Breathe in, breathe out:

Examining the role of nature within virtual reality meditations to reduce anxiety in university students

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Abstract

Introduction: Anxiety within university students finds itself at an unprecedented high, calling for both immediate as well as long term solutions. Utilizing novel technology offers new opportunities to use for anxiety reduction within students.

Objective: This research aims at combining the practice of a guided meditation with a VR environment in order to create an intervention that can aid and reduce symptoms of mental health related issues. By comparing between environments that differ in awe inspiring nature scenery, this study aims to find an environment that maximizes both restorative effects and the reduction in anxiety.

Methods: A total of 61 participants in this experimental study filled out a survey about anxiety before meditating in one of three conditions. A control group using audio only, a VR condition high in 'awe' (vast, spacious nature), and VR condition low in awe. Afterwards, participants filled out a post experiment survey regarding their Perceived Body Boundaries and restorativeness measures, as well as their anxiety levels which are then compared to previous values to allow drawing conclusions on the usefulness of this practice.

Results: The results showed the strongest reduction of state anxiety for participants using the VR meditation including awe. Additionally, higher Trait Anxiety led to a stronger reduction of State Anxiety. Meditation experience resulted in higher State Anxiety Difference, an increased feeling of Being Away, Fascination, Compatibility, and general Perceived Restorativeness.

Conclusion: Even though limitations negatively impacted this study's outcome, this study is a worthwhile indicator of the powerful effect of Virtual Reality meditation on anxiety in young adults. Furthermore, interesting and new insights about the interplay between VR meditation and Perceived Body Boundaries are provided.

Keywords: Virtual Reality, Attention, Meditation, Anxiety, Mental Health, Awe, PBB

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1. Introduction

The art and practice of meditation have been around for thousands of years. Deriving from Asian cultures, meditation has made its way across the globe and is now embedded into the daily routines of many. While the main use of meditation was to explore the mind, to create a healthy level of distance to one's thoughts, feelings, or the ego itself and more often than not to connect to a higher deity, its purpose evolved as societies did. In today's modern and westernized environment, meditation is not necessarily connected to religious spirituality, but often used to find some moments of peace and quiet amongst all the stress and noise that our packed schedules bring. Mindfulness meditations take elements from said Buddhist practices but take away the religious context. And it appears that this peace of mind is now more needed than ever, as students struggle to be offline, to cope with the boredom during the ongoing Covid-19 crisis or to simply disconnect from external influences for a day. The pressure of the fast paced and competitive society can drain on one's mental restoration capacities and quickly lead to stress and symptoms of anxiety. While the topic of mental health becomes more openly accepted, more and more teenagers and young adults address their mental well-being publicly, leading to workplaces and institutions such as universities and offices often employing professional counseling staff and psychologists.

But as professional help is bound to limited accessibility, the means must be reinvented, and novel ways have to be explored that allow those in need to find that space of calmness in their mind. With technology offering opportunities to revolutionize many parts of our daily lives, it is time for research to utilize the available innovations at hand for the betterment of life quality around oneself. Therefore, this research is set up to not only tackle the rise of mental health issues in young adults, specifically university students with the help of technology, but also to find a virtual environment that optimizes said effect. For that, the help of nature is used as it holds restorative powers to one's mental health according to the Attention Restoration Theory (Kaplan & Kaplan, 1989). As there is limited research when it comes to the details of certain environments, it is of value to take a closer look. Research pinpoints at the role of vast environments being beneficial which lays the foundation for the scope of the used environments (Berto, 2014). The optimization of nature is further investigated by comparing between two natural environments; one being closed off and narrow whereas the other one is a vast and spacious environment that is considered high in 'awe'.

As modern problems require modern solutions, a guided meditation within a virtual reality environment is chosen to tackle the state anxiety levels of students. For this purpose, the

present study investigated the effectiveness of a guided meditation experiment with either an audio guide only, a virtual reality element with the element of awe, or a virtual reality element without the added element of awe, all while being measured for indications of anxiousness and stress. The two virtual environments consist of real-world videos of a non-urban and natural environment to include the Attention Restoration Theory (ART) according to which stress can be reduced by being exposed to a natural setting (Berto, 2014). The addition of two distinct environments allows for conclusions about what type of specific nature dimensions amplify the intended effects. The meditation in VR includes simple guided instructions to account for participants who do not yet know how to follow a mindfulness meditation and its breathing techniques on their own, making familiarity with mindfulness practice unnecessary.

This research aims to fill the gaps in similar research, which so far often focused on simulated or real-world environments that simply showed a natural setting without differentiating between distinct types of nature dimensions. Previous research regarding Virtual Reality in the context of meditation, entertainment, or e-commerce often failed at inspecting the distinct features and their powers within the environment but focused on the comparative effect between VR and non-VR. The meta-analysis about the effect of VR on anxiety and depression by Parsons and Rizzo (2008) which has been cited over 1000 times solely focused on the question if VR was useful and calling for more extensive designs and data reports, instead of asking the question how VR can be designed to be most useful. This particular research instead aims at not only pointing out the effect of adding virtual reality to the meditation but pointing out significant differences between nature settings which could help to amplify the effect. Combining the natural environment's aspects such as fascination or compatibility with VR's characteristics such as virtuality and immersiveness are not only a key indicator to influence the intervention's effective success but would be a scientific answer to the claim that the "lack of certainty with respect to these and other questions regarding the relationship between nature and mental health underscores the need for future research" as illustrated in recent research about ecosystem services by Bratman et al. (2019, p. 4). Taking different aspects into account will here be executed through the means of adding the element of 'awe' to the equation. Having one environment full of characteristics that create the feeling of and belong to the umbrella term of awe (a fascinating vastness, a spacious environment, feeling small) and taking these elements away in the comparing environment enables to investigate not only if VR works, but whether awe is a beneficial experience regarding anxiety reduction as well. As this has not been thoroughly examined in research contexts, potential significant results do not only

offer insight bases for future works but provide a tested intervention which can be employed in countless manners, ranging from university libraries to office break rooms.

Next to the different environments, the originality of this study lies within its unique mixture of not only measuring anxiety indications, but additionally measuring how participants perceive their body boundaries to the physical world and if they experience a feeling of awe caused by the vastness of the natural environment. Investigating meditation's potential to feel more connected to nature and create a feeling of becoming 'one' with the environment can lay the foundation for future research into the interplay of nature and technology. While research has been conducted into not only the power meditation can have one one's mental health but also if those effects can be replicated in a virtual environment, this method adds two novel components: Firstly, its target group. While many recent studies focus on meditation experts and people from different educational backgrounds and ages, this paper focuses on university level students within a similar age range, thereby accounting for demographic differences. Secondly, this study takes on a novel approach by taking a deeper look into the differences between two natural settings on the effect of meditation on mental health. Insights into the effects of specific nature characteristics leads the way towards finding the optimal environment for meditation and hereby lays a base for further studies surrounding nature characteristics for one's mental well-being.

This intervention can be especially worthwhile for the future, as measures regarding the coronavirus do not allow for everyone to leave their premises and simply take some time off in rather untouched natural environments. Additionally, many potential users are located in urbanized areas or colder areas including frequent rain and therefore do not have the chance to easily surround themselves with a comforting natural environment which can be facilitated in a simple manner via this tool. This way, users are enabled to take a mental break and enjoy the beneficial features of meditating in nature regardless of restrictions or external conditions such as the weather or location. Utilizing virtual reality could bring the outside inside and allow for a certain degree of the outside world for those unable to experience 'the real thing'.

Therefore, the research question that will be examined within this study reads as follows:

RQ: To what extent can a nature-based VR meditation help to reduce symptoms of anxiety in university students?

2. Theoretical Framework

In order to investigate anxiety reduction as well as the restorative potential of this technological intervention, it is essential to take a look into the important concepts of the research. In the following paragraphs, anxiety, as well as meditation, body salience, and restorative elements will be defined and contextualized.

2.1. Anxiety

As the concept of anxiety lies in the core of the research, it is important to define the essence of anxiety, its symptoms, as well as potential connections to the concepts in this framework. Anxiety was chosen as a measurement in this study due to it being a rising issue over the years and sparking public discourse about topics regarding mental health. It has been at the forefront of the public debate about mental health across demographics. And research shows that just that is important and needed, as anxiety is on the rise across students (Kerr, Birdnow, Wright, & Fiene, 2021).

This upwards trend in both interest as well as presence of anxiety and mental health issues in general was accelerated by the Covid-19 pandemic and turned them into frequent experiences, as research such as Hyland et al. (2020) in Ireland including more than 1.000 respondents reported. In their research, they described anxiety as rising amongst creative students who named "increased achievement pressures and awareness of environmental and social problems" as the strongest external stress factors and "perfectionism and desire to fulfill expectations" as strongest internal stress factors (p. 1). As the rise of anxiety and stress among students and young adults is not expected to be put on a halt anytime soon, mental health offers a particularly valuable topic to dive into in order to detect possibilities to reduce its negative consequences, especially when taking into account the study pressure. Additionally, anxiety was chosen over depression due to less of a severity in symptoms and a comparatively higher frequency of occurrence. Although depression of course is a severe mental health issue, anxieties and worries are frequently experienced by the general population and therefore more applicable for this research context.

An early definition by Spielberger (1972) conceptualizes anxiety as "an unpleasant emotional state or condition which is characterized by subjective feelings of tension, apprehension, and worry, and by activation or arousal of the autonomic nervous system" (p. 482). Tallmann, Paul, Skolnick and Gallager (1980) later add the notion of anxiety being "a strong motivating force in many forms of behavior" (p. 274), which illustrates anxiety

exceeding from the mere cognitive state to one's behavioral level. This behavior can be translated to the context of universities, as research has shown that students with higher levels of test anxiety do not only put less effort into studying (Smith et al, 1990) but additionally report a lower need of achievements, lower self-acceptance as well as lower self-control and acceptance of responsibility (Hembree, 1988).

As anxiety is detrimental to one's mental and physical health, researchers across the scientific spectrum called for means of improvement with one of them being technological innovations. Virtual reality offers a therapeutic approach that is controllable and applicable to every user's context and situation. A study including a virtual walk through a forest by Hong et al. showed that watching the forest video not only significantly decreases anxiety in adults, but additionally "has a positive impact on psychological state" (2019, p. 319). In a clinical study regarding general anxiety disorder (GAD), Repetto et al. (2013) found that VR was not only well-received by the patients but an effective and advantageous tool in the fight against anxiety disorders that does not require the presence of a therapist. This offers patients the opportunity to have a calming solution at hand whenever anxiety rises and not only when appointments are scheduled. However, science also provides insights about Virtual Reality and its impact on the more momentary levels of stress expressed as state anxiety. 'State' anxiety is one's fluctuating anxiety at that very point in time. This concept is accompanied by Trait Anxiety, which is a rather constant and stable level of anxiety that is part of one's personality. An experiment by Camara and Hicks for example revealed highly significant reductions of state anxiety after a virtual tour of Hawaii (Camara & Hicks, 2020). This reduction that is investigated in this study will be named Anxiety Difference (between before and after the experiment).

2.2. Awe

Awe is a positive and meaningful feeling that is often induced by being exposed to a natural surrounding that is rich in its degree of vastness or wideness. In this study, awe is considered as an umbrella term for the feeling induced by a nature's degree of vastness, spaciousness, fascination, and a feeling of being insignificant next to the surroundings, and it lies at the very core of this research as a manipulation. These are the most crucial characteristics within awe for the context of this study. Due to this emotion often being associated with the feeling of insignificance compared to the impressiveness of one's surroundings, it is therefore also strongly associated with the element of self-salience which is an important dimension to this research and will be elaborated upon in a later section.

Haidt (2003) delegates the feeling of awe to the list of experiences that induce self-transcendence, which is strongly connected to being mindful and can thereby complement the meditation process. Awe was also found to reduce anxiety and trigger positive emotions in stressful situations (Rankin, Andrews, & Sweeny, 2020). The close relationship and connectedness of awe and meditation additionally stem from the fact that experiences in meditation and experiences that induce awe trigger associated neural mechanisms as shown by van Elk et al. (2019). In a study conducted by Chirico et al. (2017), 42 participants were exposed to either a 2D video or a more immersive one within a virtual reality environment. Their results showed that participants reported a significantly increased feeling of awe in the virtual reality environment compared to the control group. In a following study, it was shown how the VR-induced awe increased the participant's level of presence in the virtual setting (Chirico, Ferrise, Cordella, & Gaggioli, 2018). Additionally, environments that were high in overall awe led to a significantly increased presence compared to their neutral counterparts (2018).

Additionally, awe plays a vital role when it comes to the attention that students need for a successful academic performance, as positive emotions (with awe being one) possess the ability to impact one's cognitive abilities (Fredrickson & Branigan, 2005). In their research about the relationship between the concept of interest and attentional focus, Sung and Yih found that instead of interest, it is experiencing awe that has a positive effect on the attentional focus (2015). The cognitive potential of awe was already researched in 2003 when it was found that exposure to awe leads to an improved information processing (Keltner & Haidt, 2003). The potential of awe is not to be underestimated as it allows for a wide range of benefits connected to the psychological and physiological level of the one experiencing it by triggering positive emotions and reducing one's anxiety.

As stated in the problem setting, life is often hectic and rushed - and the absence of the feeling of having time is harmful to one's mental well-being (Menzis, 2005). This is where feeling awe comes into play, as it possesses the ability to alter one's time perception and make us feel like we possess more of it (Rudd, Vohs, & Aaker, 2012). This led to the finding that when people feel that they have more time and less of a rush, they report a higher level of being satisfied with life. While time perception is not a focal point in this study, the intertwined connection of life being hectic and our feeling of stress is noteworthy. All characteristics of awe considered, it is implied that awe's benefits are twofold; managing to improve the student's level of focus needed for studying while at the same time accounting for a decrease in one's momentary level of anxiety. Therefore, it is predicted that experiencing awe has a beneficial

effect on one's mental health and can support the intervention by playing its part in reducing the participants' level of anxiety. This is translated to the following hypothesis:

H1: The environment inducing a feeling of awe (that is increased by VR) creates a stronger anxiety reduction as opposed to the environment which does not induce feelings of awe.

2.3. Attention Restoration

As attention is a fundamental asset and part of both mindfulness and studying, it is evidently meaningful to take the role of attention in the context of student anxiety into account. In fact, research has shown how remaining in a calming state can ultimately increase one's creativity and attention (Yang et al, 2019). The concept of attention has been a topic of interest in social sciences for a long time and was famously defined by psychologist William James as focusing on "one out of what seem several simultaneously possible objects or trains of thought" (James, 1890, p. 403). Here, it is of importance to make a distinction between the two types of attention included in this research; the more physical dimension of attention used within meditation and study attention which is used for focusing on academic tasks without distractions.

Attention itself is often considered as a concentrated focus on one specific activity while avoiding mental distractions – and that is a crucial element which can potentially be created within a VR meditation and afterwards translated to the context of studying in order to feel more at ease and be productive. In fact, that is what the Attention Restoration Theory (Kaplan & Kaplan, 1989) implies. According to Anderson et al. (2017), "exposure to nature can reduce stress, improve mood, and restore work productivity" (p. 520). Many of the tasks that we are following in our daily routines require both mental and physical resources which are limited. However, these energy resources can be recharged by being exposed to nature, which implies three distinct important aspects; A feeling of being somewhere else, being fascinated by the environment, and considering the environment as spacious (Hartig et al., 2003).

In research about the restorative powers of nature, Kaplan (1995) found that people show an increased cognitive functioning in tasks that required their attention if they indulged in restorative activities in nature, as opposed to the control group without this exposure to nature. Additionally, there has been evolving interest in the impact of nature on psychological well-being too. Besides meditating, simply the exposure to nature has shown to be beneficial for how well people feel mentally (Ulrich, 1981). Therefore, it appears beneficial to combine meditation and exposure to restorative nature elements in order to improve the level of well-

being and attention. The research at hand in this paper focuses on using the concept of immersion to make the environment seem as real as possible and thereby making use of the benefits of attention restoration while simply sitting in a room that does not offer this kind of natural setting. Considering the wide variety of previously described benefits that feeling awe can bring for a person including the reduction of anxiety and in increase in the feeling of presence, the following hypothesis is identified:

H2: The feeling of awe in Virtual Reality leads to a stronger increase in Perceived Restorativeness as opposed to the environment without the elements of awe.

As Perceived Restorativeness is here measured through the four concepts of Being Away, Fascination, Coherence, and Compatibility, the following four hypotheses are identified:

H5: Exposure to awe leads to a stronger feeling of Being Away as opposed to the non-awe condition.

H6: Exposure to awe leads to a stronger feeling of Fascination as opposed to the non-awe condition.

H7: Exposure to awe leads to a stronger feeling of Coherence as opposed to the non-awe condition.

H8: Exposure to awe leads to a stronger feeling of Compatibility as opposed to the non-awe condition.

2.4. Meditation

Meditation has enjoyed increased interest in the past few years, as people seem to have an increased need for relaxation of the body and mind. This is often achieved through the utilization of mindfulness, which can be described as "focusing attention on the experience of thoughts, emotions, and bodily sensations, simply observing them as they arise and pass away" (Hölzel et al, 2011, p.538). Research is supporting the effectiveness of meditation as a means of treatment for disorders regarding mental health and anxiety in specific as shown by Hofmann, Sawyer, Witt and Oh (2010). Meditation offers a variety of benefits for the context of students with anxiety, as research has shown that meditation ultimately leads towards an increased cognitive functioning (Jha, Krompinger, & Baime, 2007). Not only can it increase these benefits, but meditation has also shown to decrease test anxiety in students (Powel, 2004), allowing for the assumption of meditation having a considerable impact on student's academic performances. Powel's study however focuses on cases of severe cases of test anxiety, whereas this study accounts for the more common 'day-to-day' anxiety found in students.

Students that experience anxiety do not always have immediate access to a meditation-friendly environment and therefore are in need of an instantaneous, on-demand solution to cope with anxious episodes. This is where virtual reality (further referred to as 'VR') can step in and offer students the possibility to simulate themselves into a calming environment to meditate in while physically being in front of their desks. This simulation is enabled by the immersion that is triggered by the ability to perceive one's whole body instead of just looking at a limited screen (Slater, 2018). A recent study with students revealed that spending time in comforting environments within Virtual Reality could reduce the anxiety that arises before an exam for students who are high in anxiety (O'Meara, Cassarino, Bolger, & Setti, 2020). Regardless of the technology seeming complex for the ones who are not yet familiar with it, VR is a highly feasible and practical tool. In a meta-analysis contextualizing virtual reality exposure therapy (VRET) for anxiety-related disorders (specifically for social anxiety as well as performance anxiety), Carl et al. concluded that the virtual reality approach is "more appealing and easier to disseminate" compared to alternative approaches (p. 4, 2015). Many successful studies such as the aforementioned include multiple therapy sessions or meditations instead of these being a one-time intervention. It is therefore of interest to additionally delve into the matter of meditation experience playing a role in the effect strength of the interventions by looking into reported differences between experienced and inexperienced meditators. Insights deriving from treating Meditation Experience as its own separate variable entails implications for how to best implement VR meditations depending on the outcome and offers ground for future research.

Regardless of experience however, the value of researching and utilizing VR lies not only in its practicality but additionally in its impact on one's mental well-being through the combination of the audio guidance with the relaxing nature that the user finds him-/herself in. Once optimal environments are figured out, VR offers means to recreate that certain environment in the comfort of one's home and take the user on a journey into the wild. In fact, the immersion into natural environments within virtual reality has already been proven to relax the user and alleviate anxiety, as shown by Tarrant, Viczko, & Hope (2018). In their pilot study in the United States with twelve participants that all indicated to suffer from anxiety symptoms, it was not only illustrated that a virtual reality meditation reduced self-reported signs of anxiety but additionally shifted certain brain patterns that correspond with the reduction of those symptoms, thereby providing evidence for physiological support through the intervention.

In a previous pilot study from 2017 that included 44 mindfulness experts, the results from utilizing virtual reality showed "encouraging preliminary evidence of the feasibility and

acceptability of using VR to practice mindfulness based on clinical expert feedback" (Navarro-Haro, 2017, p. 2). Additionally, they found their VR mindfulness skills training to be more effective against anxiety compared to its controlling counterpart without the element of virtual reality. In a more recent study with students in East-Asia, researchers were able to show that test anxiety could even be reduced in students that score low in anxiety overall, showing that the meditative VR environment could potentially be of help for students across the spectrum (Kwon et al., 2020). These findings considered, mindfulness meditation in a virtual reality setting offers a promising potential for university students specifically to decrease their symptoms of anxiety in the context of studying. Therefore, the following hypothesis derives from this framework:

H3: Meditating in virtual reality significantly decreases symptoms of anxiety in university students as opposed to meditating without virtual reality.

2.5. Perceived Body Boundaries

The perceived physical boundaries regarding one's own body are a phenomenon that is strongly associated with mindfulness. As one becomes more aware of his or her surroundings and starts experiencing a certain level of connectedness, the body is supposed to 'become one' with its environment and thereby transcend its usual state. In their work about the varying self-transcendent experiences, Yaden et al. (2017) describe these as "transient mental states of decreased self-salience and increased feelings of connectedness" (p. 143). In a research conducted with 45 young adults, it was shown how mindfulness training reduces the overall perceived body boundaries of the participants (Hanley, Dambrun & Garland, 2020). If one's perceived body boundaries start to become more and more imperceptible, this dissociation from one's own body (and potentially the ego connected with it) can make people feel a stronger connection to nature, playing into nature's restorative forces. Here, it is additionally interesting to take into account participant's pre-existing levels of Trait Anxiety which is why the correlation between these two will be investigated. Thereby, it is possible to draw conclusions about if highly anxious people perceive their body boundaries differently than less anxious people.

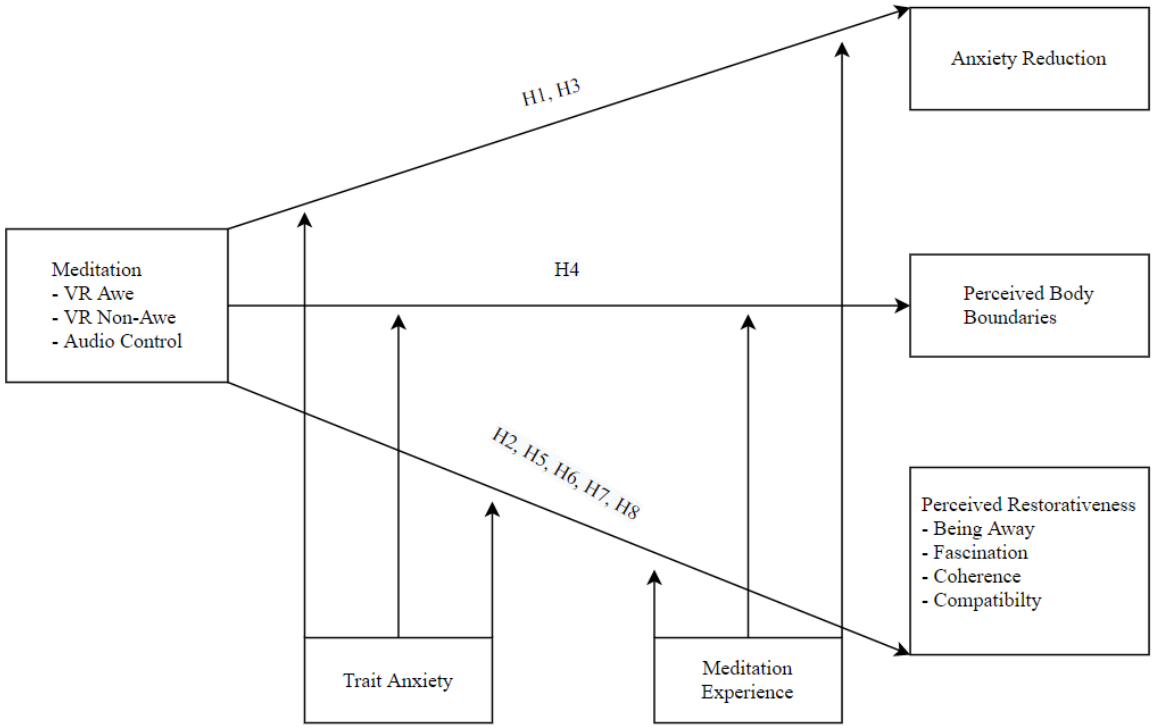
It is valuable to research the translatability of this mindfulness to the virtual environment, resulting in the following hypothesis:

H4: Meditating in VR reduces the salience of Perceived Body Boundaries by making the user feel connected to the environment.

The research question is illustrated within the research model visible in Figure 1.

Figure 1

Research Model



3. Methods

3.1. Design | Instruments

To provide an answer to the research question about the extent to which meditating in a virtual reality setting can decrease symptoms of anxiety and to test the different hypotheses, a research design with appropriate measurements has to be established. To offer novel insights while using knowledge from existing literature, a between-subject design with a pre-post test intervention is chosen to investigate attention and anxiety. The group of participants are measured in three different conditions; two groups with the virtual environment, with one of them having the addition of awe inducing elements which are absent in the other group. Thirdly, the control group does not have access to VR and instead follows the meditation by listening to the audio only.

The conditions will include three distinct groups; Two guided meditations in virtual reality, one of them containing elements that induce the feeling of awe whereas the other environment does not include these awe-inducing components. The feeling of awe is induced by exposing the participant to an environmental setting that is vast, wide, and has elements that often make people feel small. That environment was filmed on a hill in the Sallandse Heuvelrug national park in the Netherlands which allowed for awe-inducing scenery. The virtual environment without the element of awe consists of a less spacious and less vast environment, in this case in the midst of a local forest. The third group makes up the control group that solely receives the audio with the voice guide without any addition of the virtual reality environment. This setting is added to control for the general added effect and value of the virtual environment in comparison to 'traditional' methods of meditation.

3.2. Procedure

The study gathers quantitative data through the means of a self-reported questionnaire response of the participants regarding their feelings and perceptions. This study in particular used the software *Qualtrics* that was acquired via the University of Twente. Furthermore, this study was conducted individually with one participant at a time to ensure the required distancing measures and to avoid gatherings of too many people during the Covid-19 crisis. After arriving on the site of the experiments, participants were first asked to fill out a pre-experiment questionnaire involving questions regarding their trait anxiety (treated as covariate) as well as their current state anxiety. Afterwards, according to their previous experience with virtual reality systems, the participants were introduced to the gear and its functionalities and were given a short time

to make themselves familiar around it. Subsequently, the participants followed the 7-minute meditation that they were randomly assigned to; VR environment plus the element of awe, VR environment without said element, and an audio-only control group.

After finishing the meditation, the participants were asked to fill out a second questionnaire, again indicating their level of state anxiety in that given moment. This post-experiment part of the survey however additionally includes an indication of the participants' perceived body boundaries by Dambrun as well as a multitude of restorative scales. The questionnaire is ending with basic demographic information before the participants are debriefed about the purpose of the study as well as potential contact possibilities in case of additional questions or specific interest about the study's outcomes.

3.3. Materials

In order to create suitable footage for the context of this study, certain materials were used. A Samsung 360 camera was borrowed from the BMS Lab at the University of Twente in order to film the two Virtual Reality environments in 360 degrees, allowing for optimized immersion. During the experiment, the participants viewed the footage on a Samsung phone using a Samsung VR Gear headset borrowed from the BMS Lab as well. The studies were held in lab facilities on campus of the University of Twente. The two different Virtual Reality conditions can be seen in Figure 1 and Figure 2 below.

Figure 2

Screenshot of the Awe condition

Figure 3

Screenshot of the Awe Condition

In preparation for the study, a pretest including ten participants was conducted to reveal any existing obstacles and issues of clarification prior to the experiments. During the test, the

participants were asked to think aloud and communicate their thoughts regarding the instructions and questions. The pretest revealed that it is helpful to clarify Virtual Reality experience of the participants prior to the experiment and give out simplified instructions as to how to start the meditation video. Furthermore, the test was used to get first impressions on the perception of awe in the high awe environment. Here, participants indicated that they indeed perceived the environment as impressive and high in awe. Additionally, multiple participants voiced their confusion regarding the Perceived Body Boundaries scale which was resolved by reformulating and clarifying the instructions given in the questionnaire.

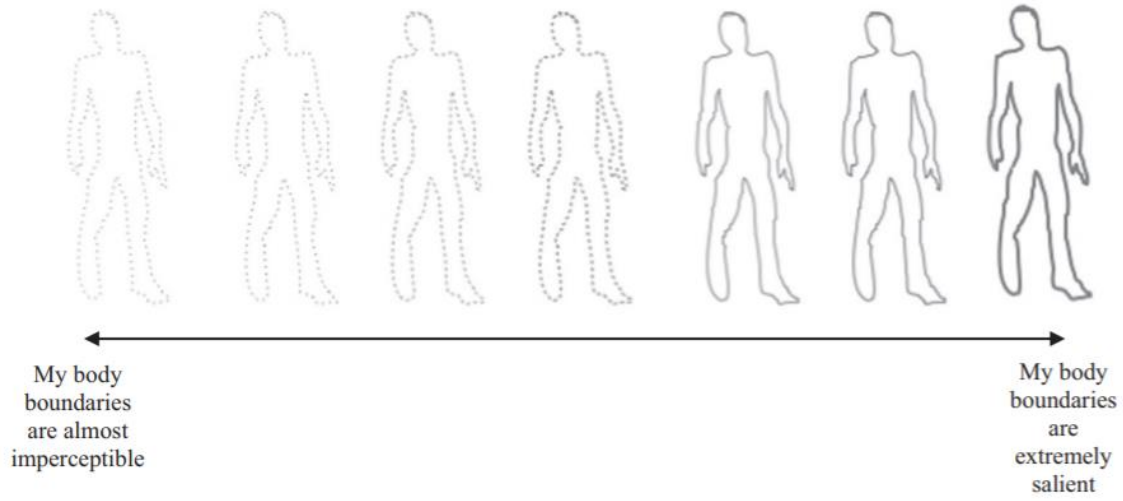
3.4. Measurements

The initial pre-experiment part of the survey measures two defined constructs; the participants' level of self-reported trait anxiety, which is treated as a covariate, as well as their more momentary state anxiety using the State Trait Anxiety Inventory (STAI) which can be found in Appendix B. Here, state anxiety is measured using the shortened version of the Y-1 form of the *State Trait Anxiety Inventory (STAI)*. The shortened version was introduced by Marteau and Bekker who found that the short form offers a "briefer and just as acceptable scale for subjects while maintaining results that are comparable to those obtained using the full-form of the STAI" (1992, p. 301). This part focuses on state anxiety by asking a total of six questions indicating one's feelings in that specific moment. Those include (but are not limited to) statements such as *"I feel calm", "I am worried", "I feel upset", or "I am content"*. Those were measured once before and once after the meditation. Within the analysis, these were added as 'State Anxiety Pre', ' State Anxiety Post', and a variable including the reduction between those, called 'State Anxiety Difference'. The anxiety difference scale was found to be reliable with a Cronbach's alpha of .82. Trait Anxiety is measured once before the meditation via 15 items statements about one's general anxiety including *"I could be experiencing some emotion and not be conscious of it until sometime later."* and *"I find myself preoccupied with the future or the past."*. This was found to be reliable with a Cronbach's alpha of .73. The scale on both trait and state anxiety related statements was changed from its initial 4-point scale going from *'Not at all'* to *'Somewhat'*, *'Moderately so'*, and *'Very much so'* to a 5-point Likert scale (ranging from *'Strongly disagree'* to *'Strongly agree'*) in order for the survey to be as coherent and understandable for the participants by providing the same 5-point scale throughout the questionnaire.

Subsequently after the meditation, participants indicate their body salience on the *Perceived Body Boundary Scale* by Dambrun (2016) as visualized in Figure 4. This scale contains seven outlines of a human figure, ranging from barely any to an extreme salience of one's body. The participants indicate which one of the figures they identify and associate themselves the most with at the current moment.

Figure 4

Perceived Body Boundary Scale (Dambrun, 2016)



The perceived restorative powers of the nature used within the meditation are measured post-test using the *Perceived Restorativeness Scale* by Hartig et al. (1997). As the control group does not include any environment, this part of the survey is only shown to the two conditions that include Virtual Reality. This scale consists of 17 items, measuring four constructs (Being Away, Fascination, Coherence, Compatibility). Here, these constructs will be analyzed independently as well as the combined scale of Perceived Restorativeness (all four constructs combined) will be investigated. *'Being Away'* is measured through the two items *'Spending time here gives me a good break from my day-to-day routine'* and *'It is an escape experience'* and is equipped with a Cronbach's alpha of .56. As this construct only consisted of two items, a correlation analysis was conducted which revealed a positive correlation between the two questions (r = .378, p = .014). *'Fascination'* is measured through six items such as *'I would like to spend more time looking at the surroundings'* and an associated Cronbach's alpha of .86. Thirdly, *'Coherence'* consists of four statements including *'There is a great deal of distraction'* and has an associated Cronbach's alpha of .74. Lastly, the construct of *'Compatibility'* is

measured through the participant's indications on five statements including *'Being here suits my personality'* with a Cronbach's alpha of .82.

Lastly, participants are asked to disclose basic demographic information regarding age, gender, country of origin and their level of education. Within this final demographic part of the questionnaire, participants are also asked if they have ever meditated prior to this experiment through the means of a yes/no question. Meditation Experience is treated as a covariate in order to further investigate the role of preexisting experience on changes in anxiety reduction, the participant's body's salience, as well as their perceived restorativeness.

3.5. Sample

The sample of the main study consisted of a total of 61 participants that were recruited via convenience sampling. Specifically, the sample consisted of participants from personal networks as well as respondents from postings in groups on Facebook as well as the study platform *Sona* from the University of Twente. To reduce demographic bias, the sample consisted of university students with no professional meditation experience. As all participants sufficiently filled out the survey and matched the selection criteria of being enrolled in a university, all 61 responses were used and most equally distributed across the three conditions.

Table 1

Condition Distribution

Condition	n	Percentage (%)
Audio	21	34.4%
VR (Non-Awe)	20	32.8%
VR (Awe)	20	32.8%
Total	61	100%

This experiment has a predominantly female sample, with 60.7% of the participants being female and the remaining 39.3% being male. The audio group consisted of 38% males (N = 8) and 62% females (N = 13), the non-Awe group consisted of 35% males (N = 9) and 65% females (N = 11). Lastly, the gender distribution in the Awe condition was 35% male (N = 7) and 65% female (N = 13). A Chi-Square test with gender and condition was insignificant (X2 = 2, N =

61) = .440, p = .803), showing that condition and gender are not associated with one another. The age of the sample ranged from 18 years to 36 years of age, with an average of 23.9 and the most frequently occurring age being 22 years old. A one-way ANOVA with age and condition was insignificant (F (14, 46) = 1.63, p = .107). Over 75% of the participants already graduated from a university program. Looking at the nationalities of the sample, it is mostly made up by Dutch (36.1%) and German (36.0%) participants. A Chi-Square test did not show a significant association between nationality and condition (X2 = 34, N = 61), = 35.303, p = .406).

3.6. Quality of Instruments

In order to ensure sufficient quality of the results, the reliability and validity of the included constructs had to be tested. Therefore, factor analyses were conducted including the aforementioned variables. For the construct of 'Fascination' (as part of the Perceived Restorativeness Scale), the items 1 and 2 had to be eliminated (*'The setting has fascinating qualities.'* & *'My attention is drawn to many interesting things.'*) as they loaded into two components. This brought the explained variance of 51% and an associated Cronbach's alpha of .74 to an explained variance of 79% with an associated Cronbach's alpha of .86. All remaining item scores were regarded as sufficient and can be found below in Table 2.

Table 2

Reliability Analyses

Construct	Number of items	Cronbach's Alpha
State Anxiety Difference	6	.82
Being Away	2	.56 / r = .378
Fascination	3	.86
Coherence	4	.74
Compatibility	5	.82
Trait Anxiety	15	.73

3.7. Analysis

The gathered data was analyzed and compared after completing the post-experiment survey to offer insights and cognitive responses about the described variables as well as mainly taking into account the comparison between anxiety differences. The software *SPSS* will be utilized for the analysis in order to investigate findings leading to confirmation or denial of the previously stated hypotheses.

If the covariates (trait anxiety and meditation experience) reached significance, follow-up analyses were conducted which treated these as a moderator variable (fixed factor) to further explore their role. Here, solely (marginally) significant effects of the covariates are reported.

4. Results

4.1. Trait Anxiety

An ANOVA with Trait Anxiety as dependent variable revealed no significant effect of the condition (F (2,58) = 2.10, p = .132) which is as expected as Trait Anxiety was measured before the conditions were tested (Table 29). The ANOVA using Trait Anxiety as dependent variable to check whether levels of Trait Anxiety was equal across conditions revealed no significant differences regarding the means between the audio conditions (M = 2.78, SD = .38), the awe condition (M = 3.02, SD = .51), and the non-awe condition (M = 3.02, SD = .38). Within the subsequent analyses, Trait Anxiety is treated as covariates.

4.2. Meditation Experience

An ANOVA with Meditation Experience as dependent variable revealed no significant effect of the condition (F (2,58) = .196, p = .823) which is as expected as those experiences were made prior to this experiment (Table 30). In total, 15 people did not yet meditate before this study (24,6%) whereas the respective 46 participants did in fact not yet meditate in their lives (75,4%).

4.3. State Anxiety Difference

A one-way between groups ANOVA with Anxiety Difference as dependent variable (Table 6) revealed a marginally significant effect of the video condition (F (2,58) = 2.42, p = .098), suggesting that the awe condition resulted in the greatest decrease in anxiety (M = -.77, SD = .54) followed by the non-awe condition (M = -.56, SD = .45) and the control condition (M = .46, SD = .33). Post hoc comparisons using the Tukey test indicated that the mean score for the Awe condition was (marginally) significantly stronger compared to the control group using audio only (p = .087). However, the non-awe condition did not significantly differ from the awe condition (p = .329) and the control condition (p = .761).

Therefore, the hypothesis H3 can be (marginally) supported as the (awe) Virtual Reality condition reveals a stronger decrease of anxiety as opposed to the control group.

In an ANCOVA (Table 7), the effect of the Trait Anxiety as covariate is significant (F (1,57) = 7.34, p = .009) showing that higher levels of Trait Anxiety can predict higher State Anxiety Differences. Here however, the effect of conditions is not significant (F (3,57) = 1.605, p = .210).

An ANOVA with Anxiety Difference as dependent variable (Table 28) revealed a

significant effect of the covariate Meditation Experience (F (1,59) = 5.99, p = 0.017), suggesting that having meditation experience results in a bigger anxiety reduction (M = -.67, SD = .44) after the experiment than never having meditated beforehand (M = -.34, SD = .47).

In an ANCOVA (Table 27), the effect of Meditation Experience is significant (F (3,57) = 5.37, p = .024) while the effect of the condition is not significant (F (3,57) = 2.169, p = .124).

4.4. Perceived Body Boundaries

An ANOVA with Perceived Body Boundaries as dependent variable (Table 9) revealed no significant effect of the video condition (F (2,58) = .79, p = .461), thereby not enabling the results to significantly suggest that any of the Virtual Reality groups, meaning the awe condition (M = 4.00, SD = 1.17) and the non-Awe condition (M = 4.00, SD = 1.21) resulted in the lower Perceived Body Boundaries than the control group condition (M = 4.48, SD = 1.75). Therefore, the hypothesis H4 cannot be supported as meditating in VR did not reduce the perceived self-salience of the participants.

Additionally, running an ANCOVA with Trait Anxiety as covariate (Table 26) did not show significant results for either Trait Anxiety (F (3,57) = 2.090, p = .154) or the effect of condition (F (3,57) = .359, p = .700).

4.5. Perceived Restorativeness Scale

4.5.1. Being Away

An ANOVA with Being Away as dependent variable (Table 11) revealed no significant effect of the video condition (F (1,38) = 1.106, p = 0.320), and therefore could not significantly show that the awe condition resulted in an increased feeling of Being Away (M = 4.20, SD =.66) compared to the non-awe condition (M = 3.98, SD = .75). Therefore, hypothesis H5 must be rejected.

An ANOVA with Being Away as dependent variable (Table 12) revealed a significant effect of the covariate Meditation Experience (F (1,38) = 5.96, p = 0.019), suggesting that having meditation experience results in a stronger increased feeling of Being Away (M = 4.23, SD = .51) after the experiment than never having meditated beforehand (M = 3.61, SD = 1.05). When adding the condition as a fixed factor (Table 13), Meditation Experience as a covariate is significant in the ANCOVA with Being Away as dependent variable (F (1,37) = 5.648, p = .044), the effect of condition in the ANCOVA is insignificant (F (1,37) = .853, p = .362).

4.5.2. Fascination

An ANOVA with Fascination as dependent variable (Table 14) revealed no significant effect of the video condition (F (1,38) = .420, p = .521), thereby not being able to illustrate that either the non-awe condition (M = 3.88, SD = .93) or the awe condition (M = 3.68, SD = 1.02) resulted in a significantly higher feeling of Fascination. Therefore, hypothesis H6 must be rejected.

An ANOVA with Fascination as dependent variable (Table 15) revealed a marginally significant effect of the covariate Meditation Experience (F (1,38) = 3.63, p = 0.064), suggesting that having meditation experience results in a stronger increase in Fascination (M = 3.94, SD = .90) after the experiment than never having meditated beforehand (M = 3.26, SD = 1.05). When adding condition as fixed factor (Table 16), Meditation as a covariate is marginally significant in the ANCOVA with Fascination as dependent variable (F (1,37) = 3.762, p = .060), the effect of the condition is still insignificant (F (1,37) = .618, p = .437).

4.5.3. Coherence

An ANOVA with Coherence as dependent variable (Table 17) revealed no significant effect of the video condition (F (1,38) = 1.078, p = .306), and could therefore not illustrate a higher feeling of Coherence in the awe condition (M = 4.12, SD = .71) compared to the non-awe condition (M = 4.35, SD = .69). Therefore, hypothesis H7 must be rejected.

After performing a median split on Trait Anxiety (into high and low Trait Anxiety) and running another ANOVA with the split Trait Anxiety as a fixed factor (Table 18), the analysis resulted in a marginal significance for the main effect of Trait Anxiety on Coherence (F (1, 36) = 3.85, p = .058), suggesting that the non-awe condition resulted in a higher feeling of coherence (M = 4.35, SD = .69) than the awe condition (M = 4.12, SD = .71). When adding condition as fixed factor, the ANCOVA with Trait Anxiety as covariate however did not show a significant effect of the condition (F (2,37) = 1.049, p = .312).

4.5.4 Compatibility

An ANOVA with Compatibility as dependent variable (Table 19) revealed no significant effect of the video condition (F (1,38) = .661, p = .421), and thereby not making it possible to suggest that the non-awe condition results in an increased feeling of Compatibility (M = 3.84, SD = .70) compared to the awe condition (M = 3.66, SD = .71). Therefore, hypothesis H8 must be rejected.

An ANOVA with Compatibility as dependent variable (Table 20) revealed a marginally

significant effect of the covariate Meditation Experience (F (1,38) = 3.85, p = 0.087), suggesting that having meditation experience results in a stronger increase in Compatibility with the environment (M = 3.85, SD = .59) after the experiment than never having meditated beforehand (M = 3.40, SD = .94). Running an ANCOVA including condition as fixed factor (Table 21) showed a marginally significant result for Meditation experience (F (2,37) = .3.27, p = .079) while the effect of the condition was insignificant (F (2,37) = .891, p = .351).

4.5.5. Perceived Restorativeness Scale

Here, the combined scale of the previous four constructs of Perceived Restorativeness is taken into account. An ANOVA with Perceived Restorativeness as dependent variable (Table 22) revealed no significant effect of the video condition (F (1,38) = .301, p = .587), suggesting that the non-awe condition results in an increased Perceived Restorativeness (M = 4.01, SD = .57) compared to the awe condition (M = 3.92, SD = .54).

Therefore, the hypothesis H2 has to be rejected, as no significant effect of Virtual Reality on the restorativeness was found.

An ANOVA with Perceived Restorativeness as dependent variable (Table 23) revealed a significant effect of the covariate Meditation Experience (F (1,38) = 4.93, p = 0.032), suggesting that having meditation experience results in a stronger increase in Perceived Restorativeness (M = 4.06, SD = .44) after the experiment than never having meditated beforehand (M = 3.62, SD = .76). When adding condition as fixed factor, Meditation Experience as covariate in the ANCOVA (Table 24) resulted in a significant difference (F (2,37) = 5.039, p = .031), the effect of condition here was not significant (F (2,37) = .504, p = .482).

4.6. Additional Analyses

Further analyses were carried out in order to investigate the relationships between the variables. Here, only the analyses leading to significant and relevant results are reported.

State Anxiety Difference

The mean averages are rather small between the three conditions, especially the differences between the two natural conditions including VR. Therefore, a filter was applied that solely takes into account the awe condition and the audio control group in order to better differentiate and understand the differences between VR and non VR. Thereby, the added value of Virtual Reality can be investigated. Additional findings are only reported based on analyses taking into account the differences between VR and non-VR (awe and audio group). When running an

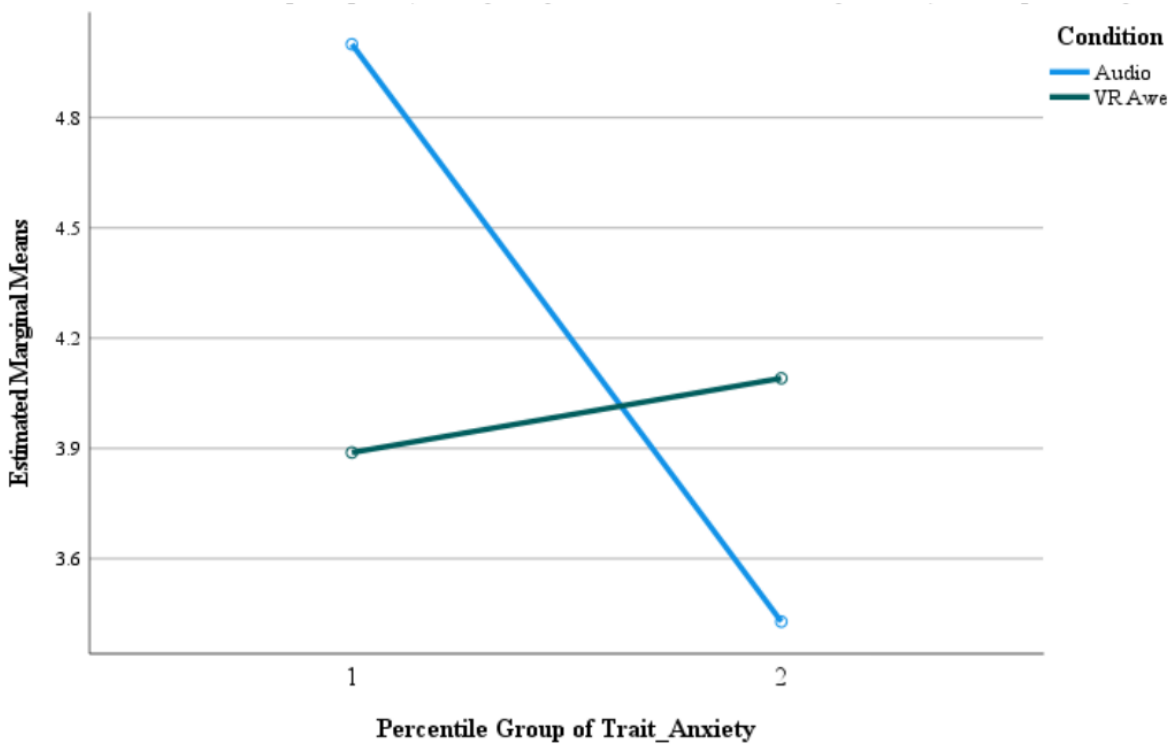
ANOVA including those two conditions, the main effect for the condition on State Anxiety Difference is significant (F (1,39) = 4.95, p = .032), suggesting that meditation in the awe condition significantly leads to a stronger decrease in State Anxiety (M = -.77, SD = .54) over the audio condition (M = -.46, SD = .33).

Perceived Body Boundaries

While solely taking into account the Audio and VR Awe group, a profile plot was created to visualize the means of the Perceived Body Boundaries in both groups of high and low Trait Anxiety. Running an ANOVA using Perceived Body Boundaries as dependent variable did not show a significant effect of the condition (F (1,39) = 1.038, p = .314). Through the profile plot however, it's visible how the low Trait Anxiety group from the Awe meditation enjoyed much lower Perceived Body Boundaries (M = 3.89, SD = 1.27) after meditating compared to low Trait Anxiety participants in the Audio group (M = 5.00, SD = 1.47). Within the Audio group, the Perceived Body Boundaries are visibly lower in the group with high Trait Anxiety (M = 3.43, SD = 1.90) compared to the Awe condition (M = 4.09, SD = 1.14).

Figure 5

Profile Plot (PBB & Trait Anxiety)



Lastly, in order to further explore relationships between the dependent variables, a correlation analysis was conducted (Table 25). This showed a significant positive correlation between Perceived Body Boundaries and the post experiment State Anxiety (r = .32, p = .012), showing that salient Perceived Body Boundaries (M = 4.16, SD = 1.41) are positively correlated with having higher reported State Anxiety (M = 1.82, SD = .45) after the meditation. Table 3 summarizes the investigated hypotheses including their status of support deriving from the results section.

Table 3

Hypotheses

Hypotheses	Supported
H1: The feeling of awe (that is increased by VR) creates a stronger anxiety reduction as opposed to the environment without elements of awe.	No
H2: The feeling of awe in Virtual Reality leads to a stronger increase in Perceived Restorativeness as opposed to the environment without the elements of awe.	No
H3: Meditating in virtual reality results in a stronger decrease of symptoms of anxiety in university students as opposed to meditating without virtual reality.	Yes
H4: Meditating in VR reduces the degree of self-salience by making the user feel connected to the environment.	No
H5: Exposure to awe leads to a stronger feeling of Being Away as opposed to the non-awe condition.	No
H6: Exposure to awe leads to a stronger feeling of Fascination as opposed to the non-awe condition.	No
H7: Exposure to awe leads to a stronger feeling of Coherence as opposed to the non-awe condition.	No
H8: Exposure to awe leads to a stronger feeling of Compatibility as opposed to the non-awe condition.	No

5. Discussion

This research was set up in order to investigate the potential effects of Virtual Reality meditation and their different environments on the mental health and associated concepts in young adults. In the following section, the findings from the results chapter will be contextualized and elaborated upon, before discussing limitations of the research, as well as recommendations for future research and potential fields of application.

An overall summary of the main findings will be presented before the findings within anxiety, perceived body boundaries, and perceived restorativeness are elaborated. The results showed that first of all, trait anxiety levels within students are worryingly high; yet VR offers a way to at least reduce the momentary state level of anxiety and thereby offer a valuable means of relaxation. Additionally, it was shown that State Anxiety Difference was higher in people with Meditation Experience as well as for the participants who scored higher in Trait Anxiety, showing that experience is beneficial as well as that the ones in need of help benefit from the intervention.

Anxiety

As all conditions had a similar State Anxiety level before the experiment the data allows for more accurate comparisons between the groups. It is noteworthy that one participant even managed to reduce his or her State Anxiety by 1.83 points (in the Awe condition) after the meditation which illustrates the extensive force with which the meditation can potentially improve one's stress levels and ultimately mental health.

The condition including the awe environment seemed to generate a State Anxiety Difference of almost a full point on the 5-point Likert scale that State Anxiety was measured on. This would in turn mean that a simple 7-minute meditation with the awe environment has the power to quite literally tip the scale on items used to measure State Anxiety such as *"I am content"* from a *'Neither agree nor disagree'* to an *'I agree'* which can have substantial consequences for one's mental health if one feels confident in his or her calmness or content in that given moment.

Even though the research could not yet prove the effect maximization by the awe environment over its non-awe counterpart, all three conditions generally made participants feel better about themselves and the moods they are in. As the differences between conditions were rather small, running the same analysis with only the high awe condition and the audio group allowed for a better comparison between VR and non-VR. Here, a significant effect of the

addition of VR was found on State Anxiety Difference, ultimately proving the potential of Virtual Reality as an added value to help improve mental health in young adults rather than meditations itself. Answering this paper's RQ, Virtual Reality can step into the world of meditations and offer a marginally significant scientific difference on State Anxiety, therefore offering an efficient means for anxiety reduction.

It is complex however to pinpoint potential reasons as to why the differences within the VR conditions were relatively small. One could argue that especially for people high in Trait Anxiety, the awe condition might have been rather counterproductive as being exposed and "put out there in the open" could trigger a feeling of being too visible and thereby cause nervousness or discomfort. The closed off environment of the forest on the other hand might be more comforting for people with high Trait Anxiety as they can feel more isolated and can more easily let go of their worries. Lastly, this group might show anxiety towards the use of less familiar technology (VR) as well as opposed to the more familiar audio condition.

It is noteworthy that having previous meditation experience resulted in a bigger reduction of State Anxiety compared to the group that never meditated in their life before with the condition effect being insignificant here. This might be due to the experienced group being more used to breathing exercises, knowing what to expect, and generally having less of a threshold to engage in such activities, which makes it easier to 'let go' for them compared to their inexperienced peers. As more and more people will have had their first meditation experience as time passes, it can be argued that people will on average be able to reap in more benefits from this meditation when they already meditated prior to this VR version.

Another interesting finding is that there is a larger State Anxiety difference for the group with high Trait Anxiety, showing that this intervention can be even more effective and helpful for people that actively suffer from anxiety and therefore are in need of that help. This however is seen regardless of the condition, meaning that the anxiety reduction does not depend on any of the VR conditions but instead has comparable effects both in VR as well as meditation rooms in a gym for example. While of course it is a nice addition to make non anxious people feel better, the real importance is to help people who feel bad to feel okay; and Virtual Reality meditation has ultimately shown that it is capable of that. VR meditation works best for the group that needs these means of stress and anxiety reduction the most - yet one of the most important findings is not that there is a potential solution within VR meditations, but rather how apparent the problem really is. A troublesome revelation deriving from the results is the overall range of Trait Anxiety found in the relatively small sample size. The participants reported Trait

Anxiety values from a 2.13 minimum to a 4.00 maximum on the 5-point scale, showing the wide array and unsettling levels of mental health within students as a baseline which is worrisome both in and out of the research context. The reported averages in both trait and state anxiety should act as a wakeup call for everyone, especially including academic institutions, to acknowledge how present and widespread the problem of anxiety amongst students and young adults really is. This is especially apparent for this demographic as they find themselves within an environment that is marked and characterized by the academic pressure, the race towards achievement and continuous competition. A global study with more than 1600 participants from over 60 countries revealed a vast difference in anxiety during times of the Covid crisis in regard to age groups, as young adults and adolescents struggle more with stress and anxiety compared to other age groups (Varma, Junge, Meaklim, & Jackson, 2021). This again especially adds importance for the context of universities as counseling and professional help both in and out of the university can be more than difficult to receive. As numerous factors like insurance, pricing, or long waiting queues keep professional help at a distance, this simple intervention can be made available for feasible use whenever needed and thereby bring the help a small step closer.

Perceived Body Boundaries

This study was not able to show that people who are exposed to nature (regardless of the addition of awe) feel less salient and more connected to their surroundings on average than people who are not exposed to natural environments. While insignificant, the data on the means is still interesting to view (M = 4.5 for the control group, M = 4.0 for both VR groups) as the figures five to seven on Dambrun's Perceived Body Boundaries scale are very salient and only start 'opening up' to their environment from the fourth figure's image downwards. This means that participants indicating a four or lower on the scale would sense a certain connectedness or oneness with the environment that they were exposed to. This is relevant outside of anxiety reduction as a focal point as well, as there is more that can be done to investigate virtual environments and their power to have the user feel one with the surroundings and thereby reconnect with the nature that is shown. This is increasingly important in our society as more and more people live in urbanized areas without instant access to nature and especially with busy schedules that do not always allow one to take the time to seek that nature.

While having to take into account that the results were statistically insignificant, it is yet important to illustrate the large impact that a small change can have or could have had. In this

case, both Virtual Reality conditions reported ‘open’ body boundaries, while the control group is positioned exactly between open and close body boundaries. This perfectly illustrates the scale tipping force of the Virtual Reality addition that can make oneself feel more like one with one’s environment and more connected to the surroundings participants find themselves in. This is once again emphasized through the correlation that was found between the Perceived Body Boundaries and the State Anxiety after meditation. That correlation demonstrates that the novel addition of Perceived Body Boundaries in this equation is indeed a valuable contributor in order to research and reduce anxiety reduction through meditation and can help to examine the optimized intervention. As for previous measures, there is a stronger effect for participants with high Trait Anxiety, which once again illustrates that the ones who need help and support the most also benefit the most from the presented intervention.

Perceived Restorativeness

While the differences are generally insignificant between conditions, both groups scored high overall and thereby showcased that the participants were enjoying the natural environments and felt good about them regardless of which environment they were assigned to. This leads to the positive conclusion that participants were able to take advantage of either one of the environments and did not depend on the added element of awe for them to feel compatible with the surroundings or to experience a degree of fascination. This is visible in Being Away too; While differences between the two VR conditions are insignificant, it is important to mention that both groups reported that regardless of condition it was still a good escape experience for the participants, which is a beneficial factor for the stress reduction, and thereby offers another reason for the utilization of Virtual Reality in meditations rather than against it.

There were surprising findings across the other dimensions of Perceived Restorativeness. Against expectations, there were no significant differences between groups when it comes to the feeling of Fascination and the awe condition did not result in a stronger increase in one's Fascination. This might be due to participants focusing more on one’s immediate surroundings in the closed off forest rather than on the distant fields of the national park. Interestingly enough, the same holds true for Coherence; Against expectations, the experiment did not result in significant differences between groups and the awe condition did not create a stronger increase in Coherence regarding the environment. That however might be explained by the forest environment leaving less room to one’s imagination about the environment since it is very closed off and has everything visible. The wider environment in

the national park can therefore seem more distracting or chaotic as there is simply more to see. Lastly, the results for Compatibility were insignificant as well and did not result in a stronger feeling of Compatibility in the awe condition. This might be due to forest environments being more familiar to participants living in the Netherlands rather than a higher altitude point of view with scenery that is unusual for the area. Additionally, forest walks might just be the more commonly occurring occasion rather than a trip to a national park.

Furthermore, it is meaningful to discuss previous meditation experience in participants regarding Perceived Restorativeness. There is a significant effect of meditation experience on the general Perceived Restorativeness, illustrating that either experienced participants were able to get the strongest effects out of the meditation or suggesting that a one-time meditation is not enough to induce the desired effect. This emphasized the need of a lowered threshold for first experiences which will be elaborated upon in the implementation section of the discussion.

The significance of previous meditation experience was seen across the variables within Perceived Restorativeness. For Being Away, it showcases how it is most likely easier to let go and enjoy the experience within the relatively short time of the meditation for experienced participants than the ones without experience who first need to adjust and get used to the instructions and meditations processes before they are able to enjoy it to the fullest. The same findings regarding meditation experience hold for Fascination as well, where previous experience with meditation likely facilitated the ability to fully take in one's surroundings while not having to focus too much on following the new breathing exercises, which in this case lead to the increased Fascination that was reported. Lastly, there too was a significant effect of meditation experience on Compatibility, which again shows that having previous experience makes the participant feel more compatible with nature as he or she already knows what to expect and how to use a meditation to one's benefits. Considering these findings leaves room to argue that continuous meditation experiences stack up their benefits over time as the experienced group entered the experiment with a different 'skill set' than their inexperienced peers which allowed them to make the most of the 7 minutes and soak in even more of the benefits.

Practical Implications

Seeing the unsettling levels of anxiety reported in young adults leaves room to wonder why not all academic institutions already employ (additional) means and further interventions that help tackle these mental health issues in students. Here, the options are plentiful; firstly, these findings stress the importance for universities to hire enough professional counsellors to meet the demand so that students with mental health issues are not left with multiple months of time waiting for their first appointment. Additionally, frequent student surveys regarding their level of mental health and the issues they experience are an easy way to figure out where and how to help. Furthermore, universities should not only normalize issues regarding mental health but also the importance of dealing with them. This could easily happen by for example granting each student a few days per semester for unexcused absences from lectures to focus on mental health and dealing with potential issues. On a wider scale, it is of utmost importance to destigmatize student life from being "the easiest time of one's life" and instead realizing how stressful and competitive university environments can be.

The fact that experienced meditators reported stronger benefits leaves room to argue that there should be means to lower the threshold of the first meditation experience. The first point of contact with meditations is often still very distant in our Western society even though this research shows that having exactly that previous experience leads to an improvement of almost all restorative elements used in this study, ultimately resulting in a more beneficial experience. When more people are facilitated to use (VR) meditations, they are simply more likely to enjoy the benefits even more the second time they come around to it. This can be achieved by destigmatizing meditation as some spiritual nonsense, but as a scientifically beneficial means to an end that in this case is an improved mental health. Furthermore, first points of contact with meditations as well as their repetitive practice should be implemented and promoted which will be further discussed in the section about fields of implementation.

Regarding the application of Virtual Reality meditations specifically, the university libraries are an optimal point of implementation. Not only are libraries usually the epicenter of students that study for (most likely stress inducing) examinations, but it is also not too practical to leave the library for some time to have to find a spot in nature (if the weather allows s) only to have lost not only time but also one's seat upon return in the library. Instead, setting up a bean bag or comfortable chair in a calm spot within the library allows students to take quick ten-minute breaks and enjoy relaxing nature without having to leave the premises or losing valuable time for studying.

Limitations

This research was subject to various limitations that impacted its outcome negatively. Firstly, the video quality was suboptimal once the videos were exported from Samsung's Gear VR app, which resulted in slightly pixelated visuals for the participants. It is likely that the participants lost parts of their immersive experience due to the environment not looking entirely real.

The most impactful limitation of this research was the sample size. The data was not only collected during the Covid-19 crisis but additionally during the summer months, which are two reasons for students to not physically be around the campus labs. This heavily complicated the recruitment processes as experiments had to be conducted in the same room to account for similar environments. As every condition could only contain 20-21 participants each, the results could not be strong enough to be generalizable which affects this study's impact and scientific strength. This led to results that show differences in their means yet are not supported enough by data in order for them to be significant.

Furthermore, this study relies on honest self-reports of the participants that might be exposed to bias since the experiments are conducted in person and participants might feel obligated to indicate that the meditation indeed calmed them down. Additionally, as one's emotions and sensations are not always conscious to oneself, participants might indicate different levels of anxiety than what they would have indicated in retrospect.

A last limitation might be the one-time exposure to the meditation as the intervention is probably more effective if used repetitively rather than the single use that was part of this experiment.

Recommendations for Future Research

Researchers who want to conduct further or similar studies can benefit from the mentioned limitations from this research by ensuring that the same issues do not occur. The two most impactful limitations, namely sample size and video quality are factors that should get most attention from researchers. Even though these two are very impactful, they are easily fixable; Recruiting a larger sample size will allow for more insightful data that more likely can lead to scientifically significant results. Additionally, the video quality can be improved by utilizing higher quality gear than the Samsung Gear VR and not working with video software that forces the data files to be compressed.

Furthermore, there are additional measures that could enhance the findings from similar studies and allow for novel insights. Firstly, this study focuses solely on self-reported

psychological measures of stress and anxiety. Instead, future research should add physiological measures in order to compare the self-reported anxiety changes with physiological measures such as one's heart rate, bodily temperature, etc. While of course it is most important how the participant thinks that he or she feels, supporting those states with bodily data can add a lot of value to the research. Additionally, this would solve the limitation of having to rely on self-reported data only that is always exposed to bias, as the tracked physiological data is more factually accurate. An additional important recommendation is for research to further pinpoint the role of awe within the virtual environments. Having deeper and more accurate insights into which elements trigger the strongest effect is highly valuable for any real-life applications and can provide more effective products for reducing anxiety. This can be done for example by replicating this study with not only a larger sample but comparing between different environments that are all considered high in awe. Such setup would allow for more detailed comparison between different elements of awe.

Additionally, time perception offers an interesting concept to investigate in future research. As both awe as well as meditation incorporate time perception altering characteristics, it can be valuable to properly elaborate on the role of time perception and the possibilities of utilizing these characteristics for (mental) health improvements or further physical benefits of the participants. Looking into the question if the experience of losing track of time through immersion can produce further benefits might be a valuable addition that amplifies the meditation effects on the participants.

Lastly, this research clearly illustrated that participants with previous experience with meditation benefited significantly more from the intervention than the ones without experience. While it is still important to not exclude one group in order to investigate further who benefits more from what construct, it is recommended to make the meditation experience as easy as possible for the ones without previous experience. That can be solved by simply making the meditation longer than the 7 minutes that were used in this case. Giving participants more time allows them to settle and adjust to the environment without being thrown in the cold water and being done with the meditation before they are able to fully enjoy its benefits. An additional recommendation for further research including meditation experience is to have a stronger decisive focus on it through for example making the conscious decision to solely include participants without any preexisting experience with meditation. Researching the best environment and context for a first experience can help maximizing the effects and thereby result in an improved mental health intervention.

6. Conclusion

This research was set up in order to investigate the restorative potential of Virtual Reality meditations as well as any potential differences occurring between environments and their degree of awe, to ultimately answer the question to what extent meditating in VR can help reduce anxiety in university students. This study offers partially significant support for the idea that meditating in Virtual Reality can in fact help reduce anxiety and thereby help improve mental health in young adults. This support is due to the marginally significant finding that a VR meditation including awe leads to the strongest reduction of state anxiety, followed by the non-awe VR meditation and lastly the control group using only the audio. This research adds to the growing and relevant body of work regarding the therapeutic power of technology by focusing on students and introducing both Perceived Body Boundaries as well as differentiations between multiple environments within Virtual Reality for anxiety reduction. Even though limitations need to be solved in order for similar research to be as fruitful as possible and yield additional significant results, this study is a worthwhile indicator of the powerful effect of Virtual Reality meditation on anxiety in young adults. The results from this paper can answer the RQ at the core of this research by illustrating that the marginally significant reduction in state anxiety as well as inducing restorative concepts (Being Away, Compatibility, Fascination) offer a valuable tool for people looking for some moments of peace and quiet in their busy days. This research shows that sometimes all we need to do is breathe in - and breathe out.

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Enclosures

Appendix A: Analysis Results

Table 4

Descriptive Statistics

Dependent Variable: Trait Anxiety			
Condition	Mean	Std. Deviation	N
Audio	2.78	.38	21
VR Awe	3.02	.51	20
VR Non-Awe	3.02	.38	20
Total	2.94	.44	61

Table 5

Descriptive Statistics

Dependent Variable: State Anxiety Difference			
Condition	Mean	Std. Deviation	N
Audio	-.46	.33	21
VR Awe	-.77	.54	20
VR Non-Awe	-.56	.49	20
Total	-.59	.47	61

Table 6

Tests of Between-Subjects Effects

Dependent Variable: Anxiety Difference

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.015	2	.507	2.415	.098
Intercept	21.515	1	21.515	102.396	.000
Condition	1.015	2	.507	2.415	.098
Error	12.187	58	.210		
Total	34.566	61			
Corrected Total	13.201	60			

a. R Squared = .077 (Adjusted R Squared = .045)

Table 7

Tests of Between-Subjects Effects

Dependent Variable: Anxiety Difference

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.405	3	.802	4.232	.009
Intercept	.266	1	.266	1.407	.241
Trait_Anxiety	1.390	1	1.390	7.339	.009
Condition	.608	2	.340	1.605	.210
Error	10.797	57	.189		
Total	34.566	61			
Corrected Total	13.201	60			

a. R Squared = .182 (Adjusted R Squared = .139)

Table 8

Tests of Between-Subjects Effects

Dependent Variable: Anxiety Difference

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.981	1	.981	4.953	.032
Intercept	15.342	1	15.342	77.447	.000
Condition	.981	1	.981	4.953	.032
filter_$	.000	0			
Condition * filter_$	.000	0			
Error	7.727	39	.198		
Total	23.871	41			
Corrected Total	8.708	40			

a. R Squared = .113 (Adjusted R Squared = .090)

Table 9

Descriptive Statistics

Dependent Variable: Perceived Body Boundaries

Condition	Mean	Std. Deviation	N
Audio	4.48	1.75	21
VR Awe	4.00	1.17	20
VR Non-Awe	4.00	1.21	20
Total	4.16	1.41	61

Table 9

Tests of Between-Subjects Effects

Dependent Variable: Perceived Body Boundaries

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3.123[a]	2	1.561	.786	.461
Intercept	1054.439	1	1054.439	530.705	.000
Condition	3.123	2	1.561	.786	.461
Error	115.238	58	1.987		
Total	1176.000	61			
Corrected Total	118.361	60			

a. R Squared = .026 (Adjusted R Squared = -.007)

Table 10

Case Summaries

Perceived Body Boundaries				
Condition	Percentile Group of Trait_Anxiety	N	Mean	Std. Deviation
Audio	1	14	5.00	1.47
	2	7	3.43	1.90
	Total	21	4.48	1.75
VR Awe	1	9	3.89	1.27
	2	11	4.09	1.14
	Total	20	4.00	1.17
VR Non-Awe	1	9	4.11	1.45
	2	11	3.91	1.04
	Total	20	4.00	1.21
Total	1	32	4.44	1.46
	2	29	3.86	1.30
	Total	61	4.16	1.41

Table 11

Tests of Between-Subjects Effects

Dependent Variable: Being Away

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.506[a]	1	.506	1.016	.320	.026
Intercept	668.306	1	668.306	1341.024	.000	.972
Condition	.506	1	.506	1.016	.320	.026
Error	18.937	38	.498			
Total	687.750	40				
Corrected Total	19.444	39				

a. R Squared = .026 (Adjusted R Squared = .000)

Table 12

Tests of Between-Subjects Effects

Dependent Variable: Being Away

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2.636[a]	1	2.636	5.958	.019	.136
Intercept	97.569	1	97.569	220.583	.000	.853
Meditation_Experienc	2.636	1	2.636	5.958	.019	.136
Error	16.808	38	.442			
Total	687.750	40				
Corrected Total	19.444	39				

a. R Squared = .136 (Adjusted R Squared = .113)

Table 13

Tests of Between-Subjects Effects

Dependent Variable: Being Away

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3.014[a]	2	1.507	3.394	.044	.155
Intercept	96.568	1	96.568	217.477	.000	.855
Meditation_Experience	2.508	1	2.508	5.648	.023	.132
Condition	.379	1	.379	.853	.362	.023
Error	16.429	37	.444			
Total	687.750	40				
Corrected Total	19.444	39				

a. R Squared = .155 (Adjusted R Squared = .109)

Table 14

Tests of Between-Subjects Effects

Dependent Variable: PRS_Fascination

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.400[a]	1	.400	.420	.521	.011
Intercept	572.544	1	572.544	601.567	.000	.941
Condition	.400	1	.400	.420	.521	.011
Error	36.167	38	.952			
Total	609.111	40				
Corrected Total	36.567	39				

a. R Squared = .011 (Adjusted R Squared = -.015)

Table 15

Tests of Between-Subjects Effects

Dependent Variable: PRS_Fascination

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3.190[a]	1	3.190	3.631	.064	.087
Intercept	88.563	1	88.563	100.829	.000	.726
Meditation_Experienc	3.190	1	3.190	3.631	.064	.087
Error	33.377	38	.878			
Total	609.111	40				
Corrected Total	36.567	39				

a. R Squared = .087 (Adjusted R Squared = .063)

Table 16

Tests of Between-Subjects Effects

Dependent Variable: PRS_Fascination

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3.738[a]	2	1.869	2.107	.136	.102
Intercept	89.069	1	89.069	100.387	.000	.731
Meditation_Experienc	3.338	1	3.338	3.762	.060	.092
Condition	.549	1	.549	.618	.437	.016
Error	32.828	37	.887			
Total	609.111	40				
Corrected Total	36.567	39				

a. R Squared = .102 (Adjusted R Squared = .054)

Table 17

Tests of Between-Subjects Effects

Dependent Variable: PRS_Coherence

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.525[a]	1	.525	1.078	.306	.028
Intercept	717.550	1	717.550	1472.698	.000	.975
Condition	.525	1	.525	1.078	.306	.028
Error	18.515	38	.487			
Total	736.590	40				
Corrected Total	19.040	39				

a. R Squared = .028 (Adjusted R Squared = .002)

Table 18

Tests of Between-Subjects Effects

Dependent Variable: Coherence

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.523	3	.841	1.833	.159
Intercept	717.473	1	717.473	1563.772	.000
Condition	.592	1	.592	1.290	.264
NTrait_A	1.764	1	1.764	3.845	.058
Condition * NTrait_A	.234	1	.234	.509	.480
Error	16.517	36	.459		
Total	736.590	40			
Corrected Total	19.040	39			

a. R Squared = .133 (Adjusted R Squared = .060)

Table 19

Tests of Between-Subjects Effects

Dependent Variable: PRS_Compatibility

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.324[a]	1	.324	.661	.421	.017
Intercept	562.500	1	562.500	1148.206	.000	.968
Condition	.324	1	.324	.661	.421	.017
Error	18.616	38	.490			
Total	581.440	40				
Corrected Total	18.940	39				

a. R Squared = .017 (Adjusted R Squared = -.009)

Table 20

Tests of Between-Subjects Effects

Dependent Variable: PRS_Compatibility

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1.423[a]	1	1.423	3.086	.087	.075
Intercept	77.111	1	77.111	167.275	.000	.815
Meditation_Experienc	1.423	1	1.423	3.086	.087	.075
Error	17.517	38	.461			
Total	581.440	40				
Corrected Total	18.940	39				

a. R Squared = .075 (Adjusted R Squared = .051)

Table 21

Tests of Between-Subjects Effects

Dependent Variable: PRS_Compatibility

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1.834[a]	2	.917	1.984	.152	.097
Intercept	77.503	1	77.503	167.641	.000	.819
Meditation_Experienc	1.510	1	1.510	3.267	.079	.081
Condition	.412	1	.412	.891	.351	.024
Error	17.106	37	.462			
Total	581.440	40				
Corrected Total	18.940	39				

a. R Squared = .097 (Adjusted R Squared = .048)

Table 22

Tests of Between-Subjects Effects

Dependent Variable: PRS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.092[a]	1	.092	.301	.587
Intercept	628.552	1	628.552	2049.050	.000
Condition	.092	1	.092	.301	.587
Error	11.657	38	.307		
Total	640.301	40			
Corrected Total	11.749	39			

a. R Squared = .008 (Adjusted R Squared = -.018)

Table 23

Tests of Between-Subjects Effects

Dependent Variable: PRS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.350[a]	1	1.350	4.932	.032
Intercept	84.434	1	84.434	308.535	.000
Meditation_Experienc	1.350	1	1.350	4.932	.032
Error	10.399	38	.274		
Total	640.301	40			
Corrected Total	11.749	39			

a. R Squared = .115 (Adjusted R Squared = .092)

Table 24

Tests of Between-Subjects Effects

Dependent Variable: PRS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.490[a]	2	.745	2.686	.081
Intercept	84.552	1	84.552	304.936	.000
Meditation_Experienc	1.397	1	1.397	5.039	.031
Condition	.140	1	.140	.504	.482
Error	10.259	37	.277		
Total	640.301	40			
Corrected Total	11.749	39			

a. R Squared = .127 (Adjusted R Squared = .080)

Table 26

Tests of Between-Subjects Effects

Dependent Variable: Perceived Body Boundaries

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	7.199[a]	3	2.400	1.230	.307
Intercept	43.002	1	43.002	22.050	.000
Trait_Anxiety	4.076	1	4.076	2.090	.154
Condition	1.398	2	.699	.359	.700
Error	111.162	57	1.950		
Total	1176.000	61			
Corrected Total	118.361	60			

a. R Squared = .061 (Adjusted R Squared = .011)

Table 27

Tests of Between-Subjects Effects

Dependent Variable: Anxiety_Difference

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.065[a]	3	.688	3.522	.021
Intercept	6.153	1	6.153	31.490	.000
Meditation_Experienc	1.050	1	1.050	5.373	.024
Condition	.848	2	.424	2.169	.124
Error	11.137	57	.195		
Total	34.566	61			
Corrected Total	13.201	60			

a. R Squared = .156 (Adjusted R Squared = .112)

Table 28

Tests of Between-Subjects Effects

Dependent Variable: Anxiety_Difference

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.217[a]	1	1.217	5.992	.017
Intercept	6.516	1	6.516	32.077	.000
Meditation_Experienc	1.217	1	1.217	5.992	.017
Error	11.984	59	.203		
Total	34.566	61			
Corrected Total	13.201	60			

a. R Squared = .092 (Adjusted R Squared = .077)

Table 29

Tests of Between-Subjects Effects

Dependent Variable: Trait_Anxiety

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.767[a]	2	.383	2.096	.132
Intercept	527.474	1	527.474	2884.837	.000
Condition	.767	2	.383	2.096	.132
Error	10.605	58	.183		
Total	538.200	61			
Corrected Total	11.372	60			

a. R Squared = .067 (Adjusted R Squared = .035)

Table 30

Tests of Between-Subjects Effects

Dependent Variable: Have you ever meditated before?

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.076[a]	2	.038	.196	.823
Intercept	94.538	1	94.538	488.014	.000
Condition	.076	2	.038	.196	.823
Error	11.236	58	.194		
Total	106.000	61			
Corrected Total	11.311	60			

a. R Squared = .007 (Adjusted R Squared = -.028)

Table 31

Tests of Between-Subjects Effects

Dependent Variable: Being Away

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.710	2	.355	.701	.503
Intercept	10.640	1	10.640	21.013	.000
Trait_Anxiety	.203	1	.203	.402	.503
Condition	.501	1	.501	.990	.326
Error	18.734	37	.506		
Total	687.750	40			
Corrected Total	19.444	39			

a. R Squared = .036 (Adjusted R Squared = -.016)

Table 32

Tests of Between-Subjects Effects

Dependent Variable: Fascination

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.897	2	.948	1.012	.373
Intercept	4.935	1	4.935	5.266	.028
Trait_Anxiety	1.497	1	1.497	1.597	.214
Condition	.412	1	.412	.440	.511
Error	34.670	37	.937		
Total	609.111	40			
Corrected Total	36.567	39			

a. R Squared = .052 (Adjusted R Squared = .001)

Table 33

Tests of Between-Subjects Effects

Dependent Variable: Compatibility

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.342	2	.171	.341	.714
Intercept	12.502	1	12.502	24.873	.000
Trait_Anxiety	.018	1	.018	.036	.850
Condition	.323	1	.323	.642	.428
Error	18.598	37	.503		
Total	581.440	40			
Corrected Total	18.940	39			

a. R Squared = .018 (Adjusted R Squared = -.035)

Table 34

Descriptive Statistics

Dependent Variable: Perceived Restorativeness

Condition	Mean	Std. Deviation	N
VR Awe	3.916	.536	20
VR Non-Awe	4.012	.571	20
Total	3.964	.549	40

Table 35

Tests of Between-Subjects Effects

Dependent Variable: Compatibility

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.092	1	.092	.301	.587
Intercept	628.552	1	628.552	2049.050	.000
Condition	.092	1	.092	.301	.587
Error	11.657	38	.307		
Total	640.301	40			
Corrected Total	11.749	39			

a. R Squared = .008 (Adjusted R Squared = -.018)

Table 36

Correlations

		Perceived Body Boundaries	State_Anxiety_Post
Perceived Body Boundaries	Pearson Correlation	1	.320*
	Sig. (2-tailed)		.012
	N	61	61
State_Anxiety_Post	Pearson Correlation	.320*	1
	Sig. (2-tailed)	.012	
	N	61	61

*. Correlation is significant at the 0.05 level (2-tailed).

Table 37

Descriptive Statistics

Dependent Variable: Anxiety Difference			
Condition	Mean	Std. Deviation	N
VR Awe	-.767	.539	20
VR Non-Awe	-.558	.485	20
Total	-.663	.517	40

Table 38

Tests of Between-Subjects Effects

Dependent Variable: Anxiety Difference

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.434	1	.434	1.652	.206
Intercept	17.556	1	17.556	66.834	.000
Condition	.434	1	.434	1.625	.206
Error	9.982	38	.263		
Total	27.972	40			
Corrected Total	10.416	39			

a. R Squared = .042 (Adjusted R Squared = .016)

Appendix B: Questionnaire

Table 39

Questionnaire

Variable	Items
Informed Consent	I hereby declare that I have been informed in a manner which is clear to me about the nature and method of the research that I am about to partake in. My questions have been answered to my satisfaction. I agree of my own free will to participate in this research. I reserve the right to withdraw this consent without the need to give any reason and I am aware that I may withdraw from the experiment at any time. If my research results are to be used in scientific publications or made public in any other manner, then they will be made completely anonymous. My personal data will not be disclosed to third parties without my express permission. If I request further information about the research, now or in the future, I may contact the researcher (Lukas van Remmerden) via vanremmerden.l@gmail.com.
Trait Anxiety	I could be experiencing some emotion and not be conscious of it until sometime later. I break or spill things because of carelessness, not paying attention, or thinking of something else. I find it difficult to stay focused on what's happening in the present. I tend to walk quickly to get where I'm going without paying attention to what I experience along the way. I tend not to notice feelings of physical tension or discomfort until they really grab my attention. I forget a person's name almost as soon as I've been told it for the first time.

	It seems I am "running on automatic" without much awareness of what I'm doing.
	I rush through activities without being really attentive to them.
	I get so focused on the goal I want to achieve that I lose touch with what I'm doing right now to get there.
	I do jobs or tasks automatically, without being aware of what I'm doing.
	I find myself listening to someone with one ear, doing something else at the same time.
	I drive places on "automatic pilot" and then wonder why I went there.
	I find myself preoccupied with the future or the past.
	I find myself doing things without paying attention.
	I snack without being aware that I'm eating.
State Anxiety 1	I feel calm.
	I am tense.
	I feel upset.
	I am relaxed.
	I am content.
	I feel worried.
Information	You completed the first part of the survey. You can now notify the researcher to get started with the Virtual Reality meditation.
State Anxiety 2	I feel calm.
	I am tense.
	I feel upset.
	I am relaxed.
	I am content.
	I feel worried.

Perceived Body Boundaries 1	Take a look at this scale of 'Perceived Body Boundaries'. On the next page, you have to indicate which of the figures best represents your current state (from left to right, 1-7).
Perceived Body Boundaries 2	Looking at the Perceived Body Boundaries scale, which of the seven figures (1 = my body boundaries are almost imperceptible, 7 = my body boundaries are extremely salient) best represents your current state?
Being Away	It is an escape experience.
	Spending time here gives me a good break from my day-to-day routine.
Fascination	The setting has fascinating qualities.
	My attention is drawn to many interesting things.
	I would like to get to know this place better.
	There is much to explore and discover here.
	I would like to spend more time looking at the surroundings.
Coherence	There is too much going on.
	It is a confusing place.
	There is a great deal of distraction.
	It is chaotic here.
Compatibility	I can do things I like.
	I have a sense that I belong here.
	I have a sense of oneness with this setting.
	Being here suits my personality.
	I could find ways to enjoy myself in a place like this.
Demographics	What’s your age?
	What’s your gender?
	What’s your nationality?
	Did you ever meditate before?

	What’s your highest completed level of education?
Completion Message	We thank you for your time spent taking this survey. Your response has been recorded.