Immersion in Digital Nature

Exploring the Role of Skin Sensing as a Means of Simulating a Natural Environment

Graduation Project Bsc Creative Technology 2024

Supervisor: Josca van Houwelingen-Snippe

Critical observer: Marcello Gómez Maureira

Jansen, S.A. (Sarah, Student B-CREA)

s.a.jansen-1@student.utwente.nl

16-07-24

Acknowledgements

Completing this thesis has been a challenging yet rewarding journey, and it would not have been possible without the support and guidance of several individuals.

First and foremost, I would like to express my gratitude to my supervisor, Josca van Houwelingen-Snippe. Her dedication, insightful guidance, and unwavering support have been invaluable throughout this process. Josca, your trust in my abilities and your encouragement, especially during times when I doubted myself or my work, have truly pulled me through. Your expertise and patience have not only helped shape this thesis but have also significantly contributed to my personal and academic growth.

I am also very grateful for my critical observer, Marcello Gómez Maureira. Your critical approach often challenged me to think deeply about the "why" behind things, leading to a more thorough and robust research. Your dedication to my success and your willingness to provide support at every stage have been immensely appreciated.

To my friends and housemates, thank you for your constant support and encouragement. Whether it was proofreading my drafts, assisting with user tests, or providing much-needed mental support, your help has been invaluable. You have been my rock during this journey, and I am incredibly thankful for each one of you.

Finally, I would like to acknowledge my parents. Your love and encouragement have been a constant source of strength. Your belief in me has been a powerful motivator, and I am grateful for your support.

Abstract

This thesis explores the role of skin-based sensory inputs on the immersion of participants in a simulated natural environment. By incorporating stimuli such as wind, warmth, and humidity, the research aims to replicate the tactile sensations of natural settings and evaluate their impact on user immersion. The methodology involved a controlled experiment with nineteen participants who experienced both a baseline condition and a condition with added tactile stimuli. Data collection was conducted through semi-structured interviews and observational notes, focusing on the perceived immersion and emotional responses of the participants. The analysis revealed that wind and warmth significantly improved the sense of presence and engagement, while humidity had a lesser impact. These findings suggest that integrating tactile feedback into digital nature experiences can enhance their realism, thus improving immersion. The research contributes to the understanding of integrating skin-based stimuli in virtual environments, which can aid in future implementation of these stimuli in research and design.

Table of Contents

Acknowledgements 1
Abstract 2
Table of Figures 5
1. Introduction 6
2. Background Research 7
2.1 Related work 7
2.1.1 Literature Review 7
2.1.2 Theoretical Framework 9
2.2 State of the art 12
2.2.1 Using nature's benefits to increase wellbeing 12
2.2.2 Creating immersive experiences 13
2.2.3 Using tactile stimuli for immersion 14
3. Methodology 15
3.1 Research Objective 15
3.2 Hypothesis 15
3.3 Experimental Design Outline 15
3.3.1 Environment 15
3.3.2 Guidance for participants 16
3.3.3 Stimuli 17
3.3.4 Story 18
3.4 Participants 19
3.5 Data collection 19
4. Specification 20
4.1 Materials and Tools 20
4.2 Experiment Procedure 20
4.3 Interview Procedure 21
4.4 Timeline 21
5. Realisation 22
5.1 Set-Up 22
5.1.1 Location 22
5.1.2 Devices used 23
5.2 Roster 25

5.3 Briefing 25
5.4 Interviews 25
5.5 Observations 25
6. Results/Evaluation/Analysis 26
6.1 Identifying themes 26
6.2 Coding 27
6.3 Analysis 28
6.3.1 General High Levels of Immersion 28
6.3.2 Reactions to Wind Stimulant (wind) 28
6.3.3 Reactions to Lamp Stimuli (warmth) 28
6.3.4 Reactions to Humidifier Stimuli (cold) 28
6.3.5 Emotional and Physical Responses 29
6.3.6 Comparison of Sessions and Order Effects (A-B/B-A) 29
6.3.7 Suggestions for Improvement 30
6.3.8 Technological Issues 30
7. Discussion & Future Work 31
7.1 Discussion of results 31
7.1.1 Different reactions to stimuli 31
7.1.2 Influences of imagination and other senses 31
7.1.3 Influences of expectations, novelty and familiarity effects 32
7.1.4 Higher immersion and bridging the gap 32
7.2 Discussion of process/decisions 33
7.2.1 Study Design and Environment 33
7.2.2 Sensory Feedback 33
7.2.3 Timing, Realism, and Balancing 33
7.2.4 Participant Considerations and Ethicality 34
7.2.5 Researcher Role 34
7.3 Future work 35
7.3.1 Immersion and Multisensory Experiences 35
7.3.2 Identifying and Refining Design Principles 35
7.3.3 Exploring Applications of Skin-Based Sensory Inputs 35
7.3.4 General changes 35
8. Conclusion 36

9. References 37
Appendix A 41
Appendix B 42
Appendix C 44
Appendix D 45
Appendix E 46
Appendix F 49
Appendix G 51
Appendix H 85

Table of Figures

Figure 1. Schematic of the skin anatomy with cutaneous sensory receptors. Source: [20] 10
Figure 2. Qwiek.up in use for older adult care Source: [25] 12
Figure 3. Zwitscherbox Oak Source: [26] 12
Figure 4. Calm app interface Source: Adapted from [27] 12
Figure 5. Immersive art experience Source: [28] 13
Figure 6. Half Life Alyx Source: adapted from [29] 13
Figure 7. Star Wars: Galaxy's Edge Source:[30] 13
Figure 8. SenseGlove Nova 2 Source: [31] 14
Figure 9. PS5 DualSense controller Source: [32] 14
Figure 10. 4D movie Source: [33] 14
Figure 11. Sketch of experiment setup 16
Table 1. Overview of experiment stimuli 17
Table 2. Needed materials for Participant 20
Table 3. Needed materials for Researcher 20
Table 4. Needed materials Miscellaneous 20
Figure 12. Timeline of experiment 21
Figure 13. Picture of Experiment Setup 22
Figure 14. Picture of Experiment Setup Dark 22
Figure 15. Medisana Infrared Lamp (Phillips 100W) Source: [38] 23
Figure 16. HEMA electric table fan Source: [39] 23
Figure 17. Beurer LB12 Mini Air Humidifier Source: [40] 24
Figure 18. Brennenstuhl plug set Source: [41] 24

1. Introduction

As the positive effects of nature on well-being have been researched and proven, there is a growing interest in simulating nature experiences digitally. Multiple studies have demonstrated nature's impact on well-being, including reduced stress levels, improved mood, and enhanced cognitive function[1]. Consequently, there is an increasing interest in replicating the beneficial aspects of natural environments through digital means, such as nature videos, sounds, and XR applications. However, while these audiovisual experiences can create a sense of nature, they often fail to capture the full sensory experience that real nature environments provide.

Research shows that multi-sensory experiences play an important role in maximizing the restorative benefits of nature. Real natural environments engage multiple senses simultaneously—sight, sound, smell, and touch—creating a rich, immersive experience that digital representations struggle to replicate fully [2]. This highlights a gap in current digital nature experiences, which primarily rely on visual and auditory stimuli while neglecting other sensory inputs, such as tactile sensations. Additionally, the effects of immersion in virtual nature on well-being [3] and the impact of multi-sensory virtual reality on immersion [4] are not well understood.

Initially, this thesis aimed to explore the use of immersive technologies for older adults, a demographic that could significantly benefit from nature-based interventions. However, recognizing the broader gap in understanding how multi-sensory stimuli, particularly skin-based inputs, can enhance immersion in digital nature experiences, the research focus shifted.

Consequently, this thesis now investigates the role of skin-based sensory inputs and their effect on the sense of immersion in simulated natural environments. This shift aims to address the gap in understanding how these stimuli can replicate natural sensations and contribute to a more immersive digital nature experience. Exploring the role of tactile feedback on the skin to improve immersion in virtual nature could be beneficial in enhancing the effectiveness and understanding of immersive digital nature experiences. Integrating tactile feedback that simulates natural elements could add complexity and depth into these environments, enhancing their immersion.

The revised research question guiding this thesis is:

> *What is the impact of skin-based sensory inputs replicating natural sensations on immersion in a simulated natural environment?*

This research explores how skin-based sensory inputs affect immersion in digital nature environments. It is structured as follows: Chapter 2 reviews the relevant literature, Chapter 3 outlines the methodology, Chapter 4 specifies the methodology, Chapter 5 presents the experiment, Chapters 6 and 7 analyse and discuss the findings, and Chapter 8 concludes the thesis.

The findings could inform the design of more effective nature-based interventions in healthcare, urban settings, and other areas. Integrating these inputs can bridge the gap between real and digital nature experiences, enhancing the immersion a person might feel. This could lead to more effective immersive solutions that promote well-being in an increasingly digital and urbanized world.

2. Background Research

This chapter reviews the relevant related works and current state of the art surrounding the theme of the project, providing the necessary context and a foundation for understanding the current research and its significance.

2.1 Related work

This section reviews related works on the topics of multisensory experiences, immersion, skin-sensing, and digital nature environments. The state-of-the-art is explored, and research gaps are identified.

2.1.1 Literature Review

As stated in the introduction, the objective of this thesis is to explore how natural sensations experienced on the skin affect the immersion of people within a digital nature environment. This research aims to address the gap in understanding how tactile stimuli can enhance digital nature experiences by creating a more immersive digital nature experience.

Initially, this thesis aimed to explore the use of immersive technologies by older adults, a demographic that can significantly benefit from nature-based interventions. For example, exposure to natural environments has been linked to improved cognitive function and emotional well-being in older adults [5]. The initial research focused on understanding how immersive technologies, particularly VR and AR, could be utilized to improve the physical, cognitive, and social well-being of older adults. The initial literature review gave insights into the potential of immersive technologies for older adults. Key findings included:

- **Diverse Modalities**: Virtual Reality (VR) and Augmented Reality (AR) were identified as key modalities with applications in physical exercise, rehabilitation, and social interaction[6], [7].
- **Perceptions and Interactions**: Older adults' perceptions and interactions with immersive technologies highlighted the importance of perceived usefulness, usability, and emotional responses[8].
- **Benefits**: Immersive technologies were shown to offer benefits such as improved cognitive function, reduced stress, and enhanced social engagement[9], [10].
- **Challenges**: Usability issues, resistance to new technologies, and accessibility barriers were identified as significant challenges[11], [12].

While this initial research built a valuable foundation, it became clear that immersive technologies primarily relied on visual and auditory stimuli, with limited exploration of other sensory inputs, especially tactile. This gap in research prompted a shift in focus to understand how skin-based sensory inputs can replicate natural sensations, thus creating more immersive nature experiences. To confirm this gap, additional research papers into multisensory stimuli and virtual environments (VEs) were explored.

Focus on Audiovisual

Visual and auditory stimuli are the most studied in VEs. [3] Found that matching visual and auditory cues improves immersion and reduces stress in virtual nature settings. But while visual and auditory senses are well-researched, incorporating other senses like smell and touch is less common. [2] Found that smells and touch can make virtual nature more realistic. [4]Combined thermal stimuli with visual and auditory cues to make human-built environments feel more realistic. [13] Showed that adding smells to virtual experiences makes them feel more real, similar to actual nature. [14]Used touchless haptic devices to enhance audio storytelling, demonstrating the potential of haptics to create rich emotional experiences. These findings suggest that olfactory and haptic stimuli can greatly enhance VEs, but more research is needed to fully understand and integrate the addition of these stimuli.

Combining measures

Combining psychological and physiological measures gives a broader understanding of multisensory VEs. [3] mainly used subjective analyses, whereas [4], [13] combined both types of measures to evaluate multisensory interactions more thoroughly. [15] Emphasized the importance of haptic feedback in enhancing emotional engagement within VR. [16], [17] Explored how different sensory stimuli affect user experience, highlighting the need to study less-explored senses like touch, taste, and smell.

Gaps found

Despite this progress on the subject of multisensory stimuli in VEs, significant gaps remain, particularly in tactile or haptic feedback. [3] Noted the need for more research on tactile feedback to improve VE immersion. [2], [4]called for more studies exploring multisensory interactions in different contexts and deeper exploration of non-visual senses. [14], [15] Suggested further research on how haptic feedback and audio interact and affect emotions. [16]recommended integrating touch, taste, and smell into digital experiences to understand their full potential.

Conclusion

Research on multisensory experiences in VEs highlights the importance of integrating various senses to enhance immersion and well-being. While visual and auditory stimuli are well-studied, more research is needed on tactile and haptic feedback. Combining psychological and physiological measures will help better understand how different senses interact in VEs. Addressing these gaps will advance the field and improve VEs for various uses, from therapy to everyday experiences.

2.1.2 Theoretical Framework

To build on the knowledge gained from the literature review, additional research is conducted to support the research question.

2.1.2.1 Immersion

The term "immersion" has many definitions depending on the field (e.g., psychology, game design, HMI). To use the term consistently in this thesis, a working definition needs to be established.

The Oxford Handbook of Virtuality's chapter on immersion in virtual worlds[18] looks at how people engage with virtual environments on a sensory and psychological level. It highlights the importance of realistic sensory experiences, interactive elements, and engaging story lines in creating a sense of immersion. Advanced technology, such as high-resolution graphics, realistic sounds, and haptic feedback, are important aspects to achieve this. Immersion is defined as how much users feel present in the virtual world, when they become deeply engaged and lose awareness of the real world.

The paper "A Framework for Immersive Virtual Environments (FIVE)"[19] outlines key factors that enhance presence in virtual environments. Presence is described as the feeling of being "there" in the virtual world. The framework emphasizes the role of realistic sensory input, spatial presence, and user involvement in creating immersion. It also discusses methods for evaluating these aspects, showing their importance for effective virtual environments.

Based on these sources, a working definition of immersion in a simulated nature environment can be made as *the sense of feeling present in another reality*. Immersion involves psychological and sensory engagement with a virtual environment. This means users feel like they are truly "there," often forgetting the real world. Key elements include sensory stimulation through visuals, sounds, and touch, and the ability to interact with the environment. High-quality graphics and realistic feedback are important. Engaging content or narratives help maintain user attention and involvement[18], [19].

Immersion in virtual environments, especially simulated nature settings, has many benefits. It can reduce stress, promote relaxation, and improve mental well-being, which might be helpful for those with limited access to nature. Overall, immersion enhances user experiences, offering both practical and psychological benefits.

2.1.2.2 Skin sensing

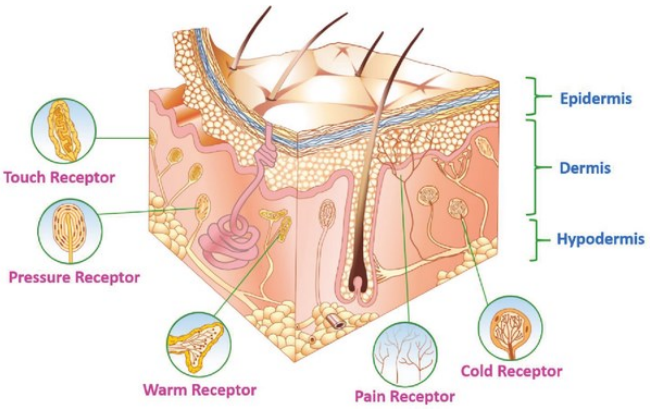

Figure 1. Schematic of the skin anatomy with cutaneous sensory receptors. Source: [20]

Understanding how our skin senses different stimuli is important for developing immersive digital nature experiences. The skin is a complex sensory organ that can sense multiple types of stimuli, which can be used to create more realistic virtual environments.

Temperature (Hot and Cold): The skin has thermoreceptors that detect changes in temperature. There are separate receptors for warmth and cold. These receptors could be used in digital nature simulations to mimic the sensation of a warm sunny day or a cool breeze.

Touch and Pressure: Mechanoreceptors in the skin respond to touch and pressure. These receptors help us feel objects and surfaces. This could translate to feeling the texture of leaves or the ground under your feet.

Pain: Nociceptors are sensory receptors that respond to potentially harmful stimuli by sending signals to the brain that are perceived as pain. While this sense will not be used when creating pleasant virtual environments, understanding this is important to avoid creating discomfort or harm for users.

Vibration: Certain receptors in the skin, like the Pacinian corpuscles, are sensitive to vibration. These might be used to simulate experiences like the rumble of a waterfall or the buzzing of insects.

Hair Deformation: Hair follicle receptors detect the movement of hair, which can enhance the sensitivity of the skin to touch and light breezes. This can be used to create subtle, immersive sensations in virtual environments.

[21], [22]

Conducting this background research is essential for several reasons. It helps in designing more realistic and engaging virtual nature experiences by accurately simulating various skin sensations. This understanding ensures user comfort and safety by preventing overstimulation or discomfort. By using the sensory capabilities of the skin, immersive digital nature environments that offer users a sense of presence and interaction with the virtual world can be created and researched.

2.1.2.3 Simulated nature environments

Simulated nature environments, also known as virtual or digital nature, are an emerging field of study. These environments use technology to recreate natural settings and offer multiple benefits for psychological well-being, education, and environmental awareness.

Research consistently shows that exposure to nature is beneficial, reducing stress and improving mood. However, not everyone can easily access natural settings. Digital simulations of nature, such as Virtual Reality (VR) and Augmented Reality (AR), can replicate these benefits when real nature is not available.

For example, immersive VR experiences have been shown to significantly enhance mood and reduce stress, offering a valuable alternative for those who cannot access real nature [23]. [24] studied the effects of simulated natural environments in VR and 2D video, confirming their stress-reducing benefits.

While digital nature environments are beneficial, they often lack the sensory richness of real nature. Adding elements such as temperature changes, wind, or tactile feedback could make these simulations feel more real and improve their effectiveness. Future research should focus on integrating these sensory elements to make digital nature experiences more immersive and closer to real-life nature. These enhancements could improve the psychological and physiological benefits of digital nature [2].

2.2 State of the art

Exploring the scope of the research subject is useful for understanding how several aspects of this topic are already used in real life, creating a broader view and knowledge of possible applications. That is why this state-of-the-art review focuses on three key areas: using nature's benefits for well-being, creating immersive experiences, and using tactile stimuli for immersion.

2.2.1 Using nature's benefits to increase wellbeing

LRTB:

Figure 2. Qwiek.up in use for older adult care Source: [25]

Figure 3. Zwitscherbox Oak Source: [26]

Figure 4. Calm app interface Source: Adapted from [27]

As discussed before, nature has been proven to benefit the general wellbeing of people. Multiple ways of harnessing these often calming benefits are already on the market, both in healthcare settings as well as personal solutions. For instance, the Qwiek.up, a mobile beamer and audio setup, aids in healthcare settings by alleviating patient stress and anxiety during interventions. It promotes social interaction through shared experiences and addresses behavioural issues with relaxing nature visuals[25]. Another example is the ZwitscherBox by Relaxound, a motion-activated sound machine that plays soothing nature sounds like birdsong and forest ambiance, initially designed for healthcare but now popular as a designer household item[26]. Apps like Calm offer personalized soundscapes and guided meditations, further demonstrating the versatility of nature-inspired relaxation techniques[27].

2.2.2 Creating immersive experiences

LRTB:

Figure 5. Immersive art experience Source: [28]

Figure 6. Half Life Alyx Source: adapted from [29]

Figure 7. Star Wars: Galaxy's Edge Source:[30]

Immersive experiences engage users by integrating advanced technology and design, making them feel part of the environment or story. In art, installations like 'London Frameless'[28] use large-scale projections, interactive displays, and dynamic soundtracks to immerse visitors in a multi-sensory experience, transforming traditional art viewing. In gaming, VR titles like 'Half-Life: Alyx' [29] provide realistic graphics, spatial audio, and haptic feedback to create a sense of presence. Themed entertainment often found in amusement parks, such as 'Star Wars: Galaxy's Edge,'[30] combine set design, animatronics, and interactive elements to transport visitors into a themed universe.

2.2.3 Using tactile stimuli for immersion

LRTB:

Figure 8. SenseGlove Nova 2 Source: [31]

Figure 9. PS5 DualSense controller Source: [32]

Figure 10. 4D movie Source: [33]

Haptic technology, enhances immersion by providing physical sensations (tactical feedback) that match digital events, making virtual experiences feel more real. VR gloves like SenseGlove Nova 2 and HaptX Gloves G1 offer precise tactile feedback and finger tracking, simulating real-life interactions in virtual environments[31], [34]. This technology is used in gaming, training, and rehabilitation. The PS5 DualSense controller, with its adaptive triggers and haptic feedback, further immerses players by simulating in-game actions and environments [32]. Additionally, 4D movies enhance viewer engagement by integrating physical effects like moving seats, wind, and scents synchronized with on-screen action [35].

3. Methodology

This chapter provides a comprehensive overview of the research approach. It outlines the research objectives, hypothesis, experimental design, participant selection criteria, and data collection methods, ensuring a clear and structured framework for the study.

3.1 Research Objective

The main focus of this graduation project is to explore participants' experiences with different types of skin-based sensory inputs in a digital nature experience. This involves collecting qualitative data on users' experiences, which can be achieved through interviews where insights into user experiences and preferences can be gained. These results might aid in the design of future immersive experiences.

3.2 Hypothesis

To test the impact of tactile stimuli on immersion in digital nature experiences, the following hypotheses are formulated:

H0: *There is no difference in the immersion felt by participants between the condition with stimuli and the condition without.*

H1: *The condition with the stimuli was perceived to be more immersive by the participant compared to the condition without the stimuli.*

3.3 Experimental Design Outline

To test the hypothesis, an experiment needs to be created. Multiple aspects need to be thought of, such as environment, guidance for participants, stimuli, and story. Besides these aspects participant selection and data collection methods need to be thought of.

3.3.1 Environment

For an experiment, a controlled environment needs to be put into place. This is to ensure that the circumstances of the experiment are the same every time. In this case it was also important to make sure that there would be the least amount of distractions and that the temperature and light could be controlled to create an environment where participants could get completely in the zone.

The temperature of the room should be the same every time as part of the experiment involves a temperature change, which could be affected by the room's temperature. To ensure the least amount of visual distractions people were told they could close their eyes if they wanted to. In the case that they would not close their eyes, the lights need to be turned off to still create the least visually distracting environment. Sound distractions will have to be minimised by choosing a strategic location and using noise cancelling headphones during the experiment. There should be no accidental/noticeable airflows possible in the room, as the experiment focuses on skin sensations and distractions such as accidental airflow could distract from the stimuli.

Besides the room being controlled, the participant should be seated. This is both to ensure safety and to make the experiment easier to control. Having the participant sit down, will ensure that each participant is in the same position for the stimuli to be added. Because the other senses of the participant are controlled or minimised there would be a chance of losing balance during the experiment, to make sure

this does not happen, the participant will be seated, grounding them both in a physical as well as mental way in the environment.

The arrangement of the room would need to be the same every time as well, once again for the setup of the experiment to be the same every time, but also to lessen distractions and to create a comfortable experience before, during and after the experiment. In this arrangement the possibility of observing the participant as well as controlling the stimuli without distraction should be possible. During one of the meetings with the supervisors of this project a setup was quickly sketched as seen in *Figure 11*.

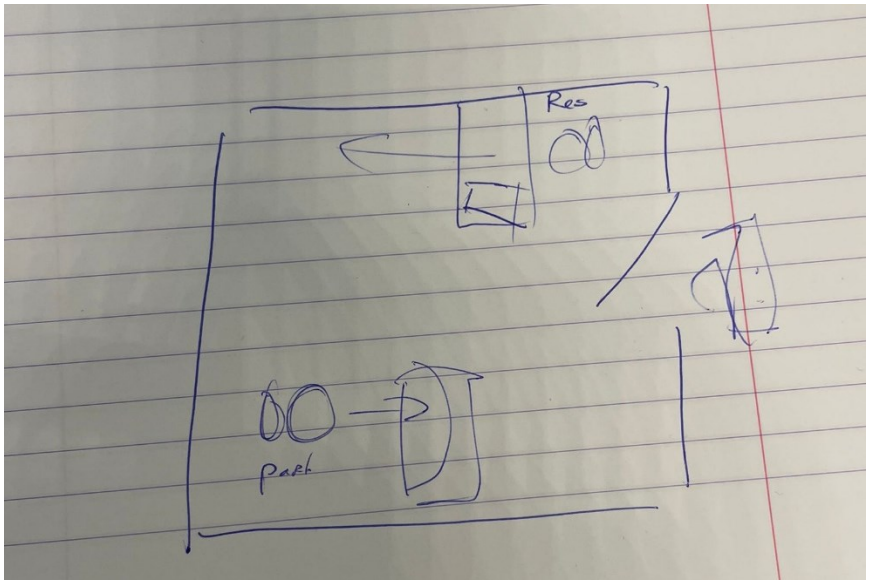

Figure 11. Sketch of experiment setup

3.3.2 Guidance for participants

To make sure the participants know what the experiment entails and to guide them through the experiment, there needs to be clear communication and guidance available. This will be done by having a (de)brief, allowing users to ask questions and a voice guided audio track guiding the participants through the experiment.

3.3.2.1 Pre- experiment brief

The brief, consisting of an information letter and informed consent form, gives the participants enough information about the method and goal of the experiment, without revealing the exact experiment. As well as informing participants of their rights and how their data will be used. After they sign the informed consent form, the participants will be asked if they had any questions about the experiment. If there are no questions or questions were answered the experiment can start. The information letter and informed consent form can be found in *Appendix A* & *Appendix B*, respectively. A more detailed explanation of the briefing process can be found in *5.3*.

3.3.2.2 During experiment audio track

An audio track was chosen as the means of guiding the participants through the experiment. Because a story as well as natural sounds can be implemented at the same time, making sure the experiment is not purely based on random imagination of participants. This is because the experiment will consist of certain stimuli, which would not make sense or would not be easy to control in accordance with timing without a storyline. This will be explained further in *3.3.4*. The audio track will be similar to existing guided meditation audio's which feature a calming voice which guides the listener through a story. This voiceover was done by a professional voice actor through the platform Fiverr [36], to ensure quality and the correct tone. Realistic nature sounds will be added in the background that change according to the storyline and the stimuli. This was done by downloading custom soundscapes from Mynoise.net [37], because of the quality and customisation of the sounds which fit the intended story.

The voiceover and background sounds were edited together to make a coherent audio track which could guide the participants through the experiment as well as being edited into a video format with cues, which will only be visible by the researcher. These cues will be about the general storyline and specific moments when the stimuli will need to be implemented.

The track will be the same for both conditions in the experiment.

3.3.2.3 Post-experiment Debrief

When both the experiment and interview are finished, the participants will be asked if they have any questions about the interview, setup, experiment, or anything else. A quick roundup of the setup and complete experiment will be given.

3.3.3 Stimuli

The skin can feel a multitude of different sensations according to the background research. Three sensations were chosen. These sensations were chosen because they would not be uncomfortable, achievable with simple devices and fitting with a natural environment narrative. The stimuli are as follows:

Weather condition	**Stimulant**	**Device**
Sunlight	Warmth	Infrared (heat) lamp
Wind	Hair deformation	Electric fan
Cold/humidity	Cold	Humidifier & electric fan

Table 1. Overview of experiment stimuli

In order to be able to control the devices manually from a distance some sort of switch on/switch off system will need to be implemented. In future iterations this might be programmed to do this automatically.

During the experiment, the stimuli will be set up stationary. The wind will come from pointed toward the face. The humidifier will come slightly from above to the side, this is so it would not be impacted by the wind too much and be directed into the participants face. The sun will come from the left and slightly from the back, this was to lessen the impact of the bright light that was a by-product of the heat lamp. This setup was decided through trial-and-error and by doing a test with a person who would not be participating in the actual experiment. At the same time, this setup mainly points the stimuli towards

non-exposed skin (face, hands, arms), in order to have the maximal contact with the skin as clothes might impact the effect, while keeping in mind logical things like the sun coming from above.

3.3.4 Story

From the background research in immersion, skin sensing and state-of-the-art it became clear that in order to create an immersive experience, a narrative should be clear. That is what the audio track is for. But in order to test the chosen stimuli they would have to make sense in a story, and within that story should be able to be timed logically. Otherwise, the stimuli might become distracting.

To make sure the stimuli could be added logically a short story was written (with the help of AI). This story sketches a scene where the participant is sitting on a bench in a forest, this is also in accordance with the actual position of the participant during the experiment. At first there is sun (the sunlight stimulant will be implemented), then the weather changes (wind stimulant will be implemented) and becomes worse (the cold/humid stimulant will be implemented). At the end, the participant will be prompted to 'come back to reality' and take of their headphones to create a clear signal the experiment has ended.

A detailed script can be found in *Appendix C*. Note that parts of the script were later removed from the final audio track to ensure enough 'empty' space in the story in order for the participant to have moments of just nature sounds.

3.4 Participants

To ensure that the study would be thorough but also manageable, specific criteria for participant selection, inclusion, exclusion, and recruitment methods were created. One other person who falls within these criteria was asked to help test the setup, experiment and interview without being included in the research results.

In-depth interviews will be conducted with 10-20 participants to achieve a rich and detailed understanding of immersion felt by participants during the experience. This range is useful for capturing multiple perspectives while making sure it is still manageable to conduct and to thoroughly analyse the experiment.

Participants will need to be 18 or older of any gender. They will need to have the capacity to understand English. This is in order to make sure they can give their informed consent.

Participants will be excluded if they are unable to hear (well), have physical problems wearing headphones, have sensory problems that would interfere with the experiment, have skin problems that might react to stimuli or problems sitting down and standing up on their own.

Participants are recruited through word of mouth and a shareable WhatsApp message with a link to a scheduling tool. The information and link are deleted after the experiments are completed, to ensure privacy. This way of reaching participants does mean that the population of participants consists of people within the student population of Enschede.

3.5 Data collection

Data collection will be done through semi-structured interviews with a focus on the perceived immersion of participants during the experiment. The interviews will be recorded on mobile phone to be transcribed later. Observational notes will be made about anything deemed noteworthy by the researcher before, during or after the experiment. These notes will be made on paper and later added to the transcription files per participant.

4. Specification

This chapter details the materials, experiment procedures, interview procedures and the experiment timeline, providing a clear and organized plan for conducting the experiment.

4.1 Materials and Tools

To conduct the experiment various kinds of tools and materials will be used. To create a clear overview of said tools and materials the tables below were made.

For Participant	
Experiment	Documentation
• Chair • Noise cancelling headphones • Audio track	• Information letter • Informed Consent form

Table 2. Needed materials for Participant

For Researcher	
Experiment	Documentation
• Heat lamp • Humidifier • Electric fan • Remote control plugs	• Pen & paper • Audio recorder (mobile phone) • Laptop (with audio/visual track) • Experiment protocol • Interview protocol

Table 3. Needed materials for Researcher

Miscellaneous
• Extension cord/power strips • Chargers for devices • Hygienic wipes • Chair + table • Tripods • Duct tape

Table 4. Needed materials Miscellaneous

4.2 Experiment Procedure

To ensure that the experiment would be conducted the same every time, an experiment procedure was created. It goes over the steps needed in preparation, the steps that need to be taken during the experiment and the steps that need to be taken per experiment condition (either with or without stimuli). The experiment will be conducted within-subject, and the order of conditions will be changed to create a 50/50 division. The exact procedure can be found in *Appendix D*.

4.3 Interview Procedure

To ensure a smooth interview session after the experiment an interview procedure was created. Included in this procedure were steps that should ensure a comfortable experience for the participants as well as reminders to check, name and safe the collected data in the right way. The prepared interview questions are also in this document, ordered by expected importance. The exact procedure and prepared questions can be found in *Appendix E*.

4.4 Timeline

To give an idea of the time during the experiment the timeline in *Figure 12* below was made. In total it will take 25-30 minutes for the participant. An extra 15 minutes was calculated in between every participant, in which the data could be saved, and the experiment reset. So, in total one session would take 45 minutes.

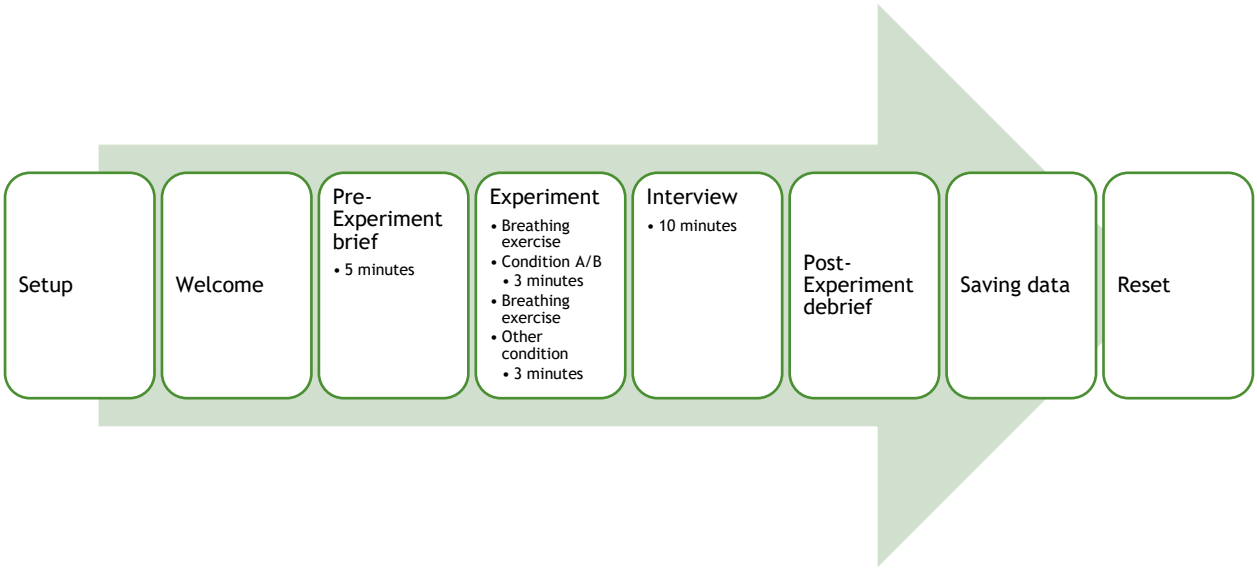

Figure 12. Timeline of experiment

5. Realisation

To give an overview of the actualised experiment the realisation chapter goes into what the setup was like on location, what the briefing of the participants looked like, how the interview was conducted in a bit more detail and how observations were done. Showing the implementation of the methodology and specification.

5.1 Set-Up

An overview of the exact location, devices in the setup and goings of the briefs, experiment, interview and observations will be discussed.

5.1.1 Location

For the experiment, a set room was needed with enough space to set up the materials. It needed to be closed off and controllable as much as possible. A room in the Horst tower on the University of Twente campus was chosen. Specifically room HT801, which was chosen due to its location and availability. It is located at the end of a hallway, which would limit the number of passersby and neighbours that could cause a disruption. Additionally, to make sure the experiment would not be disturbed, a note was put up on the door, asking people to not disturb when the door is closed.

To further be able to control the environment during the experiment, the room was chosen because it has blinds that could be closed, lights that could be turned off and a temperature controller unit, ensuring the same conditions every time.

The setup within the room was kept similar to the sketch in *Figure 11*. Only now rotated 180 degrees, where the researcher is facing the door, and the participants would be facing away as seen in *Figure 13* and *Figure 14* below.

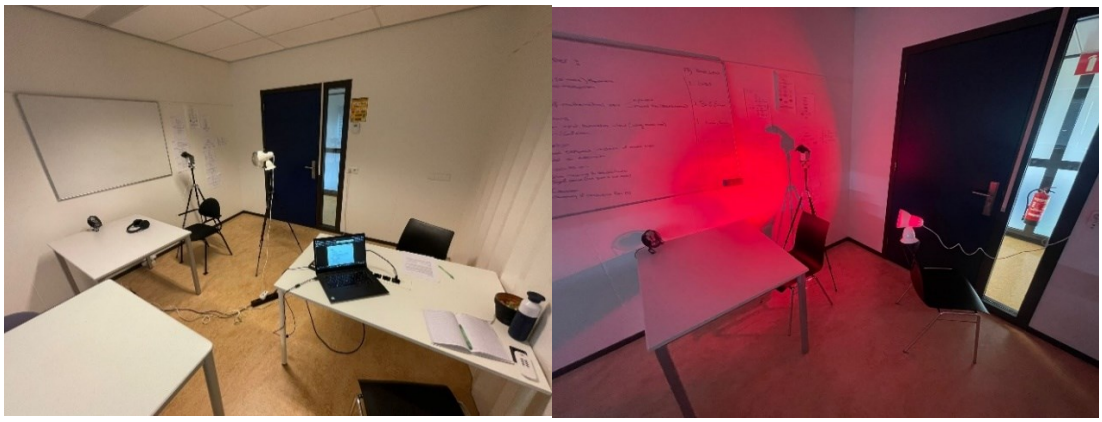

Figure 13. Picture of Experiment Setup

Figure 14. Picture of Experiment Setup Dark

This was to minimize possible distractions through the window for participants and for the researcher to be able to see and welcome participants in the room. This would create a more comfortable experience. To ensure that all devices and the distances between them and the participants stayed consistent between experiment days, tape was used to indicate the locations on the ground in the room.

5.1.2 Devices used

Infrared Lamp on tripod

Figure 15. Medisana Infrared Lamp (Phillips 100W) Source: [38]

The infrared lamp was used to create the warmth/sunlight stimulant. The exact lamp was the Medisana Infrared lamp (Phillips 100W) [38]. This lamp was bought second hand and is not available to buy new anymore. It was set-up on top of a tripod to ensure the correct height for the experiment. A sieve was used to diffuse the bright red light the lamp emits, without diffusing the intended stimulant, warmth. After the first ten experiments the lamp broke and had to be replaced. As the exact lamp or wattage of the infrared bulb could not be found, a similar second-hand lamp with a wattage of 150W was used for the remaining experiments.

Electric Fan on table

Figure 16. HEMA electric table fan Source: [39]

A HEMA electric table fan [39] was used to create the wind stimulant. It was very portable and quiet. It has only one speed, with just enough power to create a subtle breeze. Its vertical angle could be adjusted to blow in the direction of the participants face.

Humidifier on tripod

Figure 17. Beurer LB12 Mini Air Humidifier Source: [40]

The Beurer LB12 Mini Air Humidifier [40] was used to create the cold/humidity stimulant. It is a very compact humidifier, which was useful for a quick setup and reset of the experiment. It has a dial for the strength which was set to the maximum level for the experiment. The bottle which is used to add water could be removed while the device was working. This was useful as the participants would not directly see what it was supposed to do. It was set-up on top of a tripod to ensure that the participant would be able to feel the mist created by the device.

Click On/Off plug set

Figure 18. Brennenstuhl plug set Source: [41]

The three piece Brennenstuhl plug set [41] was used in order to manually control the devices in the setup discreetly from a distance using the remote. The three stimulant devices were each plugged into one of the controllable plugs which were connected to power strips.

5.2 Roster

The roster of the experiment was decided by the scheduling tool. The participants could sign up for a particular spot of their choosing. The researcher was able to see all the timeslots, but participants could not see other participants to ensure anonymity. The timeslots were decided based on the availability of the location.

5.3 Briefing

The briefings were done in accordance with the procedures mentioned in *3.3.2*. One of the first participants mentioned they thought the researcher might touch them or move around them. To make sure it was clear to other participants that this would not be the case, it was explicitly mentioned after they had read the information letter and before they signed the consent letter. Another thing which was added after the first session was to ask the participants to do box breathing [42] to create a calm state to start and to minimize the carryover effect between conditions.

5.4 Interviews

Over the course of four separate days, nineteen sessions occurred, so nineteen semi-structured interviews were conducted. The participants would be notified the recording had started, then the interview began. At first some background questions were asked questions about participants' previous experiences with meditation and nature sounds, to see if there would be some correlation with the ability to feel immersed. After which the participants would be asked if they knew what 'immersion' meant. Then the questions in the interview protocol (*Appendix E*) were asked. These questions focussed on the perceived immersion of participants during the experiment. Some questions were omitted, based on the fact that several participants had answered them in their answer on a previous question, or because the question did not match with the participants' experience.

5.5 Observations

In order to catch any comments, questions or body language from participants that were unexpected or happening outside of the interview, observational notes were made. These were written down anonymously on paper in order to not disturb the participant with typing sounds during the experiment. The observations were made on body language or movements of the participants. Things like yawning, stretching or smiling were noted. Additionally, observations were made about the inside and outside temperature as well as the clothing participants were wearing. These notes might be used alongside the data from the experiment to gain insight into the experience of the participants.

6. Results/Evaluation/Analysis

This chapter goes into the processing and analysis of the collected data. The results will be interpreted in the context of the hypotheses and research objective. A thematic data analysis was conducted to find and extract the most useful data for answering the research question. Unlike a standard thematic analysis, which usually begins with detailed coding. This analysis starts with broad initial themes which became apparent during the initial review of the data and are a logical result of the experiment and interview protocols, after which more detailed codes were generated within these initial themes. This approach allowed for an intuitive way of processing the collected data.

6.1 Identifying themes

Transcripts were made of the recorded interview. This was partly done using Descript [43] and later edited by hand to correct any mistakes the AI made when transcribing (as stated in *Appendix H*). During this process, broad themes were found. These themes were used as overarching codes and later divided into sub-codes based on a more detailed analysis of the transcripts. The following overarching themes were found:

Immersion

Immersion refers to the extent to which participants felt fully absorbed or engaged in the virtual environment. High levels of immersion were described by feelings of being transported to another place, while low levels were indicated by a difficulty in maintaining engagement with the virtual experience for example.

Wind (Wind Stimuli)

This theme captures participants' reactions to wind stimuli in the virtual environment. Reactions ranged from positive, where the wind enhanced the sense of realism, to negative, where it caused discomfort or distraction. Additionally, some participants specifically noted the sound of wind instead of the direct feeling of the stimuli.

Sun (Warmth Stimuli)

Participants' responses to the heat lamp's warmth stimuli in the virtual environment are captured in this theme. Many participants also specifically noticed the unintended light produced by the lamp, which was meant to just generate heat for the experiment. Both the heat and light produced by the lamp had positive and negative effects.

Cold (Humidity Stimuli)

This theme explores how participants reacted to humidity stimuli. Hardly any participants specifically noticed the presence of humidity, although some comments about the presence of the humidity were made after the debrief.

Comparison of Sessions (Order Effects)

This theme examines how the order of sessions influenced participants' immersion and overall experience. Some found the first session more immersive, while others found the second more engaging depending on which condition they experienced first.

Physical Reactions

This theme captures participants' physical reactions to the virtual environment. It includes reports of physical comfort and discomfort as well as specific physical sensations like goosebumps.

Emotional Response

This theme encompasses the range of emotional responses participants experienced. This includes feelings of relaxation, stress, general positive emotions (happiness, peace), and negative emotions (discomfort, anxiety).

Suggestions for Improvement

Participants provided various suggestions for improving the virtual experience, which was not necessarily the goal of the experiment, but could be useful knowledge for further research endeavours. These suggestions included making transitions more gradual, better synchronising stimuli with the narrative or audio, and adding additional stimuli to enhance realism.

Technological Issues

This theme addresses the technical problems participants encountered. Issues with audio volume, quality and abrupt transitions in lighting were notable concerns that affected their overall experience.

Nature Connectedness

This theme captures participants' feelings of connectedness to nature while engaging with the virtual environment. Some participants reported feeling a strong connection to the natural elements presented in the experience.

6.2 Coding

Based on the initial themes, more specific codes could be created. Every transcript was examined again, and codes were assigned that fit within the initial themes. For example, under the theme ‘Sun,’ codes such as ‘SUN-noticed,’ ‘SUN-positive’ and ‘SUN-negative’ were made. This was done iteratively to make sure the codes were not too broad or narrow. For example, the theme ‘Emotional Response’ first had the codes ‘EMO-relax,’ ‘EMO-stress,’ ‘EMO-positive’ and ‘EMO-negative,’ but the relax and stress codes could be moved under the positive/negative codes without losing important distinctions. The result of this coding is found in the codebook in Appendix F, where the main themes, their corresponding codes, categories, descriptions, examples from the transcripts are given.

6.3 Analysis

This research explored how different skin-based sensory inputs—like wind, warmth, and humidity—affect participants' sense of immersion in a simulated natural environment. Based on the codes in *Appendix F*, The analysis synthesizes the participants' feedback to assess what the effects were on the feeling of immersion and to identify any other notable observations.

6.3.1 General High Levels of Immersion

Several participants reported feeling highly immersed when the skin-based sensory inputs were present. For example, Participant 3 said, "I really felt like I was in the forest," showing a strong sense of presence due to the stimuli. Similarly, Participant 6 found the first session, which included the additional sensory elements, more immersive, saying, "I thought the first one when you had those extra things I thought you were more sucked into the experience." The stimuli helped participants visualize and emotionally engage with the simulated environment more deeply.

6.3.2 Reactions to Wind Stimulant (wind)

The wind stimulant was overall well-received and added positively to the immersive experience. Participant 4 noted, "I found the wind immersive," highlighting the role of wind in creating a more realistic and engaging environment. Participant 5 had the same view, stating, "Especially in combination with the wind. Then you really notice oh yeah I'm somewhere else than in a room in the Horst tower [university building]." Participant 15 also appreciated the wind's contribution, saying, "Well especially the wind, that helped." Additionally, some participants had physical reactions to the wind as will be further discussed in the emotional and physical reactions paragraph.

6.3.3 Reactions to Lamp Stimuli (warmth)

The warmth and light from the lamp also had quite an effect on the immersion of participants, although reactions were mixed because of the abruptness of the non-intended light. Participant 5 responded "yes, definitely" when asked if the warmth was an addition, indicating a positive reaction to the warmth. However, both Participants 5 and 7 found the sudden transition of the light distracting, which temporarily reduced their immersion.

6.3.4 Reactions to Humidifier Stimuli (cold)

The humidifier stimuli, designed to replicate a sensation of humidity or coldness, had hardly any impact on participants' immersion in the simulated natural environment, as it was not particularly noticeable. Some participants after being debriefed reported having felt the stimulant but attributed its effects to the wind stimulant or their imagination. While many others did not notice it at all, even when they had expected to feel something, as illustrated by Participant 4 "I didn't notice it at all. I expected a light and a wind. So, I also expected to feel a bit of a mist or something, but I didn't notice it." Overall, the humidifier's impact on immersion was not noticeable compared to wind and sun stimuli.

6.3.5 Emotional and Physical Responses

Positive emotional responses were common among participants who experienced the sensory inputs. For example, Participant 8 described the experience as " I really liked it, it felt nice. I feel completely zen. ". Participant 19 noted that they found the experience relaxing and calming. These responses indicate a successful immersive experience, showing deep engagement with the simulated environment.

Additionally, some participants experienced physical reactions that further indicate a big sensory impact. For example, Participant 13 mentioned getting "goosebumps" and finding it cold after the wind stimulus, while Participant 16 noted that longer immersion in the experience might have led to "shivers" due to deep relaxation.

However, there were also some negative emotional and physical responses. Participant 3 felt "restless" when the wind started blowing. Participant 5 mentioned feeling panicked when it started to rain in the story, saying, "Yeah so when it started to rain. Haha Yes slight panic. I was like oh my God." Participant 17 also felt anxious about the incoming rainy weather in the story when the wind started to blow, showing that the sensory inputs were convincing enough to create emotional reactions.

Other responses included distractions and irritations. Seven out of nineteen participants commented on the sudden changes in light, finding it distracting. Participant 5 noted that the sudden light change took them out of their immersion, while Participant 7 stated, "I had to laugh, because it was quite sudden." Participant 16 was taken out of their immersion when the sun stimulus was first introduced, but mentioned the general addition of the warmth and light did then help them get back into it. Additionally, Participant 18 felt irritation with the guided meditation voice at first, stating, "First when the woman started talking, I was a little irritated by her voice." These responses highlight areas that can be improved in the implementation of sensory stimuli and guidance.

6.3.6 Comparison of Sessions and Order Effects (A-B/B-A)

The order in which participants experienced the conditions (A/B or B/A) played a significant role in shaping their perceptions and the overall immersive experience. The A/B order meant that the first session included the added stimuli, while the B/A order meant that the second session included the added stimuli.

6.3.6.1 Participants in the A/B Order:

Participants who experienced the A/B order often found the first session more immersive and engaging due to the added stimuli. For example, Participant 12 mentioned being a bit surprised when the light turned on because it was unexpected. This surprise contributed to making the beginning of the session feel distinctly different from the end, emphasizing the strong impact of the novelty of the added stimuli. Similarly, Participant 6 said "when you had those extra things, you were more sucked into the experience," indicating that the added stimuli captured their attention and made the experience more vivid. Participant 8 also found the first session "a lot more intense... in a good way," suggesting that the initial exposure with stimuli was very impactful and provided a strong immersive experience.

While the added stimuli generally enhanced immersion, Participant 9 noted that they were more relaxed the second time. This implies that the absence of stimuli in the second session allowed for a different kind of relaxation, highlighting that while stimuli can enhance engagement, they can also be distracting for some participants.

6.3.6.2 Participants in the B/A Order:

For participants who experienced the B/A order, the initial session without added stimuli was less intense. However, this initial session familiarised them with the content and environment. Participant 13 stated “…right away in the beginning I already had the feeling and so I could think a lot about home directly about how it was there. I was just sitting on a bench looking at a field. And the second time you just felt the warmth of the lamp and well the wind. I was much more in it or something.” This indicates that the added stimuli in the second session, combined with reduced novelty, allowed for a deeper immersion.

Similarly, Participant 17 explained that the familiarity gained during the first session helped calm their mind, making it easier to focus and connect more deeply during the second session with stimuli. Participant 19 noted that familiarity with the narrative helped them immerse more in the second session with stimuli, stating, "it might help the second time because you already had the same story... you don't have to sketch an image in your own head... so it helped me to get into it." This underscores the role of familiarity in enhancing immersion when stimuli are introduced in the second session.

6.3.6.3 Comparison of A/B and B/A Orders:

Participants in both groups reported that the session with the added stimuli provided a strong immersive impact. For A/B participants, this was the first session, while for B/A participants, it was the second session. Participant 2, for example, said “In the first one I could sometimes imagine it a bit better, I would say. But with the second one I felt it a bit more, if you know what I mean.” Highlighting the impact of the stimuli in the second session for B/A participants.

Overall, the analysis suggests that the added stimuli generally enhanced immersion and engagement. The novelty of having the stimuli immediately in the first session created a powerful initial impact for the A/B participants, while the second session's increased familiarity created a deeper immersive experience for the B/A participants. While the added stimuli were generally well-received, it is important to note that they can be distracting for some participants.

6.3.7 Suggestions for Improvement

Participants also gave some useful feedback on how to enhance the immersive experience. A common suggestion was to make transitions more gradual. Participant 5 said, " I think if something like a transition can be made, that you slowly become sunny, or slowly change into a darker colour, it would help a lot," meaning it would reduce the distraction caused by sudden changes in stimuli.

Additionally, the addition of smell, or using something like a heart rate sensor for physiological data were mentioned as suggestions for improvement of the experience or the experiment.

6.3.8 Technological Issues

Some participants encountered technical issues, such as too high or low volume levels or hearing non-intended sounds from the device the audio was playing from. The participant whose volume levels were too low, could hear the stimuli click on or off which took away from their immersion.

7. Discussion & Future Work

This chapter discusses the implication of the findings in this research. It will also address limitations of the process and/or things that could have influenced the experiment and suggests future research endeavours.

7.1 Discussion of results

From the analysis a discussion on how the finding relate to the background research, how they answer the research questions and if there are any new insights can be done.

7.1.1 Different reactions to stimuli

One thing that became clear from the analysis is that there were different reactions to the different stimuli. Wind was the clearest and most effective in making the simulated environment feel real and thus immersive. This was probably because of its subtle, yet noticeable nature which integrated seamlessly with the audio track.

The sunlight stimulant had mixed results, mainly because of the non-intended effects of the accompanying light that the lamp emitted. The warmth was said to help with immersion, but for most people the light was the most noticeable and often times distracting. This was due to the abruptness of the lamp being turned on. The warmth would be noticed gradually, but the light was immediately noticeable. This suggests that while the warmth stimulant was effective, the (sudden) light of the lamp should be accounted for, i.e. by using a blindfold or dimmer in order to only assess the effect of sensing warmth on the skin.

The cold or humidity which should have been introduced to the skin via the humidifier in combination with the wind, was hardly noticeable. This might have been because its output was just too subtle, or because participants did not know it was supposed to happen, as they did not recognise the humidifier. After participants were debriefed, some said they might have felt it, now knowing what the stimulant was, but they might have contributed it to just the wind from the fan or their imagination. Changing the strength or delivery of this stimulant might help make this stimulant more noticeable and effective.

7.1.2 Influences of imagination and other senses

The focus of the experiment was on skin-based stimuli; however, it is difficult to close off or minimize the other senses of a participant or to guide their imagination. Participants noticing the light of the lamp or being distracted by non-intended sounds are examples of this. These things were quite sudden or changed abruptly, this is in contrast to natural experiences which usually change gradually.

The imagination and level of imagination of the participant also play a role on the immersion. An example were the comments made by participants who imagined the sun coming from the right, while in the actual setup the sun stimulant came from the left, which diminished their immersion in the environment. The audio guidance during the experiment could not go into such detail as it could differ from a participant's imagination of a scene, which might also be distracting. This highlights areas that can be improved in the implementation of sensory stimuli and guidance to minimise negative impacts and enhance overall immersion.

7.1.3 Influences of expectations, novelty and familiarity effects

Besides other senses and imagination, expectations about the experiment and novelty and carryover effects affect the immersion of participants.

As participants walked into the room, they could see the setup, consisting of a fan, lamp and a third, for most participants unidentified, humidifier. Seeing these devices, they already had the expectation of things happening, especially wind from the fan and light from the lamp. This might have affected the warmth of the lamp being less noticeable than the light, as well as the effect of the humidifier being hardly noticed. Moreover, nature is usually a multisensory experience and only skin sensations were added. Participants might have expected smells, because the guided story mentioned them, but they were not part of the setup.

For participants who experienced the A/B condition, the first round included the stimuli. They reported that the novelty of having the stimuli in the first round had a big impact on immersion, but at the same time that the reduced novelty of the story and lack of added stimuli made the second round more comfortable as it was less intense.

For participants who experienced the B/A condition, the second round included the stimuli. These participants noticed feeling more immersed the second round as the story wasn't novel anymore, they had to put less effort into imagining the scene and so the stimuli had a greater effect on immersion.

The novelty of having the stimuli immediately in the first session created a powerful initial impact for the A/B participants, while the second session's increased familiarity in combination with the added stimuli created the opportunity for a deeper immersive experience compared to the first session for the B/A participants.

These insights highlight an effect of expectation, novelty, and familiarity. By understanding these effects, more engaging and impactful experiences can be designed that cater to both to the initial awe and the following comfort for participants.

7.1.4 Higher immersion and bridging the gap

Overall, the analysis suggests that the added stimuli, such as wind and warmth, significantly enhanced immersion regardless of the order of the conditions during the experiment. This enhancement in immersion indicates that these tactile stimuli can make participants feel like they are in a different place, which is a critical aspect of immersion. The added stimuli helped participants visualize and emotionally engage with the simulated environment more deeply, proving the hypothesis (H1) and answering the research question.

Furthermore, both the wind and sun stimuli elicited positive and negative emotional responses, as well as physical reactions like goosebumps. These responses suggest that the stimuli created a realistic and immersive experience, showing deep engagement with the simulated environment. While negative responses, such as emotional and physical discomfort, might not be favourable in actual application, they demonstrate that the sensory inputs were convincing enough to evoke emotional reactions. This bridging of the gap between the simulated and real world underscores the heightened immersion created by the stimuli, adding credibility to the hypothesis.

Interestingly, these negative responses, while showing participants' discomfort, also highlighted the realism of the experience. For example, Participant 17 felt anxious about the incoming rainy weather in

the story when the wind started to blow, demonstrating that the sensory inputs were effective in creating emotional reactions. Thus, the combination of heightened perceived immersion and emotional and physical responses to the stimuli supports the hypothesis (H1) that stimuli can bridge the gap between the digital and real world, thereby creating a more immersive experience and effectively answering the research question.

In contrast, the null hypothesis (H0) states that there is no difference in the immersion felt by participants between the condition with stimuli and the condition without. However, the results of the study clearly contradict this null hypothesis, as the added stimuli significantly enhanced immersion, proving that the presence of stimuli makes a notable difference in the level of immersion felt by participants.

7.2 Discussion of process/decisions

The decisions made and the process of the research might have had an effect on the results and analysis. These implications will be discussed in this chapter.

7.2.1 Study Design and Environment

For this research a within-subject testing approach was chosen, while initially the plan was to test between subjects. This initial plan seemed logical in order to not have a carryover effect between the conditions with and without stimuli, as well as creating the most subjective results. Eventually the within-subject testing was chosen to be able to ask participants directly if the stimuli made the experience more or less immersive, as there was also a hypothesis the stimuli could be distracting from the experience. This would be hard to find out using between subject testing. Logistically within-subject testing also required less participants to gain meaningful results.

The experiment could have been more distraction and expectation free. This could have been done by choosing a different location with less distractions, having participants wearing blindfolds or not revealing the setup to the participants in order to minimize the expectation effect and distractions. The used setup was chosen because of logistic and time related reasons.

The decision to find a location that could be temperature controlled was to make sure that the environment for the experiment would be consistent and would not interfere with the story or the participants comfort by being too hot/cold.

7.2.2 Sensory Feedback

The use of certain tactile elements such as having the participants touch leaves, have their feet on textured ground or have participants sit on a real bench, could have made a more immersive experience. But it was decided not to include these in the experiment for practical reasons. Both logistically and time wise these elements would be hard to implement and control. Possible discomfort of participants was another reason these elements, for instance ‘raindrops or actual water splatter, were omitted.

7.2.3 Timing, Realism, and Balancing

The duration and timing of the weather changes in the experiment was short in comparison with usual nature experiences. This might have had an effect on the realism and immersion, as usually these changes occur gradually over a longer period of time.

Incorrect timing, intensity, or changes of stimuli can pull participants out of their immersion. So, it is important to deliver the stimuli in a logical and balanced way.

Timing during this research was done manually using cues in a video, this is an area where slight differences might have been made between participants, which could have had an effect on their respective immersion levels. Additionally, for some experiments the audio levels were not correct, creating an unbalanced experience, which might have been distracting.

7.2.4 Participant Considerations and Ethicality

One potential concern is the bias in participant responses, where individuals might feel inclined to provide answers that they believe will please the researcher, thereby affecting the objectivity of the results.

Additionally, differences in skin sensitivity of participants can cause varied sensory experiences, impacting the consistency and comparability of the data.

Minimizing sensory inputs, such as vision and hearing, can evoke feelings of fear or anxiety, as participants might feel vulnerable, have negative associations, or perceive the researcher as having power over them. To address this, participants were informed beforehand, and their consent was gained. They were also told they could look at one spot if they did not feel comfortable with closing their eyes.

7.2.5 Researcher Role

The researcher's role can impact the preparation and outcomes of the study. Background, assumptions, and interactions with participants may have introduced biases, for example during the coding of interview data. These biases could influence how data is categorized and interpreted.

Additionally, as mentioned in *7.2.4* the dynamic between the researcher and participants could have affected responses, as participants might alter their answers to meet perceived expectations.

7.3 Future work

This chapter outlines the potential directions for future research, focusing on enhancing the immersive experience, refining design principles, exploring new applications of skin-based sensory inputs, and making general improvements to study methodologies.

7.3.1 Immersion and Multisensory Experiences

Further testing of immersion levels could be done by collecting physiological data and using questionnaires to gain quantitative data besides the qualitative data from interviews.

Adding tactile stimuli, such as a wooden bench and textured ground, could enhance the immersive experience, the implementation and effect of these added stimuli could be an interesting addition to this research. Additionally, integrating other senses, such as smell, could further deepen the sense of immersion.

Exploring the effects of the added stimuli in VR/AR applications, to enhance user engagement would be another interesting research endeavour.

7.3.2 Identifying and Refining Design Principles

Identifying and refining design principles for integrating skin-based sensory inputs to enhance immersion is essential if the goal is to implement them in real life setting. This involves conducting research, reviewing existing methods, and exploring new strategies for their integration. Additionally, examining the timing and context of delivering skin-based sensory feedback is important, as it affects users' sense of presence and immersion. Insights from these studies could inform the development of effective strategies for delivering sensory stimuli in virtual environments.

7.3.3 Exploring Applications of Skin-Based Sensory Inputs

Beyond enhancing immersion, future work should explore potential applications of skin-based sensory inputs in various fields. These inputs could be used for therapeutic interventions aimed at stress reduction or for educational purposes for example. Investigating ways to incorporate these sensory inputs into non-research settings, such as building practical rigs for everyday use, could broaden their applicability and impact.

7.3.4 General changes

To improve future studies, a larger and more diverse participant pool should be used. Collaborations with experts in psychology, neuroscience, and human-computer interaction would be interesting as interdisciplinary research could deepen the findings and make them more applicable in real life.

8. Conclusion

The analysis of participant feedback suggests that skin-based sensory inputs like wind, warmth, and humidity can enhance immersion in a simulated natural environment. These stimuli help create a realistic and engaging experience by bridging the gap between virtual and real sensations. Participants reported higher levels of presence and emotional engagement when these stimuli were included, highlighting their importance in creating realistic and engaging virtual experiences. However, the implementation of these stimuli needs to be refined, particularly concerning the smoothness of transitions and the resolution of technological issues. The humidity stimulus, in particular, was less noticeable and suggests the need for further refinement.

The research demonstrates how incorporating multiple skin-based sensory inputs can significantly enhance immersion and realism in simulated natural environments, informing the design of more effective and engaging virtual experiences. Although the complex setup posed challenges in controlling variables and managing multiple stimuli, the study successfully answered the research question by showing that skin-based stimuli positively affect immersion. While other factors also influenced immersion, the findings provide valuable insights for enhancing virtual nature experiences. Future research should focus on refining the delivery of these stimuli, exploring additional sensory inputs such as smell, and expanding the participant pool to include diverse demographics.

In summary, this research provides valuable insights into the design principles of multisensory virtual environments and their application in promoting well-being and immersive experiences. The thesis contributes to the broader understanding of multisensory integration in digital nature simulations and highlights areas for future exploration to enhance the user experience further.

9. References

[1] G. N. Bratman *et al.*, 'Nature and mental health: An ecosystem service perspective', 2019. [Online]. Available: https://www.science.org

[2] L. S. Franco, D. F. Shanahan, and R. A. Fuller, 'A Review of the Benefits of Nature Experiences: More Than Meets the Eye', 2017, doi: 10.3390/ijerph14080864.

[3] S. Frost *et al.*, 'Virtual immersion in nature and psychological well-being: A systematic literature review', Apr. 01, 2022, *Academic Press*. doi: 10.1016/j.jenvp.2022.101765.

[4] K. Lyu, A. Brambilla, A. Globa, and R. de Dear, 'An immersive multisensory virtual reality approach to the study of human-built environment interactions', *Autom Constr*, vol. 150, Jun. 2023, doi: 10.1016/j.autcon.2023.104836.

[5] E. Jarosz, 'Direct Exposure to Green and Blue Spaces is Associated with Greater Mental Wellbeing in Older Adults', *Journal of Aging and Environment*, vol. 37, no. 4, pp. 460–477, 2023, doi: 10.1080/26892618.2022.2109792.

[6] D. Healy, A. Flynn, O. Conlan, J. McSharry, and J. Walsh, 'Older Adults' Experiences and Perceptions of Immersive Virtual Reality: A Protocol for a Systematic Review and Thematic Synthesis', *Int J Qual Methods*, vol. 10, 2022, doi: 10.1177/16094069211009682.

[7] L. Appel *et al.*, 'Older Adults With Cognitive and/or Physical Impairments Can Benefit From Immersive Virtual Reality Experiences: A Feasibility Study', *Frontiers in Medicine | www.frontiersin.org*, vol. 1, p. 329, 2020, doi: 10.3389/fmed.2019.00329.

[8] A. R. Roberts, B. De Schutter, K. Franks, and M. E. Radina, 'Older Adults' Experiences with Audiovisual Virtual Reality: Perceived Usefulness and Other Factors Influencing Technology Acceptance', *Clin Gerontol*, vol. 42, no. 1, pp. 27–33, Jan. 2019, doi: 10.1080/07317115.2018.1442380.

[9] M. Heinz *et al.*, 'Perceptions of Technology among Older Adults', *J Gerontol Nurs*, vol. 39, no. 1, pp. 42–51, 2013, doi: 10.3928/00989134-20121204-04.

[10] K. Zhu, Q. Zhang, B. He, M. Huang, R. Lin, and H. Li, 'Immersive Virtual Reality-Based Cognitive Intervention for the Improvement of Cognitive Function, Depression, and Perceived Stress in Older Adults With Mild Cognitive Impairment and Mild Dementia: Pilot Pre-Post Study.', *JMIR Serious Games*, vol. 10, no. 1, p. e32117, Feb. 2022, doi: 10.2196/32117.

[11] C. Tuena *et al.*, 'Usability Issues of Clinical and Research Applications of Virtual Reality in Older People: A Systematic Review', *Frontiers in Human Neuroscience | www.frontiersin.org*, vol. 1, p. 93, 2020, doi: 10.3389/fnhum.2020.00093.

[12] S. Baker, J. Waycott, F. Vetere, and T. Hoang, 'The Technology Explorers: Partnering with Older Adults to Engage with Virtual Reality and Virtual Avatars', *Ageing and Digital Technology: Designing and Evaluating Emerging Technologies for Older Adults*, pp. 231–246, Jan. 2019, doi: 10.1007/978-981-13-3693-5_14/FIGURES/3.

[13] M. K. S. Lopes and T. H. Falk, ‘Audio-visual-olfactory immersive digital nature exposure for stress and anxiety reduction: a systematic review on systems, outcomes, and challenges’, 2024, *Frontiers Media SA*. doi: 10.3389/frvir.2024.1252539.

[14] A. Sheremetieva, I. Romanovych, S. Lviv, S. Frish, M. Maksymenko, and O. Georgiou, ‘Touch the Story: An immersive mid-air haptic experience’. [Online]. Available: https://www.ultraleap.com/product/stratos-explore/,

[15] T. Qaisar, M. Mumtaz, H. Raza, M. M. Ali, K. Khalid, and I. Bajwa, ‘Emotional Engagement with Haptic Feedback in Virtual Scenarios: A Literature Review’, in *2024 International Conference on Engineering & Computing Technologies (ICECT)*, IEEE, May 2024, pp. 1–6. doi: 10.1109/ICECT61618.2024.10581267.

[16] M. Obrist, ‘Multisensory Experiences: Where the Senses Meet Technology’, in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, Springer Science and Business Media Deutschland GmbH, 2021, pp. 9–13. doi: 10.1007/978-3-030-85623-6_2.

[17] B. De Jesus Jr. *et al.*, ‘Quantifying Multisensory Immersive Experiences using Wearables: Is (Stimulating) More (Senses) Always Merrier?’, Sociedade Brasileira de Computacao - SB, Jun. 2022. doi: 10.5753/sensoryx.2022.20001.

[18] G. Calleja, ‘The Oxford handbook of virtuality’, 2013, ch. Chapter 13, pp. 222–236.

[19] M. Slater and S. Wilbur, ‘A Framework for Immersive Virtual Environments (FIVE): Speculations on the Role of Presence in Virtual Environments’, *Presence: Teleoperators and Virtual Environments*, vol. 6, no. 6, pp. 603–616, Dec. 1997, doi: 10.1162/PRES.1997.6.6.603.

[20] ‘Schematic of the skin anatomy with cutaneous sensory receptors. | Download Scientific Diagram’. Accessed: Jul. 16, 2024. [Online]. Available: https://www.researchgate.net/figure/Schematic-of-the-skin-anatomy-with-cutaneous-sensory-receptors_fig4_349459034

[21] K. Parida, H. Bark, and P. S. Lee, ‘Emerging Thermal Technology Enabled Augmented Reality’, Sep. 01, 2021, *John Wiley and Sons Inc*. doi: 10.1002/adfm.202007952.

[22] Dr ROHINI and Dr PASCHAL D’SOUZA, ‘Cutaneous receptors’, Apr. 13, 2013.

[23] G. Reese, J. Stahlberg, and C. Menzel, ‘Digital shinrin-yoku: do nature experiences in virtual reality reduce stress and increase well-being as strongly as similar experiences in a physical forest?’, *Virtual Real*, vol. 26, no. 3, pp. 1245–1255, Sep. 2022, doi: 10.1007/s10055-022-00631-9.

[24] B. Suseno and T. D. Hastjarjo, ‘The effect of simulated natural environments in virtual reality and 2D video to reduce stress’, *Front Psychol*, vol. 14, 2023, doi: 10.3389/fpsyg.2023.1016652.

[25] ‘Over Qwiek | Qwiek’. Accessed: Jul. 15, 2024. [Online]. Available: https://www.qwiek.eu/over-qwiek

[26] ‘Relaxound - The original sound boxes with nature sounds: Birdsong, ocean sound, jungle atmosphere, ...’ Accessed: Jul. 15, 2024. [Online]. Available: https://www.relaxound.com/en/

[27] ‘Calm - The #1 App for Meditation and Sleep’. Accessed: Jul. 15, 2024. [Online]. Available: https://www.calm.com/

[28] ‘Frameless | The Ultimate Immersive Art Experience’. Accessed: Jul. 16, 2024. [Online]. Available: https://frameless.com/

[29] ‘Half-Life: Alyx op Steam’. Accessed: Jul. 16, 2024. [Online]. Available: https://store.steampowered.com/app/546560/HalfLife_Alyx/

[30] ‘Disney overtreft zichzelf met Star Wars: Galaxy’s Edge - Parkplanet’. Accessed: Jul. 16, 2024. [Online]. Available: https://parkplanet.nl/2019/12/disney-star-wars-galaxy-s-edge-disneyland-hollywood-studios/

[31] ‘Find out about our New Nova 2 Glove | SenseGlove’. Accessed: Jul. 16, 2024. [Online]. Available: https://www.senseglove.com/product/nova-2/

[32] ‘DualSense draadloze controller | De innovatieve nieuwe PS5-controller | PlayStation’. Accessed: Jul. 16, 2024. [Online]. Available: https://www.playstation.com/nl-nl/accessories/dualsense-wireless-controller/

[33] ‘Long-life 4D Cinema Control System’. Accessed: Jul. 16, 2024. [Online]. Available: https://www.ieiworld.com/kr/news/con_show.php?op=showone&cid=1210

[34] ‘Gloves G1 | HaptX’. Accessed: Jul. 16, 2024. [Online]. Available: https://haptx.com/gloves-g1/

[35] ‘(291) 4DX Cinemas Next Generation - Motion Seats, Wind, Fog, Lighting, Bubbles, Water & Scents - YouTube’. Accessed: Jul. 16, 2024. [Online]. Available: https://www.youtube.com/watch?v=FN03zZRHSHA

[36] ‘Fiverr | Freelance services marketplace | Find top global talent’. Accessed: Jul. 16, 2024. [Online]. Available: https://www.fiverr.com/?source=top_nav

[37] ‘Background Noises • Ambient Sounds • Relaxing Music | myNoise ®’. Accessed: Jul. 16, 2024. [Online]. Available: https://mynoise.net/

[38] ‘Medisana Infraroodlamp | 100 Watt | Philips Lamp | bol’. Accessed: Jul. 16, 2024. [Online]. Available: https://www.bol.com/nl/nl/p/medisana-infraroodlamp-100-watt-philips-lamp/9200000106174432/

[39] ‘tafelventilator USB retro zwart Ø10cm - HEMA’. Accessed: Jul. 16, 2024. [Online]. Available: https://www.hema.nl/wonen-slapen/wonen/ventilatoren/tafelventilator-usb-retro-zwart-10cm-80200013.html

[40] ‘Beurer LB12 Mini Air Humidifier | Ultrasonic humidification technology | Quiet operation | Ideal for the office or when travelling | Continuously adjustable | Suitable for rooms up to 20m^2 : Amazon.co.uk’. Accessed: Jul. 16, 2024. [Online]. Available: https://www.amazon.co.uk/Beurer-LB12UK-Personal-Mini-Humidifier/dp/B01CFR0P6E

[41] ‘BRENNENSTUHL stekkerset RC CE1 3001 3-delig- wit (1507040) | Elektramat’. Accessed: Jul. 16, 2024. [Online]. Available: https://www.elektramat.nl/brennenstuhl-stekkerset-rc-ce1-3001-3-delig-wit-1507040/

[42] ‘Box Breathing: Getting Started with Box Breathing, How to Do It, Benefits and Tips’. Accessed: Jul. 16, 2024. [Online]. Available: https://www.webmd.com/balance/what-is-box-breathing

[43] ‘Free Audio and Video Transcription Nearly Instant | Descript’. Accessed: Jul. 16, 2024. [Online]. Available: https://www.descript.com/transcription

[44] ‘ChatGPT | OpenAI’. Accessed: Jul. 16, 2024. [Online]. Available: https://openai.com/chatgpt/

Appendix A

Information Letter

Dear participant,

This letter is meant to inform you about the research you are participating in. The goal of the research is to find out whether or not stimuli can have an impact on immersion while experiencing a simulated nature environment and if so, what that impact entails.

During the experiment you will be asked to close your eyes (or to focus on a single point if you are not comfortable with closing your eyes) and you will listen to an audio track. Your task is to just sit, relax and listen. We will do this twice. At a certain point you might notice sensations on your skin that replicate sensations found in nature. The experiment will take about 10-15 minutes in total, after which a semi-structured interview will take place about your experience. This will be recorded for reviewing at a later time. Any audio recordings that are made during the study will be deleted after transcription. You will be debriefed about the study after the interview.

During this research your age, gender and information about personal experiences will be collected. The data collected during the study might be published and/or kept and reused in future research.

There are no known risks involved in participating in this research and this research project has been reviewed by the Ethics Committee of Information & Computer Science. Your participation is voluntary and if at any time you wish to withdraw from the study, you are allowed to do so without having to give a reason. The data collected up until that point will be removed from the study and erased.

Contact details

Researcher: Sarah Jansen — **Email:** s.a.jansen-1@student.utwente.nl

Supervisor: Josca van Houwelingen – Snippe — **Email:** j.vanhouwelingen-snippe@utwente.nl

Critical Observer: Marcello Gómez Maureira — **Email:** m.a.gomezmaureira@utwente.nl

Contact Information for Questions about Your Rights as a Research Participant

If you have questions about your rights as a research participant or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee Information & Computer Science: ethicscommittee-CIS@utwente.nl

Appendix B

Consent Form for Immersive Nature Experience Experiment

YOU WILL BE GIVEN A COPY OF THIS INFORMED CONSENT FORM

Please tick the appropriate boxes	**Yes**	**No**
Taking part in the study		
I have read and understood the study information dated …./…./……., or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	○	○
I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	○	○
I understand that taking part in the study involves an audio recorded interview.	○	○
I understand that the recorded audio will be transcribed and then deleted.	○	○
I understand that I will be asked to close my eyes or to look at a single point during the experiment and I can choose the most comfortable option for me freely.	○	○
Use of the information in the study		
I understand that information I provide will be used for the writing of a report.	○	○
I understand that information I provide might be used in future publications and/or research.	○	○
I agree that my information can be quoted in research outputs.	○	○
Future use and reuse of the information by others		
I agree that my information may be shared with other researchers for future research studies that are similar to this study. The information shared with other researchers will not include any information that can directly identify me. Researchers will not contact me for additional permission to use this information.	○	○

Signatures

_____	_____	_____
Name of participant	Signature	Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

Sarah Jansen	_____	_____
Researcher name	Signature	Date

Study contact details for further information:

Sarah Jansen s.a.jansen-1@student.utwente.nl

Appendix C

Voiceover audio script

Read with a calm, friendly and positive tone throughout, to guide the listener through the story in a peaceful way. Leave small pauses between sentences and bigger pauses between every break. (I have to edit in the end to fit a pre-made background audio). Things in square brackets do not need to be read. You have the freedom to change some words if it helps with the flow of the text, but please do not take away any context.

Welcome. Get into a comfortable position, close your eyes and take a deep breath. Let's begin our journey.

[Sound of gentle wind rustling through leaves]

Imagine you're sitting on a wooden bench in a tranquil forest. Tall trees surround you, their leaves gently swaying in the breeze. *[turn on heat lamp]* Bright sunlight filters through, creating patterns of light and shadow on the forest floor.

Feel the warmth of the sun on your face. It's comforting, soothing. Listen to the birds singing, their melodies blending with the rustling leaves. Breathe in the fresh, crisp air, filling your lungs with each breath.

[Birdsong continues, with occasional rustling leaves]

Notice a squirrel darting up a tree, pausing to look at you before disappearing into the branches. Insects hum softly, busy with their tasks.

[Sound of wind picking up slightly]

Now, feel the wind change. *[turn on fan]* A cool breeze carries the scent of pine and earth. [Turn off heat lamp] The air feels crisper against your skin. Clouds gather, and the sky darkens.

The temperature drops, and a chill runs through the air. [Turn on humidifier]

[Sound of increasing wind]

The wind picks up, bringing a slight mist. It's colder, wetter. The earthy scent of rain fills your senses.

[Sound of wind and distant thunder continuing softly]

Deciding to avoid the rain, you take one last deep breath, savouring the fresh, rain-scented air. You decide to start your way back through the forest, feeling grateful for this serene moment.

Thank you for joining me on this journey, you can now slowly come back to reality, open your eyes and take of the headphones.

Made with help of chat GPT using the following prompt and some manual editing to fit the imagined experience:

Write a script for a calm voice guided nature audio experience of about 5 minutes, which is about sitting on a bench in a forest that incorporates sunshine, wind and a change of weather (cold wind/rain).

Appendix D

Experiment protocol

Preparation

- Make sure setup is in place
- Make sure everything is working properly (battery and volume)
- Welcome in participant
- Ask participant to sit down
- Brief participant about experiment
- Tell participant they can close their eyes if or focus on one point during the experiment
- Ask participant to read the information letter and to give consent by signing consent form
- Ask participant for any final questions before starting
- Ask to do box breathing (in 4, hold 4, out 4, hold 4) for 3 cycles while turning of lights

Experiment

- Ask participant to put on headphones when they are ready
- Start audio track for participant on the laptop
- Implement condition A/B
- Wait till end of condition
- Ask participant to wiggle feet -> box breath
- Implement other condition
- Wait till end of condition
- Ask participant to take of the headphones

Condition A
• Follow timing of audio track from the accompanying video on laptop • Implement 1st stimuli on time → Heat lamp • Implement 2nd stimuli on time → Fan • Implement 3rd stimuli on time → Humidifier • Observe participant while doing this
Condition B
• Follow timing of audio track from the accompanying video on laptop • Observe participant while doing this

Appendix E

Interview Protocol & Questions

Preparation

- Ask participant to sit down on chair opposite of researcher
- Explain purpose of interview to participant
- Start the recording (mention this to participant)
- Check if recorder is recording

Interview

- Ask the introduction and warm-up questions
- Ask the main questions
- Look into notes & observational notes
- Ask any follow-up questions

Conclusion

- Stop the recording
- Save the recording
- Summarize the experiment and interview fully (debrief)
- Ask the participant if they have any comments or questions
- Thank the participant for their time and input

Reset

- Check if everything saved
- Clean the headphones and chair
- Reset the experiment setup

Questions

Introduction & Warm-Up

- Did you close your eyes during the experiment, or did you look at one spot?
    - Did you have any reason why you preferred one over the other?
- Do you ever listen to or watch nature content like nature sounds or videos?
    - How often?
    - Why? (Relaxation, concentration, background noise)
- Do you ever meditate?
- What did you think of the simulated nature environment you just experienced?

Main Questions

1. **Experience and Immersion:**
    - How immersive did you find the simulated nature experience in general?
    - Can you describe what aspects of the experience made it feel immersive or not immersive? (What aspects of the experience had an effect on you?)
2. **Comparison:**
    - Was there a trial where you felt more immersed? Why?
    - Can you tell me when you experienced the stimuli being added? (first or second condition)
        1. How did the experience with the skin stimuli compare to the experience without the skin stimuli in this experiment?
3. **Impact of Skin Stimuli:**
    - Did you sense/experience anything on your skin during the experiment?
    - How did these stimuli affect your experience of the simulated environment?
    - Did these stimuli make the experience feel more or less immersive? In what way?
        1. Can you describe any specific moments when you felt particularly immersed or detached because of the stimuli?
4. **Perception and Realism:**
    - Why or why not, did the stimuli make the experience feel more realistic according to you?
        1. Can you give an example of a moment during the experience when the stimuli felt particularly real or unreal?

Follow-Up & bonus Questions

- Can you elaborate on [specific point participant mentioned]?
- You mentioned that [specific aspect] felt particularly immersive/distracting; can you tell me more about why that was?
- **Emotional and Physical Response:**
    - What, if any, emotional or physical responses did you experience due to the stimuli?
    - How did these responses impact your overall experience?

Conclusion

- Do you have any additional comments about your experience or the use of skin stimuli in simulated environments?
- Is there anything else you think I should know about how these stimuli affected your immersion?

Appendix F

Codebook

Theme	Code	Description	Example
Immersion	IMM-High	High levels of immersion reported.	" I could just imagine where I was about to be." (Participant 11)
	IMM-Low	Low levels of immersion reported.	" Whereby with the second one I think it's a bit difficult to stick to such a story in my head." (Participant 6)
Wind (Wind Stimuli)	WIND-Positive	Positive reactions to wind stimuli.	" But I did feel the wind, it felt real. " (Participant 3)
	WIND-Negative	Negative reactions to wind stimuli.	"I became a bit restless when the wind started blowing it didn't feel great." (Participant 3)
	WIND-Notice	Noticing the wind stimuli.	"the breeze and the warmth on your face," (Participant 11)
Sun (Lamp Stimuli)	SUN-Positive	Positive reactions to lamp stimuli.	"The sun works really well. At a certain time that turns on. Because I think in the beginning it's turned off. And then suddenly you feel it nicely." (Participant 6)
	SUN-Negative	Negative reactions to lamp stimuli.	"The light was more distracting that it suddenly turned on actually." (Participant 15)
	SUN-Notice	Noticing the lamp stimuli.	" I think especially the lamp helped." (Participant 10)
Humidity/cold (Humidifier Stimuli)	HUMID-Positive	Positive reactions to humidifier stimuli.	"I don't know if the smell was really there but I had the feeling it was so that was nice." Participant 2
	HUMID-Negative	Negative reactions to humidifier stimuli.	/
	HUMID-Notice	Noticing the humidifier stimuli.	"I didn't notice it [the humidifier] consciously." (Participant 10)

Emotional Response	EMO-Positive	Positive emotional responses, like reports of feeling relaxed.	" I really liked it. I found it relaxing." (Participant 1)
	EMO-Negative	Negative emotional responses, like reports of feeling stressed or anxious.	"I became a bit restless when the wind started blowing it didn't feel great." (Participant 3)
Comparison of Sessions	COMP-FirstMore	First session more immersive.	"The first one felt more intense or something." (Participant 18)
	COMP-SecondMore	Second session more immersive.	"Uh yeah the second time I felt it more Uh you feel the sun that air uh yeah. It does a lot for the immersion a kind of warm blanket that came around you." (Participant 19)
	COMP-Order	Impact of session order.	"I felt a little less restless the second time. Maybe because I knew it was coming. Or because it felt more real." (Participant 3)
Physical Reactions	PHYS-Comfort	Physical comfort reported.	"Well I'm a bit more relaxed." (Participant 17)
	PHYS-Discomfort	Physical discomfort reported.	"Well yes. In both cases I had for example that I did get a little cold chills." (Participant 9)
	PHYS-Notice	Noticing physical reactions.	"Emotionally not but physically I'm very calm." (Participant 11)
Suggestions for Improvement	SUG-Gradual	Suggestions for more gradual transitions.	"I think if something like a transition can be made that you slowly become sunny or slowly change into a darker colour it would help a lot." (Participant 5)
	SUG-AdditionalStimuli	Suggestions for adding more stimuli.	"what I miss a little is the smell. …. That would have been a nice addition, I think" (Participant 15)
Technological Issues	TECH-AudioIssues	Issues/distractions caused by audio quality.	" I immediately noticed the clicks and the sounds of the equipment. That it pulled me out a bit. " (Participant 9)

	TECH-SetupIssues	Issues/distractions caused by devices used in the setup.	"And the second time I heard the sound of the computer." (Participant 2)

Appendix G

All transcripts

Participant 1 transcription z/m

I'm going to ask you about what you just experienced. Are you familiar with immersion and what that means?

> Yes, I know what immersion means.

Yes. Um, then first. Do you ever watch nature content, sound, videos?

> Um, not really. No, not a lot.

And do you meditate?

> No, not really.

What did you think of the experience?

> I really liked it. I found it relaxing. In general, it was relaxing.

Did you feel like you were immersed?

> Yes, I could feel it. I could get myself into it, but that is something that I am generally good at I think. I was in the forest.

Um, Was there anything specific? What were you more or less into?

> Um, Does it matter if it's about the first one or the second one?

Uh, well, you've noticed the difference in your experience. Tell me about both.

> Well, I thought the first one was pretty good. Yeah, you didn't have the stimuli, but I could get a good picture. And with the second one, I thought the wind and that the light went out, that worked well. Only in my first picture, the sun was on the right and I was on the left. And then the light went on and I was like, wait a minute. So then I had to turn it around in my, in my, in my immersion.

And, uh, did you have the feeling that the wind and stuff helped a bit with getting it in?

> Yeah, that was, that was Okay, nice.

But the sun was a bit distracting because it wasn't in your mind.

Yeah, the sun was a bit distracting because it was a bit stuck on what I had expected. And then I was pulled out a bit, but the other things, so indeed the wind and that the light went out and stuff, that worked.

Was there a moment where you thought, this is it, I'm totally in it?

Uh, yeah, at the end you had a bit of that thunder or something. I think, yeah, or that was left or right, I don't know. But that, that, yeah. That was it, that was a vibe.

Um, let's see. Did you have, did you have emotional or physical responses to the things?

Yeah, well, I thought it was relaxing. And I haven't been that relaxed lately. So in itself, that's a nice start of the Monday.

A nice start of the Monday. That's nice! Um, let me think. Would you say, which one did you like more? You had the first and the second time. Where could you concentrate more, or less?

Um, I think, I think I found the first one easier to concentrate. And the second was, if you were used to the fact that there was something new. Yes. Then you could get more into it, but it didn't take very long. So then suddenly there was something new, so I was like, oh, this is new, you know. And then you're working on it, and then at some point you're used to it. And then you're like, okay, wait, and then you put it back in, and then a little more, I think. But, it was a bit with ups and downs.

Okay, well, that's a good answer. Do you have any other comments about what you just experienced? The whole set-up? General questions/comments?

No, no, I like it. Ah, actually I think it might be useful if you know in advance, that you might say to a participant, you are not going to go near them. Because I was there and I thought, is something going to happen, is she going to touch me or walk around me?

No, that's really a good idea. To tell participants in advance, “I'm not going to come near you, I'll just sit here” That's a really good idea.

Notes:

Wearing short sleeves

Phone went off

Participant 2 transcript z/m

Uh, yeah. I'll start with, how did you like it?

I thought it was chill.

It was chill? Nice, nice.

A little bit, yeah.

Nice. Do you listen to nature content yourself? Videos, music, sounds?

> No? Yeah, music.

Music, but not nature sounds?

> No, not at all.

No. Why not? Do you have a reason for this?

> Not really. I think it's chill, but I don't do it that often, I do walk through the forest and to listen to things and stuff. But to put that on [nature sounds], I think it's fake or something.

Do you meditate sometimes?

> No.

No, okay. Are you familiar with what immersion is?

> I have a suspicion. Okay, I'm going to tell you what I think it is. That you, well immersion, I assume that you emerge in a, um, Makes you feel like you're actually there. On the bench in the sun.

Yeah, exactly. Um, yeah. A bit generally speaking of the moments. Did you feel like you were there? Could you kind of envision it?

> Um, so there was a bit of a difference. There were two things that helped with the second time. Those were of course, the sun, and the wind, and in the end the smell, I don't know, that, that was really good, the last one. I don’t know if the smell was really there, but I had the feeling it was, so that was nice. Um, but, the, uh, the first time I didn't know what was going to happen. And then I was a bit, Exciting, like, am I going to get this?, is there going to be a storm or am I going to get a jump scare, or something like that. I was a bit nervous for the first time as well. And it didn't really help me get into the zone. And the second time I heard the sound of the computer.

Oh no!

> So that was in the beginning. I think it was a volume warning or something. So that didn't really help. But, uh. Yes, the first time I felt it a bit, and especially at the end with that smell, I felt it a lot, so to speak that I was there, that helped a lot. I think. Um I also the sun the wind, helped a lot.

Would you say that you were more immersed in the first or second one?

> In the second one, yes. Yes. In the first one I could sometimes imagine it a bit better, I would say. But with the second one I felt it a bit more, if you know what I mean.

Was it, uh, with the second one, was there anything distracting?

With the first one I was really busy with just envisioning thins. And with the second one it was just a bit more, uh Yeah, not really envisioning things, but more the feeling around it.

Did you have expectations for the second time? Did you expect something to come?

Well, I did expect the wind to blow. I saw the fan and I expected the wind to blow for the first time. And I also expected it for the second time. But I didn't have that smell. I don't know if it's real, but I had the feeling that it was going to happen. And on the right of me is standing a weird thing [humidifier].

We'll get to that in a minute. Let's see. Did you have an emotional or physical reaction to any of the stimuli?

I found it relaxing.

Relaxed, nice. Um, yeah. Those are the questions I have. Do you have any other questions or comments about the setup? What is it?

Um. No, not really. I thought the sun went out a bit too fast. And that didn't help at all.

No, okay. That's a good point. That's something I noticed when testing myself. You can't put a dimmer on it. [going over setup] And that's a humidifier. And I think that's what the smell is. Which wasn't the intention.

For me it did a lot [the smell].

Yes, that was it actually.

It also helped that my pants are wet, by the way.

To be honest, that's something, uh, my supervisor said, yes, you have to write down what's going on outside, because that's maybe also interesting, it's pretty good that you say it.

Notes:

Wearing short sleeves

Did not do square breathing exercises

Participant 3 transcript z/m

Then I have a few nice questions for you. Yes. Um, first of all. Do you ever listen to nature, sounds, videos, content?

No.

No. Is there a reason you don't?

No, not necessarily, but no. If I listen to something to calm me down when I'm sleeping, it's a podcast or something. Yes, oh yes. Maybe something where something really happens or something [a story].

What do you think of the experience in general? What were your experiences?

> I think it was chill. Nice. I was just sitting in a nice, cool chair. Yeah, it was nice.

Um, are you familiar with what immersion means?

> Yes, I think so. From what I've heard. That you sort of You sort of immerse yourself in an environment. Yes. That you sort of feel like you're in it. Yes. That you can imagine that you're in it.

Um Okay, now that you know that. Did you find the whole experience a bit immersive? Could you get into it a bit?

> Yes. Well, I had all, you hear around you all birds and things and stuff and that, yes, I was sitting nicely in my forest, I saw it, I saw it in front of me, I could envision it.

Uh, can you explain which parts in particular then, caused it, next to the bird and stuff? Was there something else that really, where you thought, oh, now I'm really in it?

> Um, I think, yes, I think especially the bird and the, and the wind that you hear a little around you. Yes. I think that mainly, that around you, everywhere, you hear things. So it really seemed like it was everywhere. Like if you're just watching TV, it's like, out of the TV. It's very clear that it's coming from there.

We did it [the experiment] twice. Was there a moment when you felt more or less immersed?

I thought the sunlight was chill. Yeah, yeah. Then I thought, oh yeah, oh yeah, nice. On a bench in the sun.

Okay, so that was the second time.

> Yes, that's a bit nicer.

And did you also notice that you, for example, the, yes, the comparison between the first and the second, were you more into it with the second one, or was it just nicer?

> No, I was already more into it, I think. Yes.

Is it more realistic for you that those things, that you felt I can't describe what you felt, I think I said that already. But, makes it more realistic, or is it more just a fun addition? It's a bit difficult to ask

> Yeah, I know what you mean. No, I don't think it makes that much more realistic. Maybe a little bit, but I was already quite 'there' the first time [immersed].

Was there a moment in which one of the things, the wind or whatever, specifically felt real or not real? Let's say that it felt correct or not. Or just not. Did you notice anything?

> Yes, I felt it with the wind. Yes. But with the sun less, because I had my own image, and then suddenly the sun came from a different angle than where I had imagined it, and then I had to switch. But I did feel the wind, it felt real.

Um, okay. Did you have any emotional or physical reactions to the experience?

I hmm. I became a bit restless when the wind started blowing, it didn't feel great.

Um, And did that influence the experience in general? Did it make it less fun or less relaxing? Or was it different the first or second time?

> Um, I felt a little less restless the second time. Maybe because I knew it was coming. Or because it felt more real. Because the first time you hear it, it's all around you, creepy trees. Yeah, maybe with the wind around it. Yeah, it feels more like you're walking in a forest and you're like, okay, I'm going to walk home now.

Yeah, yeah. Okay, um, those were actually my main questions. Do you still have any comments, questions, things about the setup, about the experiments, about the sounds, anything?

[going over setup]

And together with the fan, it's a bit more in your face. Yeah. But, uh, what I've learned so far is that there's not a lot of effect from that thing [humidifier].

> I maybe had a very small bit of cold. I thought more than that was because I was just sitting and I was just outside. It's cold outside. I didn't really no. No. I didn't really notice that.

Thanks. Is there anything else I should know about how one of the three things affects you? Emotions or immersion.

> Well, I think the sound is especially chill. Yeah. Yeah. At the first one I thought, oh, nice, I'm in a forest.

Notes:

Wearing long sleeves and glasses

Participant 4 transcript z/m

First of all, do you listen to the sounds of nature in video's for example?

> Yes. Sometimes.

Sometimes, for what reason?

> No specific reason. As a bit of background noise.

Okay. Do you ever meditate?

> No.

Um, what did you think of it in general? You can be very honest, you really have to.

> I liked it, it felt nice. Yeah, nice.

More things? In general?

> I especially noticed that the light turns on very quickly. That is, um, and that the wind was blowing, it fit well.

How immersive was the experience for you in general?

> On a scale? Or?...

Whatever you like…

> I found it kind of immersive, Yeah.

What was it that made it immersive or not?

> I found the wind immersive, the lamp not really, maybe the idea of it [the lamp], and that I had my eyes closed helped. The audio was also nice.

Was there a moment you were more or less immersed?

> At the beginning a little less.

Do you know why that is?

> Because I wasn't really in it yet.

And did you notice a difference between the first and the second time?

> Yes.

Was there something specific in that difference that you thought well, that stood out?

> Uh, I could only, at the first time, they were like, imagine you're sitting on a bench, I wasn't quite there yet, not quite awake yet. So then I was like, uh, yeah, imagine it quickly. And the second time it was a bit easier to envision it. Also because I knew what was going to happen.

So those things like the wind and the lamp. You said the wind was chill. That made it a bit more immersive. And the lamp not really or less.

> Yes, because it started very abruptly. And when the sun shines through the leaves, it doesn't start abruptly [in nature]. And I think that in the end, when it's[lamp] on, there were some advantages. But the abrupt start made it less immersive.

Okay. Um, did you have any other emotional or physical responses in the experience?

> It calmed me down.

Yeah, those were my questions. Do you have any other questions you'd like to ask me?

> What's the third thing [pointing to humidifier]? Yeah, okay, we'll get to that in a minute.

Any other questions?

> No.

[answering previous question]

Uh, this is a humidifier. Unfortunately, it doesn't do a lot. It should make it feel a bit colder and windier. I don't know if you've noticed anything.

> Yeah, No. I actually assumed that it would do something with water. But that, uh, I didn't notice it at all. I expected a light and a wind. So I also expected to feel a bit of a mist or something, but I didn't notice it.

Notes:

Wearing long sleeves

Tired, needed water first

Smile on face when lamp turned on

Participant 5 transcript z/m

Do you sometimes listen to nature, content, sounds, videos?

> No, not really.

Do you meditate sometimes?

> No, not really.

What did you think of it, in general?

> Yeah, quite an experience. I have to say, actually the first time, when they said, feel the sun on your skin, then you're going to try to imagine it, so to speak. To really feel it. And with the second one it got enhanced, so to speak, because you didn't have to act. So it's pretty, pretty special.

Um, how immersive did you find the experience?

> Well, especially the second one, was certainly immersive. It's probably because of the light and the wind, of course. Um, only with the light, because the transition is so, so sudden, that you get taken out of the immersion a bit. And then I think it happened [turning of the lamp] just a little bit before she said it was getting dark. And then it got dark. Yeah, suddenly it's dark, I guess. Um, so that got me out of it a little bit, but for the rest of the experience, it was very well timed. So that helped me a lot.

So, you said that the sun, the warmth was maybe nice, but the suddenness of the light is just a bit distracting?

> Yes, exactly. I think if something like a transition can be made, that you slowly become sunny, or slowly change into a darker colour, then it helps a lot.

Well, purely based on what you felt on your skin [so the warmth] that was an addition, would you say?

Yes, definitely. Especially in combination with the wind. Then you really notice, oh yeah, I'm somewhere else than in a room in the Horst tower, so to speak.

Was there a specific moment when you thought, I'm really in it now?

Um, yeah, it was mostly the darker part that you really felt like, oh yeah, the wind is getting stronger. It's dark. But that also kind of made me panicked a bit. Like, Oh no, it's starting to rain. It's not relaxed anymore.

No, but that's good in itself. Because that means you were immersed.

Yeah, exactly. I was definitely immersed.

So you were immersed, were there things that made it more or less realistic?

Yeah, so only with the change of the light was it less realistic, but for the rest, yeah, just what the woman [voiceover] was saying, you could really delve into that.

Nice. Um, did you have an emotional or physical response to the stimuli during one of the experiences?

Yeah, so when it started to rain. Haha Yes, slight panic. I was like, oh my God. Now I have to go home, because like I'm sitting under a tree [part of the audio track]. So that was a little bit, but not really anything else.

And did that panic still have an impact on, say, the first or second time? I don't know, when did you have this feeling? Did you have this the first time as well?

The second time was when I felt this panic. Not necessarily the first time. It was really, I think, also because of the wind that suddenly became stronger. I don’t know if that actually happened but it did feel like it.

Do you have any further comments for me about what you've experienced? Things you think I haven't asked you yet?

No, not really, it’s clear.

[explaining setup]

But for people, the wind actually feels the most realistic.

Yes, that's right.

Um, then we have the third thing, which is a humidifier. You probably didn't really notice.

No.

It doesn't seem to do much, so far, for people. If you know its there, which you don’t really, you feel a bit of a colder air on that side.

Maybe that actually is what I felt then, because I said, yeah, the wind picked up. It did feel a bit more rainy, so to speak. But you just don't know that it's a humidifier.

[talking about the wind and lamp] Especially the combination of those two is just pretty strong. Yeah, if it, let's say, once the sudden change phase is over of the lam, then it's like, oh yeah, this is it, this is nice and warm.

Notes:

Wearing long sleeves and glasses.

Participant 6 transcript m/z

First of all, do you listen to natural sounds? Or videos, or things?

Sometimes.

And what for?

When I want to fall asleep. It's either the car sounds or the nature sounds.

Okay. And sometimes, how often?

That's about once a month probably.

Do you ever meditate?

No.

Um, what did you think of it, in general? Laughing?

Cool! Yeah. I thought it was a really fun user test. I was really relaxed. I like it.

How immersive did you find it? The experience, complete, both, was there a difference?

Yes, there was a difference. Uh, I thought the first one, when you had those extra things, I thought you were more sucked into the experience. Hmm. Whereby, with the second one, I think it's a bit difficult to stick to such a story in my head.

So if the order was changed, do you think that would have had an effect? Would that have been different for you?

Yeah I think so, now for the second one, you expect more. Or you expect something, but there is nothing. So you immediately feel less immersed.

Were there specific moments where you felt especially immersed?

Uh, yeah, the sun works really well. At a certain time, that turns on. Because I think in the beginning its if turned off. And then suddenly you feel it nicely. That was the moment which felt really nice.

Okay. Um, were there any other things you thought, oh, that took me out of the immersion a bit?

Yeah, I thought that, uh, at the end, where you're going to talk about the weather getting bad. Because you can't really notice that through the stimuli. It didn't really work for me.

Okay. Good. Did the stimuli make it more realistic for you to or did it more just help you to get into it?

Um, yes, I found that sun particularly chill. That you just saw such a white spot in your eyes. But I would say that that was a help. Plus, through all those new things, I could to keep my attention on the experience a bit more. Because you don't know what's going to come.

Okay. That's nice. Did you have any emotional or physical reactions to the experience?

No, not really. I became relaxed…

Um, then I basically don't have a lot more questions. Did you still feel things, have you experienced things that I haven't asked you about and thought, well, maybe that's interesting to tell me. Positive or negative, whatever.

Not really… what does that thing do?

Yes, we can talk about that now, because I'm not going to ask you anything else.

[explaining setup]

And this is a humidifier. It's supposed to make it feel even colder and windier. But it doesn't do a lot. Oh, okay. You're definitely not the only one who's like, what does is it do?

Yeah, okay. I also just showered, so everything is still a bit wet and shit. So that might be why I didn’t feel it.

Notes:

Wearing semi long sleeves and glasses

Laughed when lamp/wind turned on.

Participant 7 Transcript m/z

Then, first of all, do you listen to natural sounds? Videos, sounds?

Uh, no, not nowadays. There was a spa, at my old sports school. That's where we had it. It was very chill there.

Um, do you meditate?

No.

What did you think of it? In general.

> The voice was very soothing. I'm very curious if it was an AI voice or if you had it recorded. Furthermore, I noticed that the second time the experience was a bit less immersive. I'm not sure if that's because I knew what they were going to say. But I did notice that the light, especially, added a lot to the experience. At first I had to laugh, because it was quite sudden, and I know what it is going to do, but I honestly noticed that I was more immersed. Also the wind, I noticed a breeze and though 'ah now the fan is on', I was anticipating it. But then the voice said 'smell the rain' and I thought I don't smell it, so I missed some immersion there. But the second time I missed the added stimuli.

Okay, well, interesting. Um, were there any specific moments that you, you just said the rain, or the smell of rain, that you might have missed. But were there any other things that made it more immersive or less immersive that you hadn't mentioned yet?

> No, I don't think so. Well, light is the main thing. Because, uh, on a summer day, if you're lying somewhere, and you close your eyes, you get some light through your eyes. That was, I thought, a very nice addition.

Did you have an emotional or physical reaction to the experience?

> Yeah, like I said, I had to laugh a little at first. Because I, uh, we know what you're about to do. Uh, yeah. But I have to say that, I don't know if you saw my face during that, but I had to laugh. But after that, it made me more curious about the next experience. So there was a bit of curiosity then. Is the wind going to be blowing harder? What's coming?

And did that have any impact? You said you had expectations, did that have any further impact on the rest of the experience?

> Uh, I knew that the fan still had to turn on, because I saw the fan standing there. I didn't know exactly what that thing above me was [humidifier], so I had no idea. So I didn't know there would be more.

Yeah, okay. Those were my questions. Do you have anything else I didn't ask about that you noticed?

> Yeah, I'm still wondering what would happen if I didn't know that the fan was there. If I didn't know that those things were there. That I'd just be sat there, I'd have to listen. And then I'd suddenly feel Yeah, then I'd suddenly feel it blow. Then I'd maybe I don't know. I'm wondering if I'd realize that the things around me are happening, or that I I've started to imagine that I'm really there and that it's a part of my imagination.

Notes:

Wearing long sleeves

Laughing when light and wind turned on

Told me maybe the humidifier had an effect, they just though it was a vent or something.

They didn't realize the lamp had a red coloured light. In their mind/view it was just white/yellow light.

Participant 8 transcript m/z

Um, well, you had your eyes open, but you said you found it difficult.

> Yeah, because of the light a bit. But the second time it was okay. Um. But it was also because it was just new and stuff.

I understand. Do you listen to nature, sounds, videos, things?

> Very occasionally.

And what for?

> Um. Relaxation.

And do you meditate sometimes?

> No, but it would be good.

Um, what did you think of it in general?

> I really liked it, it felt nice. I feel completely zen.

Nice. That's nice to hear. Um, and do you know what immersion means?

> Nope.

Immersion is onderdompeling in Dutch. That you, you know, feel like you're the real thing. That you're completely in it. That's kind of what I mean by immersion. Um, that's what I'm going to ask now. Um, so how immersive did you find it?

> Yeah, I found it a lot more intense the first time than the second time. In a good way.

And then were there certain aspects, that made it more or less immersive, what makes it more or less immersive or more intense or less intense for you?

> Um, the second time you had to imagine everything yourself, which is sometimes nice. But, yeah, it just helps that you don't have to think about it extra, like, oh, there's wind, oh, there's sun, etc. It's just there, so then you're less busy with it, so then it feels more natural.

So I can conclude that the first time you were more immersed, you were more in it.

> It also went a bit faster than I thought.

That you were immersed in the experience?

> Yes.

Okay. Were there specific moments that you, within the first or second scenario, that you thought, now I'm really in it?

> I think from the point that you just had that sun and then you go into the rainy part.

The switch specifically?

> Yeah

Does what you felt make it feel more realistic?

> Mm hmm [yes].

Can you explain why?

> Yeah, I think that's also what I said, it just was there, and it was described, so it just felt normal, and otherwise you have to imagine it yourself. Yeah. So I think that's why it felt realistic. And just the timing and stuff, that it was also said at the same time. Yeah. Like, you have to pay attention now, and then it actually happens in time. I think it would have been less immersive if both the wind and the sun were there from the beginning.

And did you have any emotional or physical reactions to the experience?

> Relaxation of my body.

I think those were my questions. Do you have anything that you experienced or felt? Or something that I haven't asked you about yet? Something that you noticed or that you haven't yet?

> I don't think so.

Okay.

> But I do have a question, what is that thing [pointing to humidifier]? Okay, yeah, I'm going to tell you that in a bit.

[explaining setup]

And this is a humidifier. Which, so far, doesn't seem to have a big effect on anyone. It wasn't supposed to make you wet or anything. But it should feel colder.

> I think I might have felt it.

You did?

> Yeah. Yeah, now I'm just thinking about it, because I just thought it was those two things [wind and lamp].

Yeah, okay, well, I'm definitely going to write that down.

> But do you also mention it in the text? Like, it's getting colder or something?

Yes, It was also said it in the text.

> Oh yeah, the mist coming in, that was it. Yeah, now that I look back on it, I noticed that. But I thought earlier that it was just the wind.

Did the light do anything for you?

> Hm mmm [yes].

The actual light, okay. That's actually not the goal of my experiment. Because my research question is specifically about skin sensing, so things that can really feel on your skin. Such as heat, cold, wetness and wind. Light wasn't actually meant to be a part of it. But was it a positive addition for you?

Did it become green? [the lamp]

No.

Wow

Very interesting.

Yeah I was like, hmm, its becoming a bit green, is there something in front of the light?

Ah another participant thought that it [the lamp] was white, so it's funny that it's different.

Yes, in the beginning it was yellow.

Yes, I don't know how you got green, but maybe because of your sweater or something. [wearing blue sweater] I don't know. But funny. Yes, but that was actually not the plan at all. Do you have any more questions?

Let me think. Who did the voiceover?

A random American woman.

How did you do that?

A Fiverr website.

Oh, really?

Relatively cheap. And within a day I had it back. So I started editing. I was like, yeah, I can do it myself. But most people that would be testing it with me. They know me. It would be a bit weird. I though I could do it through AI. But it's just not nice and smooth. Or calm.

But it was a very relaxing voice.

Nice. Yeah. This is what I'm going to test, but the track has to be good. Otherwise you're not in it. So, I'm going to spend some money. Okay, that was it for me. Thank you!

Notes:

Wearing long sleeves

Participant 9 transcript m/z

Uh, my first general question is, uh, do you listen to nature, sounds, content, videos?

No, no, actually, uh, no.

Okay. Is there a reason why you don't?

No, not really. I did once, once in a while, I think it was a year ago or something, that I periodically listened to a lot of this and that, but no.

Okay. Do you meditate?

No. Uh, a little bit.

A little bit, how often is a little bit?

Yeah, I think also sporadically, once a month. Yeah. If it happens, it happens.

What did you think of it in general?

Yes, I found it, uh, relaxing. Pretty chill. Especially because it's a quiet moment, a moment of rest.

Do you know what immersion means? Or should I explain it?

Yes. Can you explain it?

That you completely, uh, It feels like you're in a different place. Or completely, yeah, you get the sense, as if you're in a different place. Did you find the experience a bit immersive in general?

Yes.

And why?

Well, um, Well, yes. In both cases I had, for example, that I did get a little cold, chills. Especially, with the sun, I found it quite a strong addition.

You said the sunlight, was there something else, where you thought, I'm really in it now. Or not at all, because it took you out of the immersion?

I immediately noticed the clicks and the sounds of the equipment. That it pulled me out a bit. Uh, I thought the sunlight itself when it was on, I thought that was very nice.

Okay. Uh, yes, the clicks, how bad can you hear them? Because, you shouldn't have been able to hear them.

Yes, the sound was quite low volume.

Oh, well, that's strange because I tested it upfront. Well, can't do anything about that now. Between the two moments, was there one where you were more immersed. And if so, which one was it for you?

At the first one I found the part with the sunlight, I found it, uh, I found it very strong. Um, but, uh, what I noticed with the second one was that because I was paying less attention to the sunlight, to the fan. I was less busy. I felt like I was listening to the story better. And that's why I was also better at visualizing it then. [so the second one was more immersive for this participant]

And, um, the sunlight, you felt that positively. Was it, was it specifically the warmth effect on you? Or was it also the light you saw?

Yeah, I think, I think the combination. But the abruptness of the light, that really took me out of my immersion.

And the other things you felt, how was that?

Um, yes, so, uh, for the rest, the wind was fine. But it's not necessarily necessary, I thought it made less of a difference. Compared to the light. And the heat.

Okay, good. Did you have an emotional or physical response?

Well, I had, uh, I had, uh, at least some shivers, in both cases, because of the cold, the fact that it was cold. And, I also had tears in the second part, but I think it's because I was yawning a lot. Well, I have a little tear in my eyes [kind of jokingly].

Okay, um, yeah, those are basically my questions. Do you have anything else that I haven't asked you yet, or that you think I missed? Or that's convenient to share?

What is that thing behind you, on the right side?

I can explain it to you now. I have a very nice little thing. This is the lamp. This is the fan. This is a humidifier. It should make it feel a bit colder. Like more windy. It doesn't always have an effect.

At least I didn't feel it consciously. Oh, and I also thought that the, uh, In the story it also starts to go into smell a bit. And, yeah, I had something in my head about how things look, but I'm not that good at imagining smells. I thought that several times.

Was it a distracting thing, that you think, well, the smell isn't there, so?

Yeah, yeah, yeah. It could be that I was a bit busy with that.

Okay. Good to know. Um, yeah, that was it for now. That's all I had to say. Thanks!

Notes:

Wearing short sleeves

Height of participant might matter

Sound of headphones was too soft

After debrief noted that the addition of physiological data might be an interesting future research option

Participant 10 Transcript z/m

So, uh, what did you think of it?

Nice! Um, yeah, yeah, well, uh, relaxed.

Do you sometimes listen to natural sounds or things?

I do meditate. I don't do specific natural sounds.

And how often do you do that? Six times a day.

Next question is, do you ever meditate haha? Yes.

Um, do you know what immersion means?

nods no

I'll explain it then.

Yeah, go ahead.

It's actually, the Dutch word is “onderdompeling”. You just feel like you're really there, so to speak, in a not real environment, like a book, movie or game can sometimes do. Uh, so now we know that. How immersive did you find it? Did you find it immersive?

Yeah. Yes, the second time?

Well, about the whole experience.

Yeah, definitely.

And the second time, since you mentioned it, was it more or less or different?

Yes, more. It was cool.

Can you explain why that was more immersive?

Um, yes, it works that you don't just hear. So that you can use those, especially those lamps. So then you just have more of the idea that you’re really there, so a little more envisioning.

And the lamp, was the light wat worked for you or the heat?

The light definitely, but the warmth as well a bit. And the audio, listening to the bird sounds, helps a lot.

So you were a little bit more immersed with the second.

Yesss

So, besides the lamp, did you feel any other things?

Um, yeah, so the wind of course, but it did a little bit less for me. But of course, it helps with the immersion. And, uh, it's cool that the headphones make a sound on both sides. So you hear birds all around you. ah. Yes, uh, and of course, the wind blows through the headphones.

Nice, uh, was there anything that felt like it distracted you?

Um, I think for the first time volume is on the loud side. Um, but I have sensitive ears haha.

Does it adding the stimuli make the experience more realistic to be in it?

Um, I think so. Yeah, and I think especially the lamp helped. Yeah. Did that thing in the corner do something [humidifier]?

Yeah, it did something, I'll get to that in a minute. Um, did you have any emotional or physical responses to the experience?

I think it's a little relaxing. Yeah, so I think it's a little bit stress reducing.

Nice. Um, those were basically my questions. Did you notice anything else? Or were there things that stood out that I haven't asked you about yet?

> I don't think so.

[explaining the whole setup]

And this is the humidifier. Which, um, In principle, should make the air a bit colder. But a lot of people don't notice it, or don't notice it consciously.

> Yes. Yeah, maybe I contributed that feeling to the fan. Yeah, exactly. No, yeah, maybe it's not the intention, but you hear audio and you think, Oh, what can I experience more? So I thought, oh, am I going to smell the scent? Am I going to do this am I going to do that? So I was aware of it, but I still didn’t notice it [the humidifier]. So that's, uh, very funny.

Notes:

Wearing short sleeves

Whatsapp notification could be heard

Participant 11 transcript m/z

What did you think of it in general?

> Very nice, just very nice.

Nice. Do you ever listen to nature sounds?

> Yes, weather sounds.

Weather sounds, okay, great, great. And how often do you do that?

> Not very often, but sometimes, yes.

What do you do with those?

> If I just lie down or something. But not super often, but I think it's chill.

And why do you think that? Is it a bit relaxing? Or why do you do it?

> Yeah, I don't know. The sounds of the environment give me a bit of a I don't know. Then I can completely move in there or something. And then I don't have to do the other things or something.

Yeah. So then it's just out of your head.

> Yeah, exactly. Yeah, it is.

Um, do you meditate sometimes?

No. I never take the time for it. I would like to be able to, but no.

Are you also familiar with what immersion means?

Yes? But, explain it anyway.

Okay, yeah, the idea that you can move somewhere to, um, That you really feel like you're there. Immersion can also be in a game or reading a book, but you're just there. Um, now you know that, um, how immersed did you feel in the experience?

The whole experience?

Whatever, yeah.

Okay, um, I can imagine myself pretty well, especially those sounds of nature, they really draw me to that idea. I also often walk through the woods near my house, and I could just imagine where I was about to be. Do you want to hear differences? Okay, I noticed. Uh, the first time was kind of, uh, I was shocked at first. But then the things like, uh, the breeze and the warmth on your face, I could feel a lot more intensely, or just experience it a lot more. I noticed that. The second time I think I could focus more on the story and the sounds, but the experience was less about the senses and that kind of shit.

Um, let's see. You mentioned warmth, did you feel more things on your skin?

Yeah, the breeze…

Were there still things that were distracting?

Yes, the first time you turned on the light. But as soon as it was on, it was no longer distracting. And when you turned it off, it was very distracting again.

Yes, then you have all those hard switches. Did you still have emotional or physical things? Responses.

Emotionally not, but physically I'm very calm.

Do you have anything else that you noticed, or had heard, or that you didn't tell me about, that you would have expected a question about?

No. I don't think so. Then that was actually the question I had.

Do you have any questions about the setup and stuff?

What is that thing [pointing to humidifier]?

That is a humidifier.

Oh.

It should basically make the air feel a little colder. But most people don't really notice it.

No, I didn't notice it either. But especially, I think, because, She said, “there's a bit of fog coming”, so I thought, hmm, do I feel anything? But I was just busy with imagining, yeah. Yeah. I thought first, at least not first, but just when I sat in here, I thought Is this maybe something

about smell or something? Because at some point there also has to be something about the smell of the forest floor and stuff.

Notes:

Wearing short sleeves

Participant 12 transcript m/z

Yes, what did you think of it?

Yes, I thought it was fun. Uh, yes, I also have some experience with meditation in this way. So it was chill to fall into it a bit, so to speak. Yes.

How often do you meditate in this way?

Mm hmm. On and off. I started a few years ago and then I did it very strictly for a few months. And then I stopped for a long time. And now I do it three times a week or something. A short moment a day.

And then it's also with natural sounds or more just

Sometimes. Yeah, it's just with Headspace, so to speak. It has all those daily things. But what I've been doing a lot lately is They specifically have a walkthrough nature thing. And that thing doesn't have anything specific. I think it also makes sounds itself. But they are more like, look, you're coming to nature.

Yeah, so it's very visual, sort of, I imagine. Are you familiar with immersion? Or what immersion is?

Yeah, that you can actually imagine that you're there. At least that's how I would see it. Yeah, and in this case also with Yes, sound and light and air, how do you call that?

So in general, how did you find it? Immersive, how did you find immersive?

Yes, I would say that it was immersive. Uh, anyway, I think dark space, close your eyes, pick up the phone, that helps a lot. Um, but with other senses, you're really brought there a little more. And at least a little less distracted, I think. I think that's, uh. That's the biggest thing, I think, with meditating, that you get distracted very quickly, so to speak.

And with other senses, which senses do you feel?

Um, I think, uh, well, there was light at some point, at least with the first version, the light came on at some point. Um, and, uh, indeed, the wind on your skin and the temperature itself. Um, but of course sound is also very important. Like, uh, And it's in the chair, but at some point you forget that a bit. The touch of the chair.

There were certain stimuli being added, how did that influence your experience?

Yeah, I'm pretty sure it would have been different if I had experienced the first one before the other. But in the first one I really had that, uh I was a bit surprised when the light turned on,

because you don't expect that, of course. But because of that I really thought that the beginning was different from the end. I think that if the light had been on the whole time, it wouldn't have had that much of an effect. But when it turned on, and then it turned off, and when the wind turned on, I think, so to speak, that that Uh, it added to the fact that you were going through a story.

Um, did it make you more or less immersive?

Yes, I think that the first round, so with the stimuli, was a bit more immersed than the second one. Uh, what I noticed, I assume that in the second one there was basically nothing going on, but still it felt colder in the end. That can of course be a coincidence, it could be that I expected it. Um, but because of that, yes, what I said, because of that I was a bit more immersed that the story was going, so to speak.

Yes, okay. Yes, there were still certain specific moments that you, you said it felt colder for the second time than you might have expected, was there something else that made you more or less immersed at a certain point?

I think what would have made it a little more immersive for me would be if the lamp hadn’t been turned on and off. I don't know if you've heard it before, but I had it that when the lamp turned off again at a certain point, I was really like, wow, I was shocked, so to speak. But I thought the wind was very well done. That just came very naturally, so to speak. That was nice.

Did you have any emotional or physical responses of the experience?

It was quite relaxing, that was really nice. I think, uh, I didn't really expect it to end with a kind of, it's going to rain now. Because usually in meditation things it always goes positively, so to speak. But I didn't think it was bad either. It was more like, oh yeah, it's going to rain now, that's okay too. That was also a bit chill in itself.

Good. Well. Um, those were actually my questions. Do you have any other things that you've experienced that I haven't asked about, or do you think it might be useful for me to know?

Yes. Uh. Yeah, it also depends on what you're focusing on. I don't know, for example, on the sound design, if you're really focusing on that.

No , not really.

I thought the tree sound was a bit loud. Yeah, it cracked a lot. Yeah, it cracked a lot. That was the only other thing I thought of.

Notes:

Wearing short sleeves

Participant 13 transcript z/m

Okay, what did you think of it?

I thought, uh, I thought it was very funny. At first I tried to imagine it, to feel the warmth. But then I got used to the second round of the lamp. And when it turned on, it was a lot more, yeah, real life. Very funny.

Okay, um, some background questions. So do you listen to nature, sounds, videos, things.

Not really, no. Usually when I needed it, I'd just go to my parents' house. I'd just go in by myself. It wasn't really that I thought at home, let me just sit in the chair for a bit.

Do you ever meditate?

No.

Do you know what immersion means?

Immersion?

In Dutch is the best translation is 'onderdompeling'. Just that you can feel like you're somewhere, you're not. You can with movies, you can with books, you can with games. But just, you're there. Um, because then I'm going to ask. How immersive did you find the experience?

Very immersive. Yes. I was really, right away, in the beginning I already had the feeling and so I could think a lot about home, directly about how it was there. I was just sitting on a bench, looking at a field. And the second time you just felt the warmth of the lamp and, well, the wind. I was much more in it or something. There was just much more sucked into it.

Yeah, so what I hear you say now is that it was an addition of the stimuli, such as a lamp, and things like that.

It did help, definitely. Yes, okay. Yes, in the beginning I could envision it, but when I actually felt it, the envisioning is less present, so it's just a lot more real.

Do you have any more things that you specifically felt on your skin, or?

So, in the first round, when we started talking about the wind and all that, all those light ripples started to come, or something, I noticed that a vague bit of goosebumps started to appear. And in the second round, I really noticed that I felt less comfortable immediately, you know, when the wind started to blow harder and the Yeah. In the beginning, the first round, it all went fine. And in the second round I was like, oh, it's becoming quite cold.

Nice. Um, were there specific moments where you felt more or less immersed?

Um, let me think. Yeah, I think, yeah, at first I thought it was going to rain again. I thought I would actually get water on me. And then at some point it said, well, it's starting to rain a lot. I think I can still remember that. How that was, and I didn't have that experience [getting wet], which is nice actually haha. But that was the least immersive.

Were there things that were distracting?

That's a good question. Maybe the light turning on distracted me for the first two seconds. Oh yeah, wait. Because at first I thought, okay, it's just the same thing as the first experience. Blah, blah, blah, blah, blah, blah. Then the light tuned on. Oh, never mind. We're going to do something else for this second experience.

Um. Did you have any emotional or physical reactions to the experience?

Of course. It felt very peaceful. I mean, it just brought me straight home. Just relax, just sit down, don't think about anything, just enjoy everything around you.

Okay, those are actually the questions I have. Do you have anything else, um, experienced, felt, thought, that I haven't asked you yet, that you think might be useful for me to know?

Um, goosebumps, I've had that. Lots of it. Yeah, when the wind was done, I was like, Let's go. I want something warm.

Do you have any questions about the setup? About the experiment?

I'm curious about the exact information you're going to share. How you're going to compare it to other interviews.

My specific research is actually focused on the effects, things you feel on your skin. The warmth of the lamp, the wind, and hopefully the coldness and wetness.

Notes:

Short sleeves

Laughed when light turned on

Participant 14 transcript

Okay. What did you think of it? In general. Well, uh. Yeah. Fun, relaxed.

Yeah, relaxed.

Nice. Do you listen to natural sounds? Videos?

Actually not. No.

Is there a specific reason for that?

Not really. No.

Do you meditate sometimes?

No.

Are you familiar with what immersion means?

Not really.

Okay. The Dutch translation is “onderdompeling”. Actually, what it means is that you can really imagine that you are somewhere. It can be while reading a book, while gaming, or while doing things like that, for example. Knowing that… How immersive or how “ondergedompeld” did you feel in the experience?

> Well, the first time was pretty, you can, with the wind and the wind It was pretty yeah. You could get a good picture of what it would look like, I think. The second times a little less.

Yeah, okay. Um Were there specific things that made you think, now I'm in it more, or I'm in it less?

> Yeah, I think that light, and the warmth.

And the light made you feel more immersed?

> Yes, I think so.

Did you feel other things?

> Not really.

Did you have emotional or physical reactions to what you saw, heard, felt?

> Not really, no.

And were there any things that were distracting, or that took you out of the experience?

> Not really.

Those were actually my questions. Do you have any things that you noticed yourself, or that you thought, I noticed that, or I had those thoughts, and that might be useful for me to know. Do you have any other questions about the whole experiment?

> I'm curious what you're doing with it.

My The main goal is to look at what the effect is of, uh, the stimuli added to your skin, so that's the heat, the wind, and that third thing there is a humidifier, which should basically make the air a little colder, but so far no one has really noticed that. Um, and then, yes, that could be used for, um, digital nature experience, for example, in healthcare, people who themselves can no longer go into nature, because then, for them, they can kind of imitate it. And then it's nice to know if it has an effect at all and what kind of effect it has. Um, So that's kind of what I'm trying to find out.

Notes:

Wearing rolled up sleeves

Seemed a bit on edge/uncomfortable

Participant 15 transcript z/m

What did you think of it?

Very, uh, nice.

Um, let me ask you some background questions. Do you listen to nature sounds?

Not really.

Not really? Why?

Never, uh, had the conscious need to listen to nature sounds.

Do you meditate sometimes?

No.

How immersive did you find the experience in general?

It's pretty good.

Nice. Yeah. Can you explain why?

Yeah, just that, that you shut off all the noise. Just focus on that one voice. And it's just very descriptive in what it says.

Were there specific aspects of the experience that made it more or less immersive?

Well, especially the wind, that helped. Uh, I had the light a little less. It was more distracting that it suddenly turned on, actually. Um, but yes, the wind did, because it was so much about the story and, uh.

Nice. Um, are there any other things you felt during the experience?

No, especially light and wind. Okay. At first I had a bit of a wind because I was completely under the sweat. You feel everything that's in the room.

Did you have an emotional or physical response to what happened?

No, not really. Except that it was possible. Fair.

That was actually my question. Have you felt things just now, or noticed things just now, that you think might be useful for me to know?

Not necessarily, but what I miss a little is the smell. And that is of course a bit more difficult, because she describes the smell very well. Yes. That would have been a nice addition, I think.

Further general questions?

What is that [pointing to humidifier]?

This is the lamp. This is the fan. This is a humidifier. Which should make the air feel even colder. But until now, almost no one has had the effect of it.

Yeah, I think it might also not work because it’s so hot right now. Everyone is already a little sweaty.

Yeah, I also tested it two weeks ago and then I was cold. So it's really, no, it just doesn't seem enough.

> No, that's true. It seemed like, because I had already seen that the lamp was there, but that it [the light/heat] came from the front [instead of from behind]. I thought huh, there wasn't anything in front of me.

Some people have told me they imagined the sun on the right, but then it was on the left.

> Yeah, but it came from the right for me.

Notes:

No sleeves

Sligh smile when turning off light and wind

Participant 16 transcript m/z

So what did you think of the experience?

> Fun. I liked it. I always like to meditate anyway. So a moment of peace. Sometimes doesn't hurt.

You told me already, but you meditate sometimes?

> Uh, yes. My psychologist tells me to.

How often do you do that?

> Uhh, I haven't done it in a few weeks. But before that, I don't know. Yeah, normally I try to do it, I think once a week or so. But I have to do it more often.

Okay. And do you listen to nature sounds?

> No. I have birds outside my window, so I listen to that.

Fair. Um, do you know what immersion means?

> Yes.

How immersive did you find the experience?

> Which one?

You can tell yourself.

> Okay, um, the first one, the one with the effects, was a lot more immersive than the second one. I noticed that I was a little less comfortable with the second one. Okay. And with the first one I knew, oh, I started, well, I did get a little bit carried away by the effects. I got a little carried away by the effects again. Because I knew like Ah, this is part of it. So, I thought, ah, the sun and oh, the wind. That's why I laughed a little bit, but it did help with the wind. I noticed a big difference with the second time, where I noticed that I was transcending less or something like that. Or

what’s it called. I missed the stimuli in the second round especially. I think that if you get it the first time and don't expect it, you can get it out of your system. But if you do it a second time, it will help a lot.

Were there specific moments that you had where you were like, I'm going to get it. Specific moments that stood out to you?

Yes, when the sun came up, I was taken out of my immersion a bit. But after that, I felt just a bit more deeply in it. Okay. Um, same with the wind. But after that, especially when we went towards the sea. No, no, when it started to rain, I mean. Because it sounded a bit like the sea. Um, then I got into it completely. And then it was like, oh, we're done now. And then I was like, then I thought, oh, I'm just a kind of nicely in there. So especially towards the end, it always takes a minute or two or three to get into it. I wouldn’t mind the experience being a bit longer.

Besides the sun and the wind, did you feel any other things?

I didn't feel any water. But I did expect it. Okay. Because I saw the machine standing there. And I saw it was wet. I was like, huh?

We'll get to that in a minute.

Is it empty?

No.

But I thought, since I'm getting wind and sun, I'm also expecting You feel, uh, You feel mist. Then I thought, where is the mist?

Do you have any emotional or physical responses to The experience.

Um. Yeah. On the one hand it was a bit calmer. Um. Relaxation. A bit of calmness. Um. I Through ah, I should do this more often. I notice this is good for me. And physically I noticed that I was more relaxed. And I noticed that I could relax a bit better. I also noticed that the chair was a bit slanted, I don't know, not quite right in front of the table.

You moved it yourself haha.

I know, whoops… I think if it would have lasted even longer, I think I would have had the thing where your limbs would start shivering because you were so relaxed. You were in sleep mode. But I didn't have that just yet.

Um, oh yes, you expected that water or something, do you expect that because you saw a third thing? Say, before the experiment?

No, not because I saw it beforehand. But I expect that because I get the other sensations. And every time something is said, you feel it in the experience. And that wasn't the case with the third one [humidifier]. And I heard the rain, and I thought, I want to feel that rain. Yes, because the other stimuli were in the experience, I thought. Oh, this is going to be a kind of 4D movie experience. Yay! But that didn’t happen. Then I was a bit disappointed.

Yeah, okay. Um, those were basically my questions for you. Do you have any other things you've just experienced, felt, noticed, that I haven't asked yet? Or I don't know, maybe that's useful for me to know.

> I had expected the sun to be a bit more in the front. Because, as it says, you feel the sun on your face. Um Yes, you could make the experience even more immersive by putting a wooden bench down.

Ah, yes, that was part of a plan, but logistically difficult.

Notes:

Wearing short sleeves

Participant 17 transcript z/m

Okay, okay, what do you think?

> Well, I'm a bit more relaxed. Nice, that's the first impression.

A background question. Do you listen to nature sounds? Content, videos?

> Yes, when I really can't sleep. Sometimes. I listen to nature sounds. Yeah, nice.

And a specific sound?

> Uh, a bit of, what's it called? A bit of a hard fire with some rain.

Do you meditate sometimes?

> No, not really.

Any reason why you don’t?

> I always forget that this is actually chill. Every now and then, I do it sporadically. And then I think, wow, this is actually quite nice.

Yeah. Okay, do you know what immersion means?

> Yeah, that you just go into what you're doing, I think.

Yeah, that's about right, indeed. Know we now that, how did immersive did you find the experience?

> I noticed that the second time, when something happened around me, that you can just imagine what it looks like. And that the first time I had that a little less.

Okay. Um, can you describe what specifically the things are that you were more into?

> Well, I liked the warmth of the lamp. Um, and the breeze. For sure. I have the feeling, I guess that there should be rain, but I didn't really notice that.

We'll get to that later.

Um, but yeah, I thought that, yeah, that helped to really get into it and not get distracted.

Nice. Did it have an effect that you already saw things? Like, a lamp and a fan?

Yeah, like, I could already guess what I could expect. That it would be one time without the stimuli and one time with. So maybe that also had a bit of an influence on how I experienced it.

Were there any things that were distracting or less chill?

I was distracted when the light turned on for the first time. That I thought for a moment, wow, okay, oh, what? So that distracted me a bit. And I think it also helps that the second time you've already had a meditation moment. So then you're already relaxed. The monkey brain has become a bit calmer. So I can focus on that a bit more.

Did you have any emotional or physical responses to the experience?

Well, I thought I'd have a nap in a minute, actually. Nice. It's just nice to relax.

Um, those were basically my questions. Do you have anything else you'd like to add?

[asked about setup]

[talking about humidifier] Yeah, I don't know, I think that maybe if you would have it in front of your face, that you would Because now you can see that it's kind of blowing over my shoulder. Yeah. And I'm wearing a shirt, so it doesn't do much.

No, it was a bit like, how much do you put things in peoples faces? Because then people also find it exciting. I get that. So that was a bit of a test. But yeah, it's just not the optimal thing. You're almost no effect.

No, and I think that if you, with that lamp, it was very nice. But if you could just put a little dimmer for the on and off moment, then it's a little less distracting in your face. Where you think, wow, okay, oh, there's a light on. And oh, too bad, it's off.

Do you have any more questions?

No. Did you make that meditation thing yourself [talking about audio track]?

Yes.

That's just out of interest.

Yeah, I made it myself.

Notes:

Short sleeves

Later said they felt a bit stressed when the story went from nice and sunny to windy/stormy and the wind started to blow

Participant 18 transcript m/z

What did you think of it?

> Yeah, I thought it was nice. How can I say it? Sort of what I thought of it.

Tell us what you thought.

> Yeah, I thought it was nice. You did notice the first one, that you were more into it. Uh, in the beginning, when that light came, I thought, oh, light or something. Yeah, um, it would have been more chill if it can go more gradually. Um, yeah, the first one felt more intense or something. And then you're a little further away from here [here being reality] and then I had a little less trouble getting here with the second one. Um, but I did find it nice. It felt a bit like meditation.

Do you sometimes listen to the sounds of nature?

> Um, yes, very sometimes. A little more than when I want to go to sleep or something. When I want to have some sound. But not often or something.

And do you meditate sometimes?

> Yes, I do. Yes, I think I try to do that every morning.

Nice. Um, are you familiar with what immersion means?

> Um, yes, a little bit. That it's very, that you're like, um, In. Yeah. Yeah. experience. Um, and that you have that light, that makes you feel like you're there. So I thought that was nice. I'm looking at the thing next to it. I have no idea what it is. I'm curious.

Well get to that. You said light, but did you also feel things on your skin?

> Uh, wind. And other than that, not really.

Let's see. You've already answered a few questions, that's nice. What other emotional or physical responses have you experienced?

> Um, first, when the woman started talking, I was a little irritated by her voice. But after that it didn't annoy me anymore. But that is actually further, yes, that you relax a bit, actually.

Okay. Nice. Um, yeah, those were the questions I had. Did you answer them? Yes. Do you have any questions that you just felt, experienced, noticed, that I haven't asked you yet? Um Or that you think is maybe a chill for me to know?

> Yes. Um, I thought in the beginning that there were quite a lot of wind sounds. And because of that it was a little less relaxing or something. Yes. Well, that. Yes.

Okay. Uh, more questions about the general setting?

> Yes, what that one thing is. I have an idea.

Yes, tell me.

> That it should be something like rain.

Yes.

Yes. But I didn't really feel anything.

This is a heat lamp. So, did you feel any heat?

Not specifically. I mostly saw light.

You saw light?

Yes, I saw light.

Um, this is the fan, the simplest thing here. Um, This is a humidifier. It wouldn't necessarily have to take care of rain. I don't want to make people wet or anything, but it would have to make the wind feel a bit colder.

Yeah, I see.

But until now no one has really noticed the effect of it, so that's okay. And also because it's very minimal.

Yeah, that's probably true. If you had something like water drops you feel that but then I understand that you don't do that because that's kind of intense.

Yeah, that's true. I can explain the idea more anyway, because it's not at all the idea that I want to make a whole immersive experience or anything, it was more the effect between two experiences and then see if stimuli have an effect. Specifically stimuli on the skin, that's why it's actually annoying that that lamp is so bright, because I actually just want the warmth of it.

Oh, okay. So I thought the lighting was pretty nice.

Yeah, well it's not like people say that the lighting sucked. It was very sudden, but it wasn't meant to be a part of the experience. No, exactly.

Notes:

Wearing short sleeves

Participant 19 transcript z/m

So, what did you think of it?

Relaxing, very relaxing. Yes, very calming. Calming and relaxing, I think.

Chill. Um, some findings. Do you listen to natural sounds? Natural videos?

No.

Any reason for that?

No, not really a reason for it.

Do you ever meditate?

I've tried it once, but not at the moment.

Okay, fair. Why not then?

Uh, yeah, I don't have a lot of extra needs at the moment, I think.

Fair. Um, and do you know what immersion means?

A very, very little bit, but

Try to explain.

Uh, that you're completely, uh, absorbed in a situation that maybe you're not Yeah, you're just completely immersed in a situation.

Yes. Knowing that, how immersive did you find the experience?

Yes, good, yes.

Can you explain why?

Uh, the buildup was good in the story. That the step by step added something. So that helped to visualize it for yourself. Um, so that was nice. Um, and also the voice, it helped, it's calm. What I also really liked was every time, um, a few times the story came back to the breathing. That also helped me a little bit more.

You said 'the first time', so you noticed a difference?

Uh yeah, the second time, I felt it more, Uh, you feel the sun, that air, uh, yeah. It does a lot for the immersion, a kind of warm blanket that came around you. Uh, and also the wind, you could feel it in your face. You really did notice more of a difference. It became more realistic.

Were there things that were distracting, or experiences, or within an experience, or a moment?

No, I can't think of anything really.

Were there more things that you felt?

Yeah, only in terms of the surrounding factors, the temperature, the kind of warm temperature and the wind. Okay. And maybe a colour for the second time.

Okay, what colour then?

Yeah, it suddenly became green.

That's very interesting.

Okay, I saw, at a certain point it became more, I got more green, green aura. Okay, but that wasn't very explicit. No. The other two were much more significant.

Yes, okay, um, Did you notice any differences between the first and the second time?

> Not really, but it might help the second time, because you already had the same story. Yeah. That you don't have to sketch an image in your own head. Where you are, what you're doing, so it helped me to get into it. Because you already know the story.

Did you get any emotional or physical responses during the experiment?

> Oh, that you just calmed down a bit. Yes, but I think that also is a factor when it comes to the breathing. Every time I hear it I'm like, you're paying attention to your breathing. It gives you a certain peace of mind.

You've already answered a lot of my questions. Do you have any other things you've noticed, felt, noticed, thought about, that I haven't asked about yet?

> Um, I think No, no, actually not.

Do you have any other questions about the setup, or the experiment.

> Yeah, so was I correct? Were those the two things that you applied? [talking about warmth and wind]

Well, I have, uh, the sun, or warmth. Um, I don't know, did you notice the light?

> No, I didn't notice a big difference. You could just feel the warmth coming from behind, which was nice.

Then you have the fan. It's quite self-explanatory, I think.

> Exactly.

And this is a humidifier. Which is supposed to make the air around you a bit colder. Not that you get wet or anything, or that you really feel like it's raining.

> What was it, that green colour? Really halfway. Hmm. Something after halfway. It looked like, no, just like your eyes, I always see a colour. But it looked like, someone changing the colour.

I have no clue; the lamp has a red light. But it is interesting that you mention it.

Notes:

Wearing short sleeves

Appendix H

During the preparation of this work the author used Descript [43] in order to transcribe interview recordings. After using this tool/service, the author reviewed and edited the content as needed and takes full responsibility for the content of the work.

During the preparation of this work the author used ChatGPT [44] in order to check for grammar, spelling, consistency and flow errors, as well as text clarity enhancement and the creation of a storyline for the script in *Appendix C*. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the work.