Spatial Sound in Digital Nature

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Bachelor Thesis - Creative Technology

Impact of immersion through spatial sounds on the effects of a digital nature experience for older adults

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Abstract

Nature sounds are considered healing and have restorative functions on stress levels and wellbeing. In the field of digital nature, most research has been performed on the effects of the digital nature as a whole, but not on the effect of different audio complexity for the nature sounds. Spatial sounds have shown to be promising for increasing immersion and attention, making it useful for enhancing the digital nature experience. In this thesis, we use VR glasses to explore the difference between mono audio and spatial audio in a digital nature experience. Results are measured with questionnaires and an observational scale. The results shows a slight positive trend in relaxation and no change in spatial presence and attention. A difference in curiosity was measured between the two conditions. A difference was not actively noted by the participants, but the results suggest that the change in audio could be perceived subconsciously.

Acknowledgements

First of all I want to thank my supervisor and critical observer, Josca and Thérèse, for being as supportive as they were. Without your amazing guidance and our lovely tea meetings I wouldn't have made it as far as I have. Thank you.

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Lastly, I want to thank all my participants for working with me and wanting to help with my thesis. Thank you all!

Contents

1 Introduction

Birdsong has a positive impact on human wellbeing (Alvarsson et al., 2010), it helps relax and sooth the nervous system and can trigger the feeling of reminiscence. Without birdsong, (digital) nature might even feel a little eerie. Even though a (digital) nature experience is a personal experience, based on memories and experiences, it connects us all. Experiencing nature, even if digital, has shown to increase a sense of connectedness and relaxation (van Houwelingen-Snippe et al., 2020), making it useful for people who have limited abilities to experience nature on their own. This makes it a really valuable asset for nursing homes, where loneliness tends to roam.

Nursing homes have a rising demand for staff (Actiz, 2023), there are less people willing to work in social work and more older adults in need of help. To reduce the pressure on the nursing home staff, digital nature can help. It could provide the benefits of nature for the residents who need it, without the help of staff.

In the upcoming technology of digital nature, the level of immersion plays a role in the effectiveness of such an experience (Otten et al., 2022). Watching a digital nature video on a phone has a different effect than experiencing digital nature on a large screen. Spatial sound has shown to have promising qualities that can help the attention and curiosity of users (Hirway et al., 2024), making it useful for increasing the effects of a digital nature experience. In the current research, the focus of digital nature and its' benefits is mostly on the visual input. However, research shows that sound also has a large impact on our experience of the world and our sense of realism (Hirway et al., 2024). Spatial sound is widely used in the world of video games, but not in other virtual reality experiences.

In this thesis, I will explore the use of sound immersion in a digital nature environment for older adults and investigate how the use of sound immersion affects older adults' digital nature experience. For this, spatial sound will be used in combination with virtual reality glasses. Furthermore, there will be a focus on bird presence, birdsong and their use to elicit a positive mood state. The research questions for this research are:

Main Research Question

How does a higher level of immersion through spatial sounds in a VR experience impact the effect of digital nature for older adults?

Sub Research Questions

Which sounds from nature can help improve human wellbeing, and what effect do they have on moods?

Which factors influence the level of immersion of a virtual reality experience?

2 Theoretical Framework

2.1 Literature review

A body of knowledge is needed to start designing the experiment. For this, there first needs to be a literature review to help understand the current knowledge that is out there. This literature review exists of three parts, first the effects of digital nature are explored and an initial image is shaped for what kind of nature is most preferred for a calming experience, then the sounds of nature are explored and there is a deeper dive into how the nature sounds affect people and what sounds are best to use for a calming experience and lastly, there is a section about the current state of immersion and how it could be used in a digital nature experience.

2.1.1 Digital Nature

In the research tended nature showed to have a better impact on older adults for themes such as an increased feeling of connectedness and positive mood states. Van Houwelingen-Snippe et al. (2020) found that short dosages of digital nature could help to feel less isolated by inducing enhanced feeling of connectedness. They also found that digital nature could improve mood and attention. This gets supported by later research (van Houwelingen-Snippe, Ben Allouch, & van Rompay, 2023) (van Houwelingen-Snippe, Allouch, & van Rompay, 2023) where they found similar effects on older adults. Participants felt more positive emotions (peaceful, content and serene) after experiencing digital nature. They also experienced less negative emotions after the digital nature experience (annoyance, irritation and anger). Markwell and Gladwin (2020) however, found that 'real' nature works better for themes such as improved wellbeing and mental refreshment, whereas digital nature was more associated with a loss of concentration. This experiment was held in the forest for one group and inside with a video of the forest for the other group. Since this research used a non-immersive medium (computer screen) for the digital nature, it would be interesting to explore if a more immersive or realistic digital nature experience could be more beneficial for improving wellbeing.

Otten et al. (2022) looked further into why nature can inspire conversations and found association to be of importance. Associations triggered by digital nature promoted nice conversations surrounded by positive feelings. Kim et al. (2023) looked at the causes for feelings of relaxation caused by nature and found 4 influences; Qualities of the scene (e.g. time of day and colours), engaging qualities, familiarity of the scene, and qualities added by memories or imagination. This agrees with the findings of Otten et al. (2022), personal associations with nature are a great influence on how we experience (digital) nature. Also, personal relatedness to nature can improve after experiencing digital nature (Leung et al., 2022). This means that digital nature might be beneficial for most people, even if they do not have a connection with nature.

Spacious, as opposed to dense, nature can help solicit social aspirations (van Houwelingen-Snippe, Allouch, & van Rompay, 2023), landmarks can be used to direct attention and allow for perspective (Otten et al., 2022). Human made objects can be important to give a sense of human presence, providing a safer feeling to the environment. van Houwelingen-Snippe et al. (2020), van Houwelingen-Snippe, Ben Allouch, and van Rompay (2023) and van Houwelingen-Snippe, Allouch, and van Rompay (2023) found tended, spacious nature to be of importance for eliciting social interactions. This can be achieved by adding objects that indicate human presence, such as lamps and benches. Adding engaging qualities, such as elements of mystery (hills, curved pathways), can also help make the area more interesting and conversation provoking (Otten et

al., 2022) (Kim et al., 2023).

2.1.2 Effects of Nature Sounds

The following was written for an assignment related to this project (Zoutman, 2024).

From the research follows that there are two categories of the sounds of nature; Animal sounds and environmental sounds. Water and birdsong being the most prominent for the use of making nature sounds relaxing. Furthermore, a perceived increase in biodiversity can also lead to a positive increase in perceived wellbeing. In 'beyond landscape', Bates et al. (2020) asked participants to share their idea of well-being boosting sounds. 58 percent mentioned birdsong and 34 percent mentioned running water, like waves and rivers. In other research (Song et al., 2023) (Jo et al., 2019) (Alvarsson et al., 2010) (Ratcliffe et al., 2013) where they looked into the relaxing features of sounds, they also used either birdsong, running water, or a mix of both as their 'nature' sounds. These papers all concluded positively on the well-being and health effects of these sounds. Ratcliffe et al. (2013) found that the effect of the sounds were often associated with personal experiences. Restorative effects are found to be different between species, depending on the specific species aesthetic and acoustic properties, but the restorative perception of nature is also due to personal memories. Lastly, Ferraro et al. (2020) found that an increase in *perceived* biodiversity aided in peoples' perceived increase in well-being. Meaning that if people think there are more kinds of animals, they will feel better than if they think there are less kinds of animals.

Nature sounds are thus more useful if the biodiversity is varied, even though the specific bird species do affect different people differently. Research does agree that birdsong and water are most useful for creating a calming nature soundtrack. However, the current research lacks the effect of nature sounds in a digital environment, which could interesting in research of digital nature.

Hearing nature-based sounds of varying origins increases peoples' sense of well-being and has an effect on peoples' perceived health. Song et al. (2023) and Jo et al. (2019) had really similar results, both reported the participants felt more natural, relaxed and comfortable. They also stated the negative mood state was improved after hearing the nature-based sounds. Ratcliffe et al. (2013) also stated that after hearing the additional bird sounds (in his research only an addition of bird sounds was used as the experiment took place in a park) may offer "perceived restorative benefits" Ratcliffe et al., 2013. However, Bates et al. (2020) found that there is no single soundscape for everyone, since the experience is very personal. They state that there is no inherent increased sense of well-being in a nature-based sound experience, but that is important to leave space for imagination in 'sensescapes'. Finally, Ferraro et al. (2020) states the perceived sense of well-being is also impacted by an increased perceived biodiversity, but they also found that an actual increase in biodiversity is usually unnoted by a casual parkgoer. An increase in different types of birdsong (real or fake) is however noted and perceived as an increase in biodiversity, and can therefore help create in a better sense of well-being. For future research it could be interesting to compare different nature environment soundscapes, comparing a meadow to a forest for example to see the different impact of both on human mood and well-being.

Nature sounds have a measurable effect on the human body. Song et al. (2023) found that listening to nature sounds while in a more active and stressed state helped relax and reduce stress faster than when resting without the nature sounds. Alvarsson et al. (2010) also found faster recovery of psychological stress after being exposed to nature sounds, in comparison to pleasant noise of similar "sound pressure level" (Alvarsson et al., 2010).

Exposure to nature sounds was also found to show significant improvement in oxygen levels in the prefrontal cortex in the brain and lower heart rates when compared to urban city sounds (Jo et al., 2019). A lower level of oxygen (oxy-hemoglobin) in the prefrontal cortex means there

is less activity and thus a more relaxed mind state can be reached. Bates et al. (2020) looked into the origin of the restorative properties of nature sounds and found memories to be of importance to the recovery effects of nature sounds. Ratcliffe et al. (2013) agree with this, stating personal experience and associations with specific sounds, such as different species of birds, are one of the three main themes connected to the effectiveness of restorative properties of nature sounds. The other two themes included "cognitive appraisals" (Ratcliffe et al., 2013), meaning it is a nice distraction while stressed, and the ease of listening to the sounds. But the most important outcome of that research was the importance of personal connection to nature. Interestingly enough, Leung et al. (2022) found that by exposing a participant with a lesser connection to nature to a digital nature environment through virtual reality glasses could improve the "nature relatedness" (Leung et al., 2022) of that participant. This could mean that if a nature room were in use in a nursing home, it effectiveness could improve as it gets used and the experience can be useful (at least over time) to both people with a higher and lower affinity to nature.

2.1.3 Immersion in Digital Nature Experiences

Sound is very important for immersive experiences and improving the realism of a scene (Kenwright, 2020) (see figure 1). The research performed on immersion and spatial sounds in virtual reality experiences are mostly about video games and how sounds influence the experience. Kenwright (2020) discussed the ways sounds are important in virtual reality gaming. How it influences the players' mood and aspirations.

In a recent study spatial sound was found to significantly change patterns in gaze and pose fixations during a virtual reality experience and also on physiological responses (Hirway et al., 2024). The complexity of the sounds (e.g. spatial, stereo or mono) had an impact on the participants heartrate and pupil dilation. The spatial sound condition led to a more enjoyable and attention grasping experience.

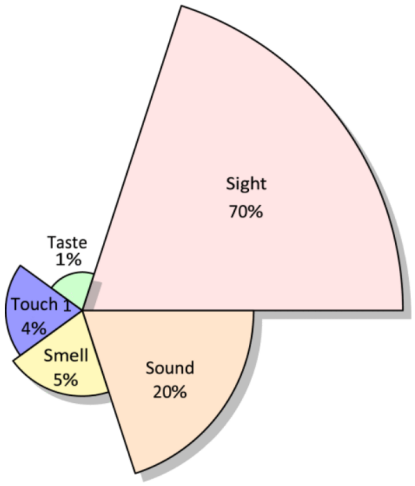

Figure 1: Comparison of the importance of the human senses in an interactive environment (Kenwright, 2020)

2.1.4 Outcome measures

Previous research (Otten et al., 2022) (more sources) found relaxation and a feeling of connectedness to be inspired by viewing digital nature. Otten et al. (2022) stated in his limitations that immersion might have reduced the effectiveness of the experiment. Since a feeling of connectedness is difficult to investigate in a smaller study, the main focus will be on the increased feelings of relaxation and immersion.

2.1.5 Birds song in the Netherlands

To create a realistic and pleasing soundscape, it is good to know the birds in the Netherlands and to know what bird sounds are most appreciated. According to a public poll from BNNVARA

(2009), black birds have the most pleasing song, followed by the nightingale, the song thrush and the robin.

2.2 State of the Art

In this section, a few recent developments in the field of digital nature, sound immersion, and VR for relaxation will be explored to find insight to use in the final design for this thesis.

2.2.1 Digital Nature

Van Houwelingen-Snippe, Allouch, and van Rompay (2023) created a digital nature experience for older adults to help reduce loneliness in nursing homes. The experience is made to increase a feeling of connectedness. This is made as an additional way to experience nature for people who cannot experience nature on their own. The video is shown on a large screen, making it very accessible. The video is a walk-along through nature, where the focus was on transitioning from dense to spacious (and the other way around). Spacious nature showed to elicit significantly higher social aspirations (van Houwelingen-Snippe, Allouch, & van Rompay, 2023).

2.2.2 Spatial Sound in VR

Hirway et al. (2024) performed research on the effect of spatial sound in a virtual reality setting. They found that the user is more active and has more curious visual attention when listening to spatial sounds compared to other sound types. The spatial sound influenced what the participants looked at and for how long. It also affected the participants head movements, increasing the frequency of changing head positions.

2.2.3 VR Environments for Relaxation

The company 'Atmosphaeres' provides nature scenes from all around the world for VR (Atmosphaeres, 2024). These virtual environment videos are made to provide relaxation, but use additional meditative music and guided meditation to accomplish this. These VR experiences are live recorded, instead of 3D modelled. This makes it easier to produce, but less easy to adapt the scene. Using real footage could help older adults feel more at ease, since real people could walk by and it might feel less static.

3 Methodology

In this chapter, the elements necessary for creating the experiment will be outlined.

3.1 The Creative Technology Design Process

The process most used in the study Creative Technology is the Creative Technology Design process (Mader & Eggink, 2014). This was created by A. Mader and W. Eggink. This process is an iterative design process that uses four phases to create a design; Ideation, specification, realization and evaluation. This process is key to design for users and was used in this thesis.

3.2 Ideation

To gain ideas for the setup of the experiment, brainwriting and mindmapping were combined. For this a circle was drawn with the premature research question "How can we increase feelings of relaxation and connectness in a digital nature experience for older adults?". This circle was surrounded by themes that could influence the effectiveness of digital nature. This was repeated twice more. From this the main idea of using spatial sound emerged. More on this in chapter 4: 'Ideation'.

3.3 Outcome measures

To test the effect of the experiment, relaxation was chosen to be investigated. Improving social aspirations will be too difficult to test properly with a smaller testing group. Therefore relaxation, a different effect of a digital nature experience, was chosen. Next to this spatial presence, attention and curiosity were chosen as outcome measures.

Relaxation can help bring down stress levels, helping the participant to feel at ease. This will be measured by asking to rate the relaxation they experience before, between and after, using the Relaxation State Questionnaire Steghaus and Poth (2022) (see Appendix 21).

Spatial presence is important for assessing the difference in immersion and will be measured using the Spatial Presence Experience Scale Hartmann et al. (2016) (see Appendix 22, items 10-18).

Lastly, the levels of focus and attention were measured. This was done to ensure the spatial scene had been implemented successfully. This is based on the research of Hirway et al. (2024), where he found that spatial sound improves the levels of curiosity and attention. To measure attention, a small questionnaire had questions on the attention of the participant (see Appendix 22, items 19-21), these were created for this research and have not been tested like the previous questionnaires.

Curiosity will be measured with with an observational scale using pose monitoring during the tests (for the checklist see Appendix 24). The movements were tallied on paper to find a difference between the mono and spatial audio.

3.4 Participants

Since this project is ultimately about helping reduce the pressure on nursing homes and improving the wellbeing of residents of nursing homes, the participants have to be able to relate to that user group. The participants also need to be able to perceive the virtual environment. Therefore the participants need to qualify for the next points:

- They need to be at least 65 years of age.

- They have to be visually able enough to see the environment in VR.
- They need to be able to hear from both ears.

11 participants were collected by convenience sampling. Ten of these participants live in the province 'Zuid Holland'. They are all keen on nature and still physically able. 1 participant is slightly visually impaired, but could still see enough to participate in the experiment. Convenience sampling was used to gather participants for the experiment. The participants are all without cognitive impairment, they could consent for themselves.

3.5 Testing

Before testing, the participants were given an explanation on the research and were handed a consent form. After signing the consent form they will be asked to fill in questionnaire 1. After filling in the questionnaire, the participant will be shown the first nature scene. The two variants of nature experiences will be randomised in order minimize the effect of bias on the tests. After the first experience, they will be asked to fill the in second questionnaire. Afterwards, the second scene will be shown. Lastly, the third questionnaire will be filled in and a final interview will be held on the effects and differences of the scenes.

4 Ideation

4.1 Main Idea

For an initial direction two common ideation techniques were combined, mindmapping and brainwriting (see figure 2). Brainwriting is an ideation technique where ideas are created by writing ideas in columns. During a round, you write an idea in every column. The next round, you write an idea in the row beneath the previous on, where the idea is based on the idea in the previous row. The middle states a research question. Going outwards, the new layers represent new ideas. Mindmapping is an ideation technique where you start in the middle of a page and ideate outwards, creating branches of ideas. By removing the constraint of the mindmap, where you stay in one branch at a time, the ideas were merged easier. By mixing the ideas (for example 'Sound' and Immersion' resulting in 'Spatial sound') the flow of ideas did not have to be categorized in a single category. From this the 'spatial sound experience in virtual reality' was chosen to further investigate.

To test the influence of spatial sound is tricky since it is a relatively small adjustment to the experiment. Therefore, within-subject testing will be done. There will be 2 experiences with the same scenery, but different soundtracks. One will have spatial audio and the other mono audio. Two limit the influencing factors, the experience will be sitting on a bench surrounded by nature. This way the participants can really focus on the details of the scene. In the next subsection, the specifics of the experience will be explained.

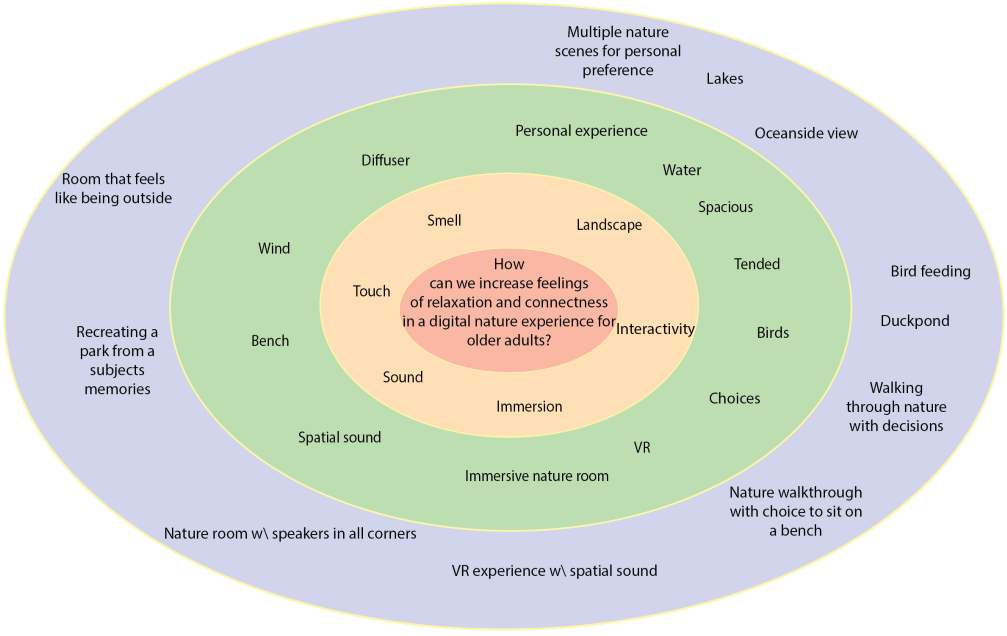

Figure 2: The brainwritten mindmap

4.2 Interaction

To make the scene feel more interactive, there will be birds approaching the viewer. Since sparrows are birds with mostly positive associations and are common in the Netherlands, they

will be most (visually) apparent in the scene.

4.3 Landscape

The background research showed that tended and spacious nature elicited more social aspirations, so this will be the base of the landscape. To give a sense of human presence, there will be lanterns, benches and paths through the landscape to help the participants feel safe. The landscape will mimic a field in a forest in the Netherlands. This will hopefully give people positive feelings by associations. The bench the participant is 'sitting on' will be on a slight hill, giving the viewer a bit of a vantage point. Behind the viewer, there will be trees. These will be used as a place for the birds to sing from and to give the scene a more dynamic feel.

4.4 Soundscape

The sounds most important for a relaxing nature experience are wind, birds and water sounds. Since the scene will not contain a body of water, the latter will not be necessary. Sounds that did not come up in research but will be added to the soundscape for realism are leaf rustling sounds. These sounds will be put together in a 'flat' soundtrack (for the mono sound condition), and in Unity (for the spatial sound condition) be attached to the places they originate from.

4.5 3D models

Since the experience will be a nature environment, there will need to be a lot of 3D models. These will all be either modelled in Blender, or be imported from the Unity Asset Store. For most of the nature models, the 'Meadow Environment - Dynamic Nature' pack by *NatureManufacture* will be used. This pack contains scanned nature models which are very realistic. Next to plants, there also need to be birds, benches and lanterns. The bench and lantern can be easily found on the Unity Asset Store, but the birds are more challenging. There need to be two types of birds; the birds flying around and the sparrows that interact with the viewer. Both will be modelled.

4.6 Format

The experience will need a way of showing the visual part of the scene. There are a few options for this, such as a phone or television screen, a projector onto a wall, or virtual reality glasses. These options all come with benefits and downsides. The medium has a few requirements. It needs to be portable, since the tests will be done at different locations. It needs to allow the viewer to look around the scene, not just show a single view. The phone or television would be easy to come by, but has the issue of lower immersion and doesn't allow for natural view changing. A bigger screen is great for immersion, but is hard to obtain and get to different locations for testing, also it doesn't allow for natural view changing. Lastly, the VR glasses are easily portable, very immersive and allow for looking around the scene naturally, but they could potentially be more off-putting for some older adults and harder to obtain. VR glasses will be used since they are most suitable.

5 Specification

The scene for this project consists of two main parts: The scene and the audio. In this chapter, the process of making these will be elaborated.

5.1 Technology

The scene was created using some tools. The tools include:

- Meta Quest 3 VR Glasses
- Unity
- Blender
- Meadow Pack - Dynamic Nature
- Reaper
- freesound.org
- xeno-canto.org

5.2 Scene

In this section, the making of the scene will be explained and visualized. The scene exists of 2 parts; The landscape and the birds.

5.2.1 Landscape

For creating the visual aspects of the scene, Unity was used. To create a landscape, a plane object was placed and molded. This can be seen in figure 4

After shaping the terrain, a spot was determined for the viewer to sit. From here, the trees can be modelled so the viewer get the optimal spot in this landscape. The terrain was modified using the builtin terrain tools from Unity. The trees were placed using the 'Place Trees' tool, as was the grass. All plant models are from the Dynamic Nature - Meadows pack. The forest was auto-generated, but the grass was placed using the terrain tree painting tools.

The bench model was acquired from the Unity Asset Store (see figure 5).

The Netherlands is often cloudy, so a skybox with realistic clouds was added to the scene. See figure 6

5.2.2 Birds

In the scene there should be some birds were the audio can come from. Two types of bird where chosen for this; Sparrows on the path and birds flying over. The sparrows need to move a bit so people can spot them more easily, this is done with some simple animation.

The first sparrow model that was attempted to make work was an asset with open wings, which would make it better to animate, as this meant more freedom of movement in the final rig (see figure 7. This model was then rigged, but it turned out to take more time than it was worth and was left for an simpler model with closed wings. See figure 8 This new bird model came with a tree stump, but this was removed using Blender.

The sparrows themselves were given simple animations in Unity (see figure 9)

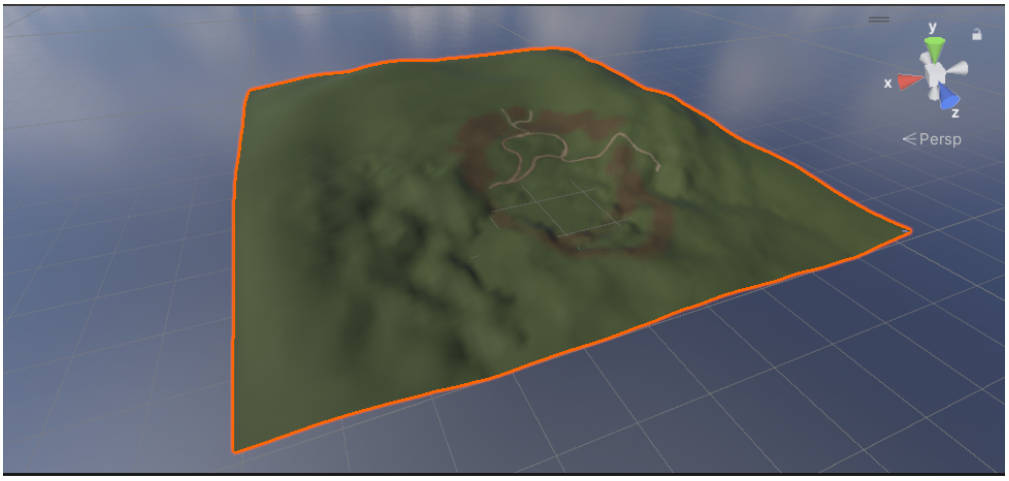

Figure 3: The Unity scene with the painted terrain

Figure 4: The Unity scene with trees and the viewer position

For the flock of flying birds, a bird model was created and animated. This model was then placed in an animated icosphere that would act as the flock movement (see figure 13. However, sadly the flock was not added into the final scene due to problems surrounding the visibility of the 'icosphere (see figure 14) and time limitation. To replace this source of sound, a bird was placed in a tree close by the viewer (see figure 10).

5.3 Audio

The most important part of this research is the sound design. There needs to be a clear difference between the mono audio and the spatial audio. For this

Figure 5: The bench asset

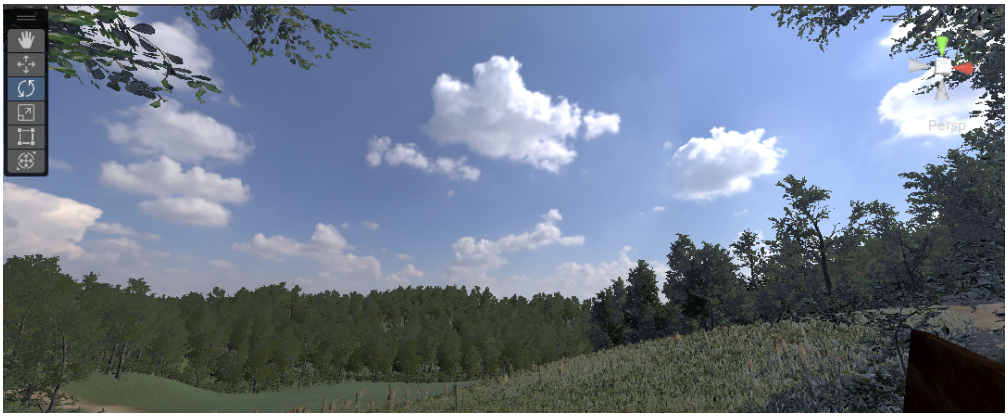

Figure 6: The sky

5.3.1 Mono Audio

The audio used for the mono audio setting was a sound file from freesound.org by the user 'klankbeeld'. It is a recording of a field in The Netherlands in May. It has already been denoised and made ready for use. So for this project, it only needed to be turned into a mono audio sound file.

5.3.2 Spatial Audio

For the spatial audio setting, the birds found in chapter 2 were used to create a soundscape. These were placed around the forest to create a realistic soundscape. To try and raise awareness to the spatial qualities of the scene two points of 'interaction' were placed; A group of sparrows was placed a few paces from the bench and a bigger bird was situated in the tree right next to the listener. These were both provided with their own audio sources (see figure 16).

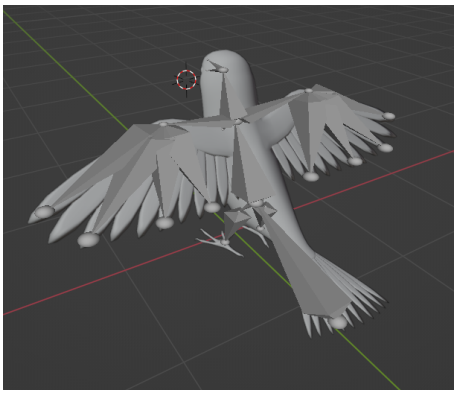

Figure 7: The rigged sparrow asset

Figure 8: The final sparrow asset

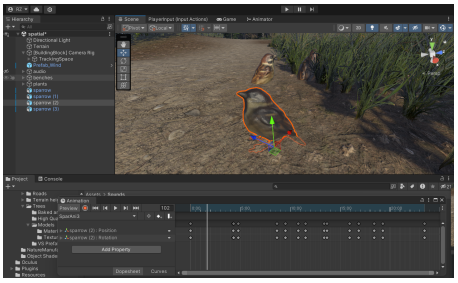

Figure 9: The sparrow animation

Figure 10: The close by bird in a tree

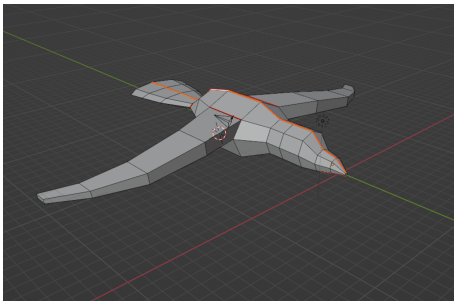

Figure 11: The modelled flock bird

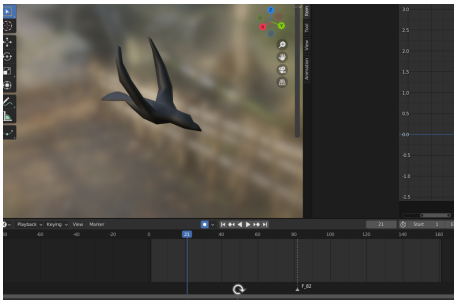

Figure 12: The flock bird during animation

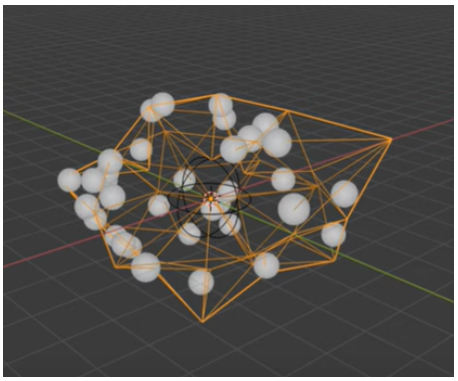

Figure 13: The flock bird with the animation icosphere

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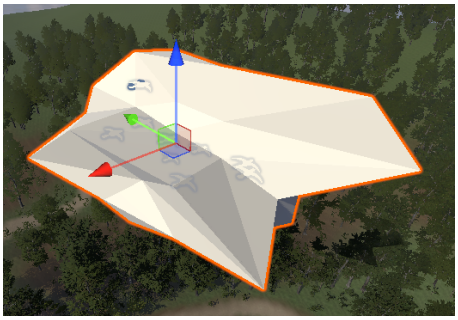

Figure 14: The issue, cloud of birds and icosphere

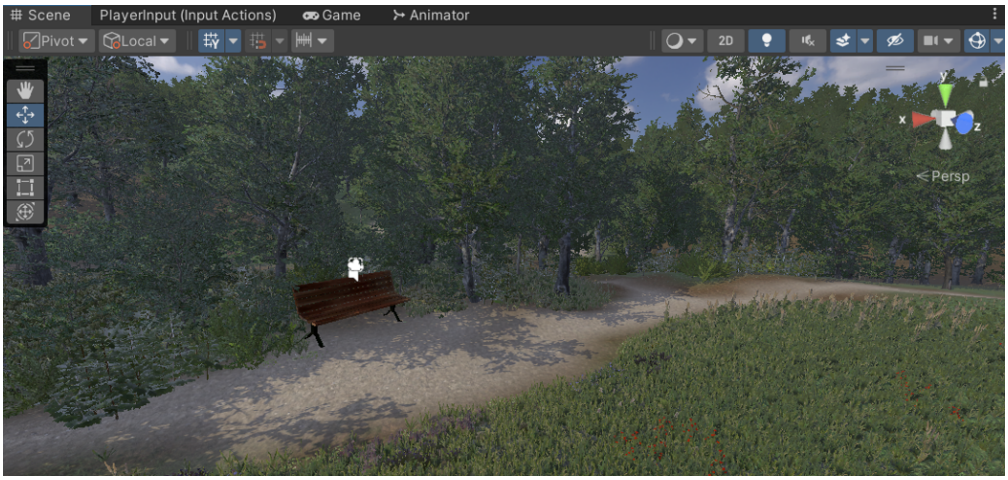

Figure 15: The Unity scene with a single audio source

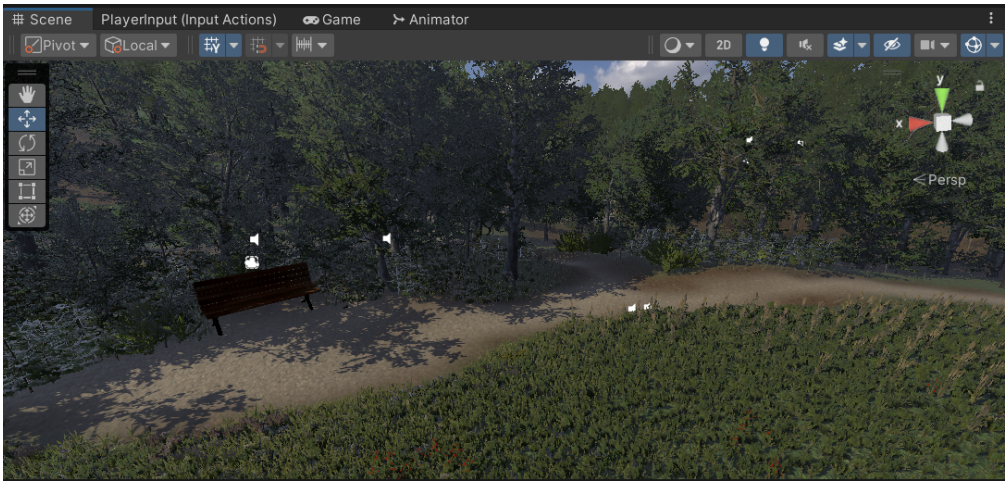

Figure 16: The Unity scene with multiple audio sources

6 Realization

In this chapter the experimental design for this project will be elaborated.

6.1 Test Setting

The experiments took place at the homes of the participants. After arriving, a place at a table was requested to do the experiment. At the table the researcher sat to the left of the participant, so the VR glasses could be worn with the link cable attached to the laptop. The participant was sitting down during the entire experiment.

6.2 Procedure

After a short explanation of the project, the purpose of the research and an explanation of the course of events, the participant got the consent form and the first questionnaire. Then the participant got to view the first scene. The VR headset was placed on the participants head and adjusted to fit properly. Then headphones were placed on the participants head and they went into the first scene for 3 minutes. After this, the VR glasses and headphones were removed and the second questionnaire was given to the participant. Then, the VR headset and headphone were placed on the participant again and the second scene would play. This was followed by the last questionnaire and a recorded interview that can be viewed in Appendix A.

The order of the scenes was randomized, so that the outcomes would not be influenced by the order of viewing. 5 of the participants viewed the spatial audio scene first, 6 viewed the mono audio scene first. The experimental design can be seen in figure 17.

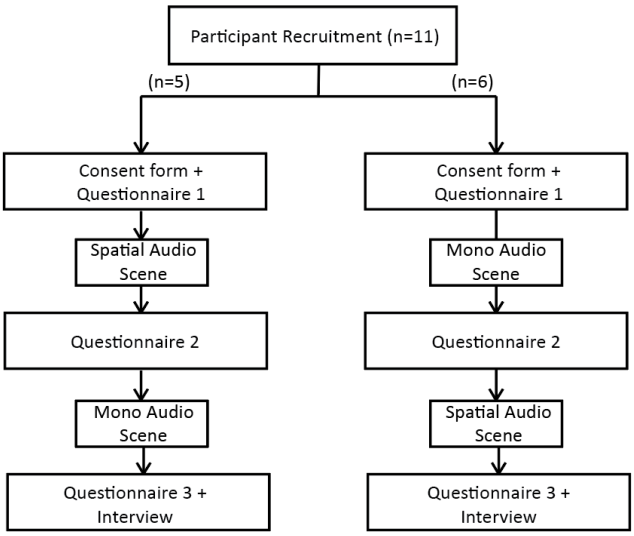

Figure 17: The Experimental Design

7 User Evaluation

In this section, the results from the questionnaires and the observations made during the testing phase will be analysed. First, the qualitative results and statistical observations will be analysed, followed by the outcome of the interviews and curiosity measurements.

7.1 Part 1; The Questionnaires

7.1.1 Statistic modulation

For the data comparison, questions 1, 2 and 3 from the relaxation scale were reversed, as well as questions 1 and 2 from the focus/attention scale. The data was organized in Excel and statistical calculations were performed in SPSS.

7.1.2 Relaxation

The relaxation questionnaire included a few reversed items, which led to some confusion. Because of this, the internal validation is probably lower. The Crohnbach's Alpha values of the first, second and third questionnaire were respectively 0.627, 0.419 and 0.669.

The initial questionnaire on relaxation shows that participants were quite at ease from the beginning, they also reported this verbally. This is probably due to the fact that the experiment took place at their home. A higher perceived relaxation was therefore not expected. The average mean of the pre-test, mono and spatial questionnaire were respectively 3.23, 3.43 and 3.59. This shows a slight positive trend.

7.1.3 Spatial Presence

The outcomes of the Spatial Presence scale show a very small increase for the spatial audio scene. If we take the mean of the means both outcome lists we get an average of 3,50 for the mono scene and 3,57 for the spatial scene.

7.1.4 Attention

Mono and spatial audio scene both have an average mean of 3,7. The internal validity of the mono audio scene is 0,5 where item 3 is most deviating (with that item, the internal validity is 0,77). An explanation for this is that the participants didn't find the scene stimulating enough and wanted more interaction. Item 3 states: *"My attention is drawn to many interesting things."* The spatial audio scene has a better internal validity (0.6), with the most troublesome item being the first (without item 1 the internal validity is 0.86). Item 1 states: *"I find it difficult to focus on what's happening in the present."*. This item scored lower than the others, with a mean of 3,55.

7.2 Part 2; Curiosity

To measure a difference in curiosity during the two scene, the different poses and head movements were recorded in an observational scale (see Appendix 24). Movements were tallied on paper during the testing. The participants were not notified that their movements were being recorded as to not influence the results. Since the participants mostly did not note a difference between the two scenes, a difference in curiosity (measured in movement) was not expected. However, the total movements recorded during the spatial sound condition was larger by 58 movements.

The total movements during the mono audio condition was 110. The total movements during the spatial condition was 168.

Mono	1	2	3	4	5	6	7	8	9	10	11
Head L	4	4	4	3	4	3	1	5	2	4	2
Head R	3	2	3	2	4	2	2	6	3	2	5
Head Up	0	4	1	2	3	2	1	2	1	3	4
Head Down	1	0	0	1	1	1	0	1	2	2	1
Body Left	0	0	0	0	1	0	0	1	0	0	0
Body Right	0	0	0	0	1	0	0	2	1	1	0
										Total:	110

Figure 18: Curiosity Measured in Pose and Head Movement, type: Mono audio

Spatial	1	2	3	4	5	6	7	8	9	10	11
Head L	5	4	8	4	4	5	0	7	3	5	7
Head R	4	4	4	4	3	4	3	4	4	2	5
Head Up	3	6	2	4	4	3	0	2	6	7	2
Head Down	3	2	2	1	2	3	0	2	1	3	2
Body Left	0	0	1	2	1	1	0	1	1	1	1
Body Right	0	0	0	0	1	0	0	2	1	1	1
										Total:	168

Figure 19: Curiosity Measured in Pose and Head Movement, type: Spatial audio

7.3 Part 3; The Interviews

9 out of the 11 participants did not note a difference in sounds. Most comments were on the visuals and how little action there was in the scene: "I think that there is too little action. I would like to experience more. Also to get triggered to look around more" (participant 5, see appendix B.5).

The difference in the scenes was only actively noted by two participants and subconsciously noted by one. Participant number 4 did note the difference in sound, named the difference correctly, and preferred the spatial audio over the mono audio: *"The sound surrounded me. It came from different sides."* (see appendix B.4 for the full interview) This is most likely due to her visual impairment, meaning she had less visual stimuli to be distracted by. It is important to note that this participant has not been visually impaired for long, about two months. While there have been studies done on improved (spatial) auditory function in people born blind or who lost their vision early in life (Battal et al., 2020), there is not much evidence for increased hearing abilities for people who lose their sight later in life. Participant 2, although she also mentioned a difference in sound, preferred the mono scene: *"I felt like there was more birdsong, more different types of bird. I like that."* (see appendix B.2 for the full interview).

Participants noted that they felt they needed to see everything to be able to answer the interview questions, but in their visual attention left no room for auditory attention or curiosity. The order of the scene viewing was randomized, but the favoured scene was the second scene for 6 of the participants, the other participants did not have a favoured scene. The reason for this was that most of the participants were more accustomed to the VR experience and were therefore more comfortable the second time: (*"The second time I was more used to the experience. I could concentrate more on what I could see."*, see Appendix B.8). It is interesting to note that even though the participants stated they preferred the second scene, the spatial scene did get higher

scores in curiosity. This suggests that while the participants did not actively note the difference in the two scene, they could have registered it subconsciously and looked around more because of it. This is further confirmed by participant 11, he could recognize the spatial sound condition after being told of the difference.

8 Discussion

The aim of this research was to explore differences between spatial audio and mono audio during a digital nature experience for older adults. The outcomes from the questionnaires have shown slight positive trend in relaxation and spatial presence, and no increase in attention. However, an increase in curiosity during the spatial scene was observed, but almost no participants actively noticed a difference in sound.

8.1 Relaxation

The outcomes of the relaxation scale were inconclusive. The relaxation scale is difficult to interpret due to the low internal validity. The average mean was slightly higher for the spatial sound condition, but the results showed no significant improvement of relaxation in the participants. During the testing, the participants were often apologizing for misreading the questions on the questionnaire. This was because there are some reversed items on the list. This is probably the cause of the low internal validity of the questionnaire. Some of the items on the list were also not helpful for the internal validity. These include the last three items (see Appendix B). These confused the participants as they weren't about relaxation, but more about how awake they felt.

8.2 Spatial presence

The statistical analysis of the spatial presence outcomes did not indicate a significant difference between the two scenes, but there was a slight improvement. Participants reflected that they needed more time to get used to the environment. The novelty of the VR experience might have been too much to experience the benefits of digital nature. This could mean that if the participants had gotten more used to the environment, the spatial scene would feel more realistic.

8.3 Attention

There was no measured difference in attention from the questionnaires between the two scenes. This could be due to the fact that most participants did not notice the difference between the scenes.

8.4 Curiosity

The levels of curiosity (measured using an observational scale) were higher in the spatial sound scene than in the mono sound scene. There was a difference in pose and head movements between the two conditions. This supports the research of Hirway et al. (2024), curiosity is higher in an experience with more complex audio. Even though the curiosity was higher in the spatial scene, most people said they preferred the second showing of the scenes. This could suggest that the difference in sound was maybe not actively noted, but could be perceived subconsciously. As said before, the scenes were shown in a random order, meaning that the difference in curiosity is independent from the viewing order.

8.5 Interviews

The difference between the two scenes was only noted by two out of eleven participants. A notable finding was that while most participants preferred the scene they saw last, the spatial scene was met with more curiosity. The second scene was probably preferred due to the novelty of the VR experience to them. The participants did not get to get accustomed to the digital

environment. It is probable that participants were too taken in by the visuals to note any difference in sound.Kenwright (2020) stated that sound can help improve interactive environments. Since this project is static, it makes sense that the spatial audio is less noticeable.

8.6 Limitations

Since the participants were all new to virtual reality, it was quite difficult to focus on all aspects of the experience. The fact that the virtual world fully visually surrounded them was impressive and probably overtook the audio, since that seemed 'normal'.

One participant could recognize the different sound types after the debriefing. Since the debrief was not recorded, there is no record of this.

This research lacked time for a manipulation check, meaning there was no check if the difference between the spatial audio and mono audio was big enough to sense. This could mean that the difference in audio was simply not big enough to sense. Luckily, one participant did note the difference, but since she was visually impaired, there is the possibility that she had increased hearing abilities (although research on that is extremely limited).

9 Conclusion

This bachelor thesis aimed to answer the following questions:

Main Research Question

How does a higher level of immersion through spatial sounds in a VR experience impact the effect of digital nature for older adults?

Sub Research Questions

Which sounds from nature can help improve human wellbeing, and what effect do they have on moods?

Which factors influence the level of immersion of a virtual reality experience?

Due to the size of this research and the inconsistencies in the questionnaire answers, it is difficult to draw a real conclusion. There seems to be a positive trend in relaxation, although the sample size was too small to test for significance. The spatial presence seemed to also have a small positive trend. Attention did not change between the two scenes. The observed curiosity did increase between the two scenes, this could be an indicator that the change in audio, while not noticed actively, could be perceived subconsciously.

To answer the main research question more research should be performed on the topic. More data is needed to get a definite conclusion.

The sub-questions have been answered in the theoretical framework. Birdsong and elemental sounds, such as water and wind, are most helpful in improving wellbeing. They provide relaxation and improve perceived wellbeing (Alvarsson et al., 2010). The levels of immersion are impacted most by our visual input (Kenwright, 2020), as can also be seen in this research. Hearing is second most important for an immersive experience (see figure 1).

A few people did notice a change in spatial presence. Therefore, more testing on this subject should be done. Most people didn't notice any change due to the novelty of the experience, so a acclimatizing scene should be shown before the actual experiment.

10 Future Work

Since the participants were testing the scenes while still in awe of the general experience of the VR glasses, creating a virtual space to get the participants used to the VR glasses and the feeling of being in a virtual environment could be useful for future research in VR for older adults. This could take the novelty out of the initial experience and give more insightful results.

Secondly, this user group was still very active and quickly got bored with the stillness of the scene and wished for more interaction with animals. This could be interesting to look into for future research.

Lastly, since the one participant who did notice the difference had a visual impairment, it could be interesting to look at the effect of spatial audio in nature experiences for visually impaired people and to see if there is a difference between non-visually impaired, lifelong visually impaired and newly visually impaired people.

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A Consent Form

Toestemmingsformulier

Betreft: Toestemming voor deelname aan het onderzoek '*Spatial Sounds in Digital Nature*' van de Universiteit van Twente.

Als u akkoord gaat mee te doen kunt u hieronder aankruisen dat u toestemming geeft.

Gelieve de juiste vakjes aan te kruisen	***Ja***	***Nee***
Ik ben over het onderzoek geinformeerd en begrijp wat er gaat gebeuren.	○	○
Ik geef toestemming om deel te nemen in dit onderzoek.	○	○
Ik begrijp dat ik mag weigeren te antwoorden op vragen en op elk moment kan stoppen zonder reden te hoeven geven.	○	○
Ik begrijp dat persoonlijke informatie die mij zou kunnen identificeren, zoals naam en woonplaats), niet gedeeld zal worden met mensen buiten de betrokken onderzoekers.	○	○
Ik geef toestemming voor het verzamelen van geanonimiseerde onderzoeksmaterialen zoals beschreven in de bijbehorende informatie brief.	○	○
Ik geef toemstemming voor het publiceren van geanonimiseerde quotes.	○	○
(optioneel) Ik geef toestemming voor het maken van audio-opnamens voor het opnemen van vragen en antwoorden. De opnamens worden enkel door betrokken onderzoekers beluisterd en zullen nooit publiek worden gemaakt of vertoont aan derde partijen. De audio bestanden zullen direct na het transcriberen verwijderd worden.	○	○

Handtekeningen

_____	_____	_____
Naam deelnemer	*Handtekening deelnemer*	*Datum*
Roos Zoutman		
_____	_____	_____
Naam onderzoeker	*Handtekening onderzoeker*	*Datum*

z.o.z.

Figure 20: Consent Form in Dutch

B Interview Transcripts

B.1

Interviewer : Kun je in je eigen woorden vertellen wat je zojuist hebt ervaren?

1 : Wat ik heb ervaren. Dat ik in een bosrijke omgeving zat, op een bankje wat ik naast me ook kon zien. En links van me een boom met een hele grote mus erin. Voor een soort gebied met allemaal wilde planten en bloemen met daarachter bomen en daarboven een mooie wolken lucht. En drie vogeltjes bij elkaar die elkaar voelde, of ik weet niet wat ze deden. Ja het was net of je daar op een bankje in die natuur zat.

Interviewer : Oke, en heeft u een verschil ervaren tussen de twee scenes?

1 : Ehm, een verschil was dat ik de tweede keer veel meer gezien heb dan de eerste keer.

Interviewer : Oke.

1 : De eerste keer vielen me niet de witte stengeltjes op naast de boom, de korenbloemen had ik wel gezien, klaprozen had ik de eerste keer eigenlijk niet gezien. De tweede keer wel. Maar de tweede keer zag ik duidelijk meer dan de eerste keer.

Interviewer : Oke, en was er een voorkeur voor de eerste of tweede scene?

1 : Ja misschien was het een kwestie van wennen. Kijk, als je een film ziet, je ziet hem een eerste keer en je ziet hem daarna een tweede keer dan zie je ook veel meer. Ik wil niet zeggen daarom dat de tweede keer beter was dan de eerste.

Interviewer : En dat waren de enige verschillen tussen de twee scenes?

1 : Ja, verder had ik niet veel opgemerkt. Misschien had ik beter op moeten letten.

Interviewer : Nee, dat is prima. Nog laatste opmerkingen?

1 : Ik vond het een belevenis. Leuk, ja.

B.2

Interviewer : Kun je in je eigen woorden vertellen wat je net hebt ervaren?

2 : Ik vond het een hele nieuwe ervaring. En ik vond het een hele leuke ervaring. En het tweede filmpje was bijna hetzelfde alleen er waren een paar dingen toch anders, het vogeltje was anders.

Interviewer : Kan je benoemen wat er nou anders was?

2 : In de tweede filmpje, in de boom zat een andere vogel. En ik vond dat de musjes zich anders gedroegen. Ik weet niet of de bomen nou allemaal hetzelfde stonden, dat heb ik nou allemaal niet direct kunnen zien.

Interviewer : En was er een voorkeur voor de eerste of tweede scene?

2 : Ik vond de tweede, oh de tweede! Was meer vogel geluid in mijn gevoel, meer verschillende vogelgeluiden. En dat vond ik leuk.

Interviewer : Zijn er nog laatste opmerkingen?

2 : Ik heb graag meegedaan aan je onderzoek! Verder niet echt.

B.3

Interviewer : Kun je in je eigen woorden omschrijven wat er zojuist is gebeurt, wat je hebt meegemaakt, gezien?

3 : Ja, ik heb zitten kijken naar een stuk natuur, waar wat vogel heen en weer bewogen. En het was interessant om te kijken naar wat die vogels gingen doen.

Interviewer : Oke, heb je een verschil ervaren tussen de twee scenes?

3 : Ja de eerste scene was tamelijk saai, daar gebeurde niks. Beetje bloemetjes kijken, maar daar hield het op. Bij de tweede daar waren beestjes en ja die waren vanalles aan het doen.

Interviewer : En heb je een voorkeur voor een van de twee scenes?

3 : Ja, de tweede want er moet wel wat leven in de brouwerij zijn.

Interviewer : Oke. Nog laatste opmerkingen?

3 : Nou ik vond het een leuke presentatie dat je zo helemaal om je heen kan kijken naar wat er gebeurd. Ja, vond ik erg leuk om zo te kijken ja.

B.4

Interviewer : Kun je in je eigen woorden omschrijven wat je net hebt ervaren?

4 : Ja, zeker. Dat ik ergens op een bankje zat en naar de natuur zat te kijken om me heen. Mooie dag. En in de eerste presentatie gebeurde niet zo veel, in de tweede gebeurde wel het een en ander. Ben heel nieuwsgierig waar die plek is.

Interviewer : Kan je je vinger leggen op wat er anders was in de tweede scene?

4 : In de tweede presentatie was het geluid meer om me heen. Het kwam van verschillende kanten. En er gebeurde iets in het beeld. De eerste presentatie was alleen maar een beetje wapperen van de planten en verder niet. Maar nu gebeurde er wat. Maar ja, uhm, wat er gebeurde verandere verder niet zo veel. Maar dat vond ik wel interassant, maakt me nieuwsgierig.

Interviewer : Oke, en was er een voorkeur voor de eerste of tweede scene?

4 : De tweede heeft mijn voorkeur.

Interviewer : Oke, zijn er dan nog laatste opmerkingen?

4 : Ja, van mijn kant kan ik me altijd heel moeilijk verplaatsen in zoiets. Dat ik toch gewoon hier aan tafel blijf zitten in deze wereld. Maar dat is misschien mijn... Ja ik weet niet waar dat aan ligt. Mijn, mijn... Ja dat zit in mijn aard.

B.5

Interviewer : Zou je in je eigen woorden kunnen omschrijven wat je net hebt ervaren?

5 : Uhm, ik vind het nogal na-makerig. En dat is jammer. Ik vind ook dat er te weinig actie in is. En ik zou wel wat meer willen beleven. Ook dat je meer word getriggerd om om je heen te kijken. Aan de rechterkant gebeurde helemaal niks, in de verte ook niet. Je zou nog kunnen zeggen, er loopt daar een hertje. In de book zie ik natuurlijk een uiltje. Ik zou dus meer beestjes toevoegen.

Interviewer : Heb je een verschil ervaren?

5 : Ohh, ik denk dat de tweede iets kleuriger was.

Interviewer : Oke.

5 : Ik vond het niet zo duidelijk beeld. Als ik echt iets definitiefs moest zeggen, zou ik een beetje een duidelijker beeld willen hebben. Misschien ook wel met iets meer kleur erin. Meer bloemen. En je word getriggerd door steeds dat ene beetje die boven het veld springt.

Interviewer : Haha, ja. Dus heb je een voorkeur voor een van de twee scenes?

5 : Nou, de laatste denk ik.

Interviewer : Nog laatste opmerkingen?

5 : Nou het lijkt me een heel erg leuk project, maar ik zou er veel meer actie in willen zien.

B.6

Interviewer : Zou je me in je eigen woorden kunnen vertellen wat je hebt ervaren, gezien, gehoord?

6 : Ik zat in de natuur, op een bankje. Ik vond niet dat ik echt op het bankje zat, ik zat er meer bovenop. Ik vond die vogeltjes wel een beetje raar lopen. Op een gegeven moment ontdekte ik de vogel die links in de boom zat. Die had ik nog niet eerder gezien.

Interviewer : Oke, merkte je een verschil tussen de eerste en tweede scene?

6 : Nou ja, die vogel die ik dus links zag. En ik zag de wind, de bladeren heen en weer.

Interviewer : Oke, en had je een voorkeur voor de eerste of de tweede scene?

6 : De tweede leek me leuker.

Interviewer : Nog laatste opmerkingen?

6 : Nou ik had eigenlijk gehoopt dat ik ergens een hert uit het bos zag komen.

B.7

Interviewer : Kan je in je eigen woorden omschrijven wat je zojuist hebt ervaren?

7 : Ik was in een mooi groen landschap, waar heel veel gekletter was van vogels. En waarvoor twee bijzonder rare wezentjes, het leek wel of ze wieltjes hadden, bezig waren te pikken in het zand, in het groen. En elkaar steeds in de gaten bleven houden. Dus, verder nog gekeken of er wat in de lucht zat, maar dat was er niet. Wel veel ander fluitertjes.

Interviewer : Oke, heb je nog een verschil ervaren tussen de eerste en de tweede scene?

7 : De tweede keer had ik het gevoel dat het beeld iets gekantelt was.

Interviewer : Oh, oke. Dat is raar.

7 : Was dat niet zo?

Interviewer : Het hoorde niet zo, maar het zag er ook een beetje zo uit op mijn scherm dus het kan fout gegaan zijn.

7 : Oh, het leek een beetje zo (onverstaanbaar). De rest was hetzelfde.

Interviewer : Oke, dus geen voorkeur voor een eerste of tweede scene?

7 : Nee.

Interviewer : Oke, nog laatste opmerkingen?

7 : Nou ik dacht dat de vogels dichterbij kwamen, ik had ze wel van dichterbij willen zien. Volgens mij hadden ze wieltjes.

B.8

Interviewer : Zou je kunnen vertellen wat er net is gebeurt, wat je hebt ervaren?

8 : Nou, in de eerste plaats, is het heel raar dat als je beweegt datje dan inderdaad ergens anders naartoe kijkt. Dat is een nieuwe ervaring voor mij. Zowel naar boven als beneden, dus echt drie dimensionaal. Was een rare ervaring. Maar ik besef wel dat het niet echt is, het is niet helemaal goed genoeg om helemaal echt te zijn. De kipjes die heen en weer lopen en bewegen, het blijft een beetje kunstmatig. Maar dat besef je dan ook wel. Maar ik vond het wel een hele bijzondere ervaring. Ik heb wel twee keer hetzelfde gezien, dat weet je?

Interviewer : Ja, heb je nog iets opgemerkt aan het geluid?

8 : Nee, dat hoor je hier in de tuin ook, al die vogeltjes en dingetjes.

Interviewer : Heb je een verschil ervaren tussen de eerste en de tweede scene?

8 : Ja, de tweede keer was ik minder verbaast en heb ik meer gezocht naar dingen. De eerste keer dacht ik, ja rare beleving allemaal. Dus de beleving meer. De tweede keer... Ja de beleving was al iets bekender. Dus een beetje meer concentreren op dingen die ik dan kon zien.

Interviewer : Maar meer omdat je het dus al een eerste keer had gezien.

8 : Ja, een beetje (draait hoofd). En de tafelpoot, dat je tegen een tafelpoot stoot die je helemaal niet ziet. Maar oke.

Interviewer : Dus de voorkeur zou naar de tweede scene gaan.

8 : Ja, omdat ik even aan moet wennen. Even aan het gevoel wennen voordat je er dieper, kritischer, naar kijkt.

Interviewer : Nog laatste opmerkingen?

8 : Nou ik vind het heel knap gemaakt, goed gedaan.

B.9

Interviewer : Zou je in je eigen woorden kunnen vertellen water er zojuist is beurt, wat je hebt ervaren?

9 : Er was een omgeving en geluiden die me heel rustig maken, waar ik van hou. En, wat ik net zei, waar ik heel graag zou willen wonen. Met uitzicht, ik hou van uitzicht.

Interviewer : Ja, fijn. Heb je een verschil ervaren tussen de twee keren?

9 : Eigenlijk niet. Maar ik heb wel meer gedraaid omdat ik meer kon zien van de omgeving, wat ik de eerste keer niet zag, maar geen verschil.

Interviewer : Dus er is geen voorkeur voor een van de twee scenes?

9 : Nee, dat heb ik niet zo gezien, misschien.

Interviewer : Ja, dat is prima. Nog laatste opmerkingen?

9 : Absoluut niet. Nog eens, dit uitzicht zou ik graag willen hebben.

B.10

Interviewer : Zou je in je eigen woorden kunnen vertellen wat je zojuist hebt ervaren, gezien, gehoord?

10 : Aanvankelijk dacht ik dat ik op een golfbaan was. Maar, ja. Een lekker stukje tuin achtig natuur. Met wat vogeltjes, vraag me niet wat. Knorhoenderen ofzo, ik weet het niet. En er zat nog een grote vogel in de boom, links naast me. Dat was volgens mij geen uil, want hij had een klein kopje. Of was het wel een uil?

Interviewer : Nee.

10 : Nee het was geen uil. En voor de rest werd ik vooral getrokken naar wat bewoog. Niet zo zeer van, wat een serene rust. Nee, vooral die rare vogeltjes, waarvan er een elke keer eruit sprong. Dat was het.

Interviewer : Oke, heb je een verschil ervaren tussen de twee scenes?

10 : Nou, in de tweede scene viel pas die grote vogel in de boom me op. In de eerste scene heb ik daar waarschijnlijk overheen gekeken. Zou kunnen. Maar voor de rest waren er vier vogeltjes, volgens mij.

Interviewer : Weet je of er iets was waardoor je aandacht getrokken werd naar de vogel, of was je gewoon meer aan het rondkijken?

10 : Ja, ik was meer aan het rondkijken, dat is het eigenlijk. En er stonden wat witte... Aan de zijkant. Ik dacht "is dit nou plastic wat hier staat, of papier, ofzo?" Dat viel me ook de tweede keer pas op.

Interviewer : Oke, ja. Heeft u een voorkeur voor de eerste of tweede scene?

10 : Nee.

Interviewer : Oke, dan nog laatste opmerkingen? Iets dat je is opgevallen?

10 : Nee, niet over wat ik gezien heb, nee.

B.11

Interviewer : Zou u me in uw eigen woorden will en vertellen wat u net heeft ervaren? Gehoord, gezien.

11 : Ja. Het gravende vogeltje, dat vond ik heel leuk, en was rustgevend, enzovoort. De omgeving, kijk, die is natuurlijk erg statisch, behalve die vogeltjes daar links. Je hebt wat beweging gesimuleerd in de velden daarvoor, en de bomen iets minder, de lucht helemaal niet. Wat ik verder... Wat was de vraag?

Interviewer : Wat heeft u ervaren? Gezien of gehoord.

11 : Ja, gehoord. Dat is natuurlijk veel echter eigenlijk dan het beeld. Het is natuurlijk statisch, er gebeurd weinig. Maar het totaal is wel rustgevend.

Interviewer : Heeft u nog een verschil ervaren tussen de twee scenes?

11 : Nee.

Interviewer : Oke, dat is prima. Dus er is geen voorkeur voor de eerste of tweede scene?

11 : Nee, dat heb ik niet.

Interviewer : Laatste opmerking, iets u zou willen zeggen?

11 : Ik ben benieuwd wat voor conclusies je hier uit kan trekken.

C Questionnaire Outcomes

Questionnaire 1

English Translation	Dutch Translation	1	2	3	4	5	6	7	8	9	10	11
My breathing is faster than usual.	*Ik adem sneller dan normaal.*	4	5	5	5	5	3	4	5	5	5	5
My heart is beating faster than usual.	*Mijn hart klopt sneller dan normaal.*	4	5	5	5	4	3	4	5	5	5	5
My muscles feel tense and cramped (clenched fist and/or jaw; furrowed brow).	*Mijn spieren voelen gespannen (gespannen vuist en/of kaak).*	4	5	5	5	5	3	4	5	5	5	5
My muscles feel relaxed.	Mijn spieren voelen ontspannen.	4	1	4	1	4	4	4	5	5	1	5
I'm feeling very relaxed.	Ik voel me ontspannen.	3	1	4	1	4	4	4	5	5	1	5
Right now, I am completely calm.	Ik voel me op dit moment helemaal rustig.	3	1	4	1	3	4	4	5	5	1	1
I'm feeling sleepy and tired.	Ik voel me slaperig en moe.	1	2	1	1	2	2	3	1	1	1	1
I'm about to doze off.	Ik kan zo in slaap vallen.	1	2	1	1	1	2	2	1	1	1	1
I'm feeling refreshed and awake.	Ik voel me verfrist en wakker.	5	3	1	1	4	2	3	5	5	1	1

Figure 21: Results from questionnaire 1 with translations, italic items are reversed

Questionnaire 2

English Translation	Dutch Translation	1	2	3	4	5	6	7	8	9	10	11
My breathing is faster than usual.	*Ik adem sneller dan normaal.*	3	4	5	5	5	4	3	5	5	5	5
My heart is beating faster than usual.	*Mijn hart klopt sneller dan normaal.*	4	4	5	5	5	4	3	4	5	5	5
My muscles feel tense and cramped (clenched fist and/or jaw; furrowed brow).	*Mijn spieren voelen gespannen (gespannen vuist en/of kaak).*	4	4	5	5	5	4	3	4	5	5	5
My muscles feel relaxed.	Mijn spieren voelen ontspannen.	4	2	4	5	4	2	4	2	5	4	4
I'm feeling very relaxed.	Ik voel me ontspannen.	3	2	4	5	4	2	4	5	5	4	4
Right now, I am completely calm.	Ik voel me op dit moment helemaal rustig.	3	2	4	5	4	2	4	4	5	4	4
I'm feeling sleepy and tired.	Ik voel me slaperig en moe.	1	1	1	1	1	1	4	2	1	1	2
I'm about to doze off.	Ik kan zo in slaap vallen.	1	1	1	1	1	1	3	2	1	1	1
I'm feeling refreshed and awake.	Ik voel me verfrist en wakker.	4	4	4	5	4	4	3	4	5	4	2
I felt like I was actually there in the environment of the presentation.	Het voelde alsof ik echt daar in de omgeving van de presentatie was.	5	4	4	1	3	4	3	3	5	4	4
It seemed as though I actually took part in the action of the presentation.	Het leek alsof ik echt deelnam aan de actie in de presentatie.	4	4	2	2	3	4	3	4	5	1	3
It was as though my true location had shifted into the environment in the presentation.	Het leek alsof ik in de omgeving van de presentatie was in plaats van in mijn echte locatie.	5	4	5	2	3	4	3	4	5	4	4
I felt as though I was physically present in the environment of the presentation.	Het voelde alsof ik lichamelijk aanwezig was in de omgeving van de presentatie.	4	4	3	1	3	4	3	3	5	1	3
I experienced the environment in the presentation as though I had stepped into a different place.	Ik ervoer de omgeving in de presentatie alsof ik een andere plek binnenstapte.	4	4	4	3	4	4	4	4	5	4	2
I was convinced that things were actually happening around me.	Ik was ervan overtuigd dat echt dingen om me heen gebeurde.	4	3	2	2	3	4	3	3	5	1	2
I had the feeling that I was in the middle of the action rather than merely observing.	Ik had het gevoel dat ik midden in de actie zat en niet alleen maar observeerde.	4	3	2	2	3	4	3	4	4	1	2
I felt like the objects in the presentation surrounded me.	Ik had het gevoel dat de natuur mij omringde.	5	4	3	3	3	4	3	4	5	4	3
I was convinced that things were actually happening around me.	Ik was ervan overtuigd dat de dingen in de presentatie zich aan verschillende kanten van mijn lichaam bevonden.	5	4	4	3	4	4	3	4	5	4	4
I find it difficult to stay focused on what's happening in the present.	*Ik vind het moeilijk om te focussen op het huidige moment.*	4	5	2	1	4	4	4	4	5	5	3
My thoughts tend to wander off.	*Ik dwaalde veel af met mijn gedachtes.*	4	5	3	2	3	4	4	3	5	5	4
My attention is drawn to many interesting things.	Mijn aandacht wordt naar veel interessante dingen getrokken.	4	5	3	3	3	4	2	3	4	3	4

Figure 22: Results from questionnaire 2 with translations, italic items are reversed

Questionnaire 3

English Translation	Dutch Translation	1	2	3	4	5	6	7	8	9	10	11
My breathing is faster than usual.	*Ik adem sneller dan normaal.*	4	5	5	5	4	4	4	4	5	5	5
My heart is beating faster than usual.	*Mijn hart klopt sneller dan normaal.*	4	5	5	5	4	4	4	3	5	5	5
My muscles feel tense and cramped (clenched fist and/or jaw; furrowed brow).	*Mijn spieren voelen gespannen (gespannen vuist en/of kaak).*	4	5	1	5	4	4	4	3	5	5	5
My muscles feel relaxed.	Mijn spieren voelen ontspannen.	4	5	5	5	4	4	4	4	5	4	3
I'm feeling very relaxed.	Ik voel me ontspannen.	4	4	5	5	4	4	4	4	5	4	3
Right now, I am completely calm.	Ik voel me op dit moment helemaal rustig.	3	4	1	5	4	4	4	4	5	4	4
I'm feeling sleepy and tired.	Ik voel me slaperig en moe.	1	1	1	1	2	2	3	3	1	1	2
I'm about to doze off.	Ik kan zo in slaap vallen.	1	1	1	1	2	2	2	2	1	1	1
I'm feeling refreshed and awake.	Ik voel me verfrist en wakker.	5	4	4	3	4	2	3	4	5	4	3
I felt like I was actually there in the environment of the presentation.	Het voelde alsof ik echt daar in de omgeving van de presentatie was.	4	4	4	5	2	4	2	4	5	4	4
It seemed as though I actually took part in the action of the presentation.	Het leek alsof ik echt deelnam aan de actie in de presentatie.	4	4	5	4	2	4	2	4	5	1	2
It was as though my true location had shifted into the environment in the presentation.	Het leek alsof ik in de omgeving van de presentatie was in plaats van in mijn echte locatie.	4	4	5	4	2	4	2	4	5	4	3
I felt as though I was physically present in the environment of the presentation.	Het voelde alsof ik lichamelijk aanwezig was in de omgeving van de presentatie.	4	4	4	4	2	4	2	4	5	4	2
I experienced the environment in the presentation as though I had stepped into a different place.	Ik ervoer de omgeving in de presentatie alsof ik een andere plek binnenstapte.	5	4	4	4	3	4	3	4	5	3	3
I was convinced that things were actually happening around me.	Ik was ervan overtuigd dat echt dingen om me heen gebeurde.	4	3	5	4	3	4	2	3	5	1	3
I had the feeling that I was in the middle of the action rather than merely observing.	Ik had het gevoel dat ik midden in de actie zat en niet alleen maar observeerde.	5	3	4	3	2	4	2	3	5	1	2
I felt like the objects in the presentation surrounded me.	Ik had het gevoel dat de natuur mij omringde.	5	4	4	3	3	4	3	4	5	3	3
I was convinced that things were actually happening around me.	Ik was ervan overtuigd dat de dingen in de presentatie zich aan verschillende kanten van mijn lichaam bevonden.	5	3	4	3	4	4	4	4	5	3	4
I find it difficult to stay focused on what's happening in the present.	*Ik vind het moeilijk om te focussen op het huidige moment.*	2	5	4	4	4	4	4	4	5	5	3
My thoughts tend to wander off.	*Ik dwaalde veel af met mijn gedachtes.*	4	5	2	2	2	4	3	3	5	5	4
My attention is drawn to many interesting things.	Mijn aandacht wordt naar veel interessante dingen getrokken.	5	4	5	2	2	2	3	4	5	4	4

Figure 23: Results from questionnaire 3 with translations, italic items are reversed

D Pose Checklist

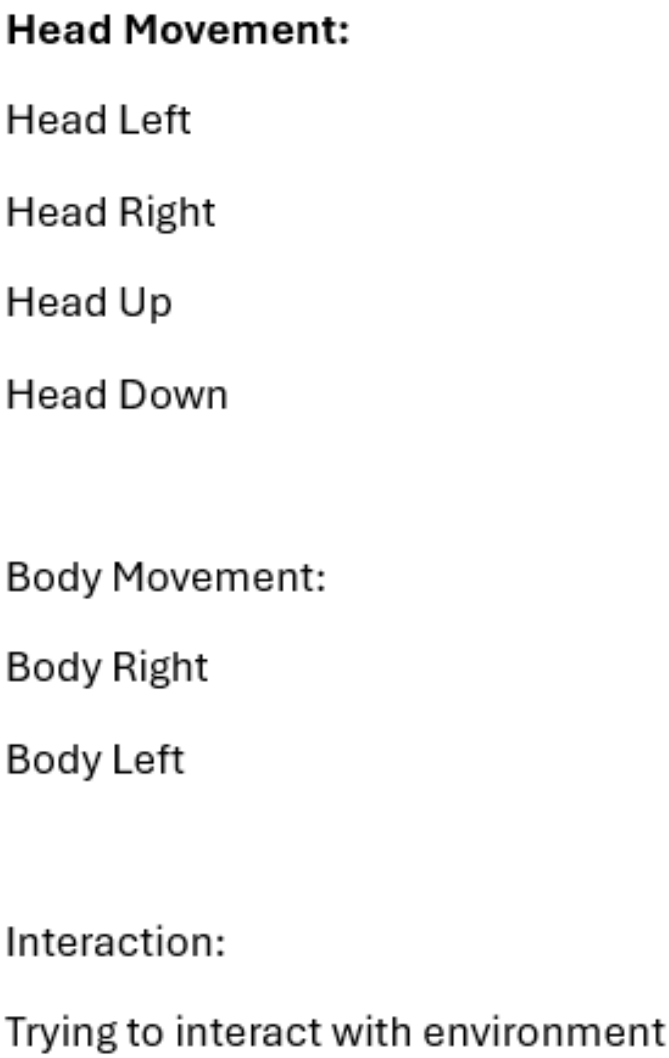

Figure 24: The final Pose Checklist