among passengers holds promise in enhancing in-car relaxation experiences, fostering a sense of connectivity, and communal enjoyment while also attending to individual wellness needs.

Moreover, conducting additional research into offering personalized options for the multisensory system, such as customizable audio concepts, adjustable neck pillow sizes, and providing the opportunity to explore different stars during the experience instead of staying fixed on one, would provide valuable insights into catering to individual preferences and enhancing system adaptability. These considerations highlight the importance of addressing social dynamics and personalization in future iterations of the in-car relaxation system, ensuring that it meets the diverse needs and preferences of users. In addition, assessing the adaptability of AR technology to external environments, including daylight settings and various driving conditions, is crucial for realistic implementation in cars. Testing the system's performance across different environments would ensure its functionality and user experience across diverse real-world scenarios.

9 CONCLUSION

In summary, this thesis has shed light on the potential of in-car leisure experiences to promote wellness, with a particular focus on designing and evaluating an in-car leisure experience tailored for electric vehicles during charging sessions. Through the application of soma design methods within a RtD framework, this research has demonstrated the effectiveness of designing experiences that leverage subjective felt experiences to enhance wellness within the automotive domain. Positive user feedback, emphasizing deep relaxation and a sense of escapism, validates the system's ability to enhance the "Coping Self" dimension of wellness, especially during the typically mundane task of vehicle charging, while also adding value to the essential user journey of the EV.

The study also revealed that a harmonious multisensory experience, incorporating visual, audio, and tactile elements, significantly contributed to enhancing relaxation. In the realm of AR and VR technology, AR technology demonstrated better potential for in-car relaxation among participants, mitigating concerns such as motion sickness and discomfort associated with VR headsets, while also prompting considerations regarding its social aspects. Furthermore, participants expressed anticipation for the final design's integration into future Polestar vehicles. They perceived the system as enhancing the in-car experience while aligning seamlessly with existing Polestar features. Notably, the feasibility of implementation is bolstered by the fact that most required systems are already present in the vehicle.

Moving forward, this study lays the foundation for future research endeavors in the field of in-car wellness innovations. Identified constraints, including AR integration complexities, and the need for enhanced customization

and adaptability, present opportunities for refinement and expansion. Future investigations should aim to address these limitations by testing the design in real-world scenarios on an AR platform, refining AR integration for seamless social interactions, and prioritizing personalization and adaptability to cater to individual needs and environmental dynamics. By embracing these imperatives, upcoming iterations of in-car leisure experiences can aspire to elevate wellness, user satisfaction, and comfort, thus enriching the driving experience for EV owners in a holistic manner.

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This thesis investigates the design and evaluation of an in-car leisure experience to enhance user wellness during electric vehicle (EV) charging. Amidst the rapid transformation of the EV market, driven by technological advancements such as Extended Reality (XR) and biosensors, the project seeks to create engaging in-car experiences that transcend traditional transportation. Using soma design principles within a Research-through-Design (RtD) framework, the study introduces a multisensory strategy to foster wellness, leveraging the benefits of Virtual Restorative Environments (VRE) and deep breathing. Designed within the context of Polestar, a luxury EV brand, a final design concept, aptly named 'Star Visit', integrates visual, auditory, and tactile stimulation. During the final evaluation conducted with 10 participants, the design revealed profound somatic sensations centered on deep relaxation and escapism, with harmonious multisensory elements enhancing these experiences. Additionally, the study identified the limitations of VR and the potential of AR for in-car applications, along with user expectations and enthusiasm for integrating the system into Polestar vehicles. Key findings underscore the efficacy of the soma design method, the design's potential to contribute to the "Coping Self" dimension of wellness through bringing benefits of VREs and deep breathing, and the necessity for personalization and adaptability in multisensory systems to accommodate diverse user preferences and environmental variations. By embracing these insights, the research sets the stage for future advancements in in-car wellness experiences, enriching the overall user experience in electric vehicles.

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Denna avhandling undersöker design och utvärdering av en in-car fritidsupplevelse för att förbättra användarens välbefinnande under laddning av elfordon (EV). Mitt i den snabba omvandlingen av EV-marknaden, driven av teknologiska framsteg som Extended Reality (XR) och biosensorer, syftar projektet till att skapa engagerande in-car upplevelser som går bortom traditionell transport. Genom att använda soma designprinciper inom en Research-through-Design (RtD) ramverk, introducerar studien en multisensorisk strategi för att främja välbefinnande, utnyttjande fördelarna med Virtuella Restorativa Miljöer (VRE) och djupandning. Designad inom ramen för Polestar, ett lyxmärke för elfordon, integrerar ett slutgiltigt designkoncept, lämpligt namngivet 'Star Visit', visuell, auditiv och taktil stimulans. Under den slutliga utvärderingen genomförd med 10 deltagare, visade designen djupa kroppsliga sensationer centrerade på djup avslappning och eskapism, med harmoniska multisensoriska element som förstärkte dessa upplevelser. Dessutom identifierade studien begränsningarna av VR och potentialen hos AR för in-car applikationer, tillsammans med användarnas förväntningar och entusiasm för att integrera systemet i Polestar-fordon. Viktiga fynd understryker effektiviteten av soma designmetoden, designens potential att bidra till dimensionen "Coping Self" av välbefinnande genom att erbjuda fördelarna med VREs och djupandning, samt nödvändigheten av personalisering och anpassningsbarhet i multisensoriska system för att tillgodose olika användarpreferenser och miljövariationer. Genom att omfamna dessa insikter, banar forskningen väg för framtida framsteg inom in-car välbefinnandeupplevelser, vilket berikar den ö vergripande användarupplevelsen i elfordon.

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bilbaserad fritidsupplevelse, välbefinnande, multisensorisk, förstärkt verklighet, soma design
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