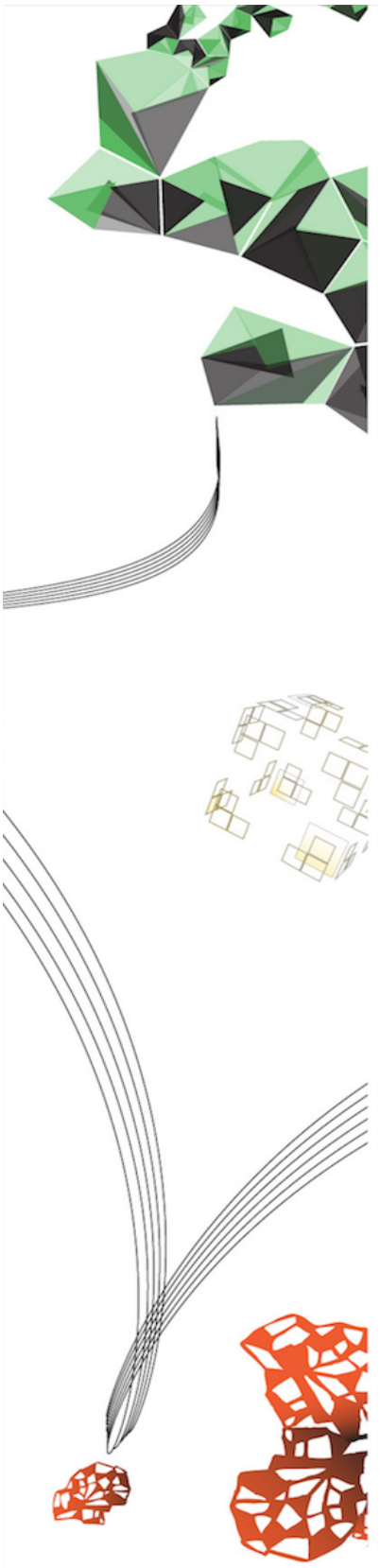

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Master Thesis Psychology:

Relaxing at the Perfect Beach: Influence of Auditory Stimulation on Positive and Negative Affect in a Virtual Environment

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CONTENT

ABSTRACT

Virtual environments promise a scientific and applied approach in improving an individual's emotional quality and wellbeing. Yet little research is focused on the effectiveness and potential of improving such applications. In response to the lack of research in this field, this study investigated the effect of auditory stimulation in a virtual environment to an individual's experience of „presence" and „positive affect". Before and after being placed in a relaxing virtual environment, where in participants were exposed to either natural sounds or a guided meditation exercise, the positive as well as negative affect was noted down. A mediational association between the auditory stimulation, affect and presence functioned as a predictor was conducted. Results revealed that (i) the virtual environment decreased negative affect but had no influence on positive affect, (ii) there were no differences in the intesifying of positive affect or decrease of negative affect in regard to auditory stimulation through natural sounds or a guided meditation, and (iii) auditory stimulation and its effects is neither associated nor mediated by presence. The study arrived to the conclusion that auditory stimulation in the form of natural sounds and a guided meditation within a relazing virtual environment has the potential to improve an individuals positive affect.

SAMENVATTING

Virtuele omgevingen bieden een wetenschappelijk en toegepaste benadering om emoties en welzijn te verbeteren. Echter richt zich weinig onderzoek op de effectiviteit en verbetering van dergelijke virtuele applicaties. Daarom onderzoekt deze studie het effect van auditieve stimulatie in een virtuele omgeving op affect en presence. Zowel positief als negatief affect werden gemeten voor en na de presentatie van een ontspannende virtuele omgeving waarin deelnemers werden blootgesteld aan natuurlijk geluid of een geleide meditatie oefening. Verder wordt een mediatie analyse uitgevoerd tussen de auditieve stimulatie, affect en het gevoel aanwezig te zijn in de virtuele wereld (presence). Uit de resultaten bleek dat (i) de virtuele omgeving een afname van negatief affect bevorderde, maar positief affect niet, (ii) geen verschillen in de toename van positief affect en de afname van negatief affect tussen natuurlijke geluiden en geleide meditatie bestaan, en (iii) dat de auditieve stimulatie noch geassocieerd is met affect noch gemedieerd wordt door het gevoel aanwezig te zijn in de virtuele omgeving. Het kan geconcludeerd worden, dat auditieve stimulatie het potetieel heft om negatief affect positief te beïnvloeden als het gebruikt wordt in een virtuele omgeving.

1. INTRODUCTION

Positive psychology is a fast growing branch in the field of psychology that focuses on resilience, wellbeing and other aspects of positive health. Areas of interest in this field of study gear towards discovering the individual's potential to live a happy, meaningful and fulfilled life. This field provides new insight in regard to preconceived notions about human mental health. From a positive psychology point of view, mental health is more than the absence of symptoms and syndromes, as the traditional view claims, but rather a combination of absence of illness and presence of wellbeing (Bohlmeijer, Bolier, Westerhof & Walburg, 2015). These insights can be used in the practical field of clinical psychology to enhance patients' recovery, prevent risico-groups from the development of syndromes and improve practices in therapy. This has lead clinical psychologists to become more interested in positive psychology-oriented interventions that were designed and studied to promote positive feelings, thoughts and emotions (Rashid, 2009). The benefit of positive psychology goes beyond the enhancement of clinical work, as this knowledge can also help non-clinical individuals live a happier and more fulfilling life (Seligman, Rashid & Parks, 2006 cited by Banos, Etchemendy, Castilla, García-Palacios, Quero & Botella, 20012).

In order to enhance mental health within a clinical and non-clinical population, an approach within the field of positive psychology is focused on the increase of "positive affect". Several teams of researchers (Fredrickson, Tugade, Waugh & Larkin, 2003; Tugade, Fredrickson & Barret, 2004; Gable, Gonzaga & Strachman, 2006; Stein, Folkman, Trabasco & Richards, 1997) show that people who experience positive affect experience increased optimism, calmness, resilience, mental health, and higher quality personal relationships compared to individuals who experience less positive affect. For instance, Tayyab (2009) showed that experiencing positive affect improves physical health and alleviates depressive states. Furthermore, a study by Greenglass and Fiksenbaum (2009) reveals that individuals who reported higher positive affect were less likely to develop depressive symptomatology or to miss work. Sin and Lyubomirsky (2009) indicated that interventions designed to promote positive emotions resulted in increased wellbeing levels as well as in decreased depressive symptomatology. In sum, it can be deduced that positive affect facilitates the development of important skills and resources in people that maintain mental and physical health (Sheldon & King, 2001).

The broaden-and-build-theory (Fredrickson, 2013) sheds more light on this. This theory states that positive affect extend people's cognitive and behavioral resources. Whereas

negative affect limits the focus in preparation for immediate actions, positive affect temporarily broadens peoples' cognitive processes, so new information can be processed and connections at a higher level are made, thereby broaden ideas and perception ranges (Fredrickson, 2000). In a positive state, people are more able to consider new ideas, look for alternative problemsolving, reconsider situations and initiate new courses of action (Fredrickson, Cohn, Coffey, Pei & Finkel, 2008; Fredrickson, Tugade, Waugh & Lakin, 2003; Tugade, Fredrickson & Barret, 2004). Although the experience of positive affect is temporary, the resources strengthened as a result of broadened mental focus last throughout one's lifetime (Banos, Etchemendy, Castilla, García-Palacios, Quero & Botella, 2012). Consequently, positive affect enables new behaviors that simultaneously promote and support healthier decisions and action plans. A number of studies (Fredrickson, 2000; Fredrickson, Mancuso, Branigan & Tugade, 2000; Fredrickson & Branigan, 2005; Wadlinger & Isaacowitz, 2006, Rowe, Hirsh & Anderson, 2007) reveal results that support Fredricksons (2013) broaden-and-build-theory.

As a result of uncovering the benefits of positive affect on mental and physical health, interventions were designed to enhance peoples' positive affect. This lead to the development of different technologies used to induce positive affect, including virtual environments, also known as virtual realities.

1. 1. VIRTUAL ENVIRONMENT AND PRESENCE

"Virtual Environment" (VE) is defined as a set of computer technologies that allows the simulation of real-life situations in a computer-generated or mobile-generated environment, where the user can actively interact with this environment (Villani, Riva & Riva, 2007; Serrano, Banos & Botella, 2015). A VE is able to detect and directly respond to a users input and adapt the presented virtual situations to this information (Burdea & Coiffet, 2003). In other words, the user sees a change in the virtual world in response to their action or behavior. Therefore, the user's visual, auditory, tactile and olfactory senses are stimulated in a way that they feel immersed and involved in the virtual world (Serrano, Banos & Botella, 2015). A key feature of a VE is the sense of presence (Riva, Davide & Ijsselsteijn, 2003). "Presence" is traditionally considered the psychological sense of being in or existing in the VE in which one is immersed (Rizzo, Wiederhold & Buckwalter, 1998; Banos, Botella, Rubio, Quero, García-Palacios & Alcaniz, 2008). Witmer and Singer (1998) define presence as "the subjective experience of being in one place or environment, even when you are

physically located in another" (p. 225). Accourding to Steuer (1992), a participant's perception on the realness of a virtual environment is defined by their experience of presence.

Several studies discover the experience of presence to be a multidimensional construct (Sheridan, 1992; Biocca & Delaney, 1995; Sheridan, 1996; Ijsselsteijn, Ridder, Freeman & Avons, 2000), which includes "immersion" and "involvement" (Banos, Botella, García-Palacios, Villa, Perpina & Alcaniz, 2000). Immersion can be defined as the perception of inclusion that an individual develops through interacting with a virtual environment, while involvement can be defined as an emotional or personal association with a set of stimuli that the user considers meaningful (Banos et. al., 2000). When a user's experince in the virtual environment is inclusive, interactive and considered meaningful, the user will behave, feel and think as if they are in a real-life situation (Felnhofer et al., 2015). In other words, a virtual environment designed to mimic a real-life situation that triggers relaxtion and calmness will be able to elicit these emotions if the user experiences a sense of presence, immersion and involvement.

Studies suggest that a sense of presence is linked to emotional reactions within a virtual environment. Banos, Botella, Alcaniz, Liano, Guerrero and Rey (2004), Banos, Botella, Rubio, Quero, García-Palacios and Alcanit (2008) and Banos et. al. (2012) found correlations between presence and emotions such as sadness (Banos et. al., 2004), joy (Banos et. al., 2008) and relaxation (Banos et. al., 2012). Riva et al. (2007) used VE to induce relaxation and anxiety, and their results also confirm a relationship between affect and presence. Frijda (1988) suggested that affect is influenced when events are assessed as real, where intensity corresponds to the degree of realness. When investigated in the context of virtual environments, a perception of realness is synonymous to a sense of presence. Examined from this point of view, it can be assumed that participants who experience a strong feeling of presence would also report a stronger positive emotional reaction. Furthermore, research shows that a sense of presence can increase when more senses are stimulated within a VE, especially when auditory stimulation is included (Dinh, Walker, Hodges, Song & Kobayashi, 1999). Thus, adding auditory stimuli can enhance a user's sense of presence and realness within a VE (Västfjäll, Kleiner, Larsson, 2002). In turn, a high sense of presence can beneficially influence a user's emotional reaction (Villani, Riva & Riva, 2007). However, while presence is commonly regarded as a vital feature to stimulate emotions in an individual while in a virtual environment, research has not been able to clarify the relationship between auditory stimulation and emotional experience in virtual environments (Diemer, Alpers, Peperkorn, Shiban & Mühlberger, 2015). With that said, this

study will focus on the relation between auditori stimulation in a VE to a user's positive affect and sense of presence.

1. 2. VIRTUAL ENVIRONMENT IN POSITIVE PSYCHOLOGY

Today, only a few virtual environment applications are focused on the enhancement of a person's positive affect, wellbeing, strength and resilience (Botella, Riva, Gaggioli, Wiederhold, Alcaniz & Banos, 2012). Nonetheless, these applications reveal promising results. Botella et al. (2009) developed a virtual environment to improve the elderly's quality of life, called the Butler System. The VE stimulates a walk through nature that includes a narrative inviting the user to relax in a green field. Users can practice breathing excercises, concentration excercises, and mindfulness exercises. The Butler System was proven to be effective, where in users experience an increase in positive emotions increased and a decrease in negative ones (Botella et al., 2009). Banos, Etchemendy, Farfallini, García-Palacios, Quero and Botella (2014) developed a VE to induce relaxation and joy made up of six sessions over a period of two weeks. Participants were placed in a VE based on nature where they could walk, listen to a relaxing narrative or solve short attention exercises. Users report a feeling of joy and relaxation after each session. In another study, Banos et al. (2013) developed a virtual urban park and forest that intends to induce joy and relaxation in hospitalized patients with metastatic cancer. Results show an increase in positive affect and a decrease in sadness and anxiety. Herrero, García-Palacios, Castilla, Molinari and Botella (2014) evaluated the efficacy of using a VE in a group session to induce positive affect in patients with fibromyalgia syndrome. Results showed significant increases in joy, surprise, calmness, vigor, motivation and self-efficacy. Serrano, Banos and Botella (2015) also found that after mood-induction within a VE, participant's relaxation level increased, and arousal level decreased significantly through use of the VE. In sum, these applications reveal the potential of VE in enhancing an individual's positive affect (Botella, Riva, Gaggioli, Wiederhold, Alcaniz & Banos, 2012).

Presently, little is known about how virtual environments should be designed to be most effective in inducing presence and positive affect. As an untangible medium, VE relies on the sensual and perceptual stimulation of the user (Diemer, Alpers, Peperkorn, Shiban & Mühlberger, 2015). Most studies on virtual environments and the effect on emotion focus on providing a high-quality realistic visual stimulation, while limited attention has been given to other forms of stimulation. (Västfjäll, Kleiner & Larsson, 2002). When hearing someone screaming, people feel fear or alertness. On the other hand, people feel happy while listening

to their favorite music. The accurate reproduction of sounds from the real world appears to be necessary to fully capture the realism and richness of a mediated environment (Freeman & Lessiter, 2001; Annerstedt et al., 2013). Realistic auditory stimulation is just as important as visual information to induce emotional reactions and increase realism and presence (Larsson, Västfjäll & Kleiner, 2001; Västfjäll, Kleiner & Larsson, 2002; Banos et. al., 2004).

Research by Serrano, Banos and Botella (2015) show that a combination of high quality visual and auditory stimulation in a VE leads to a high sense of presence, an increase in positive affect a decrease in negative affec. Banos et al. (2012) report similar results. They compared a VE only with visual stimulation against a VE that combines visual and auditory stimulation and found an increase in presence when auditory stimuli were used. Other research shows that auditory stimuli, such as a fast-paced voice and melodies that are arousing, can be used to effectively increase joy (Banos et. al., 2012). Stress recovery, stress reduction and relaxation can be stimulated with a voice speaking in a slow tempo (Peretz, Gagnon & Bouchard, 1998; Balkwill & Thompson, 1999; Gabrielsson & Lindstrom. 2001) or with melodies of a slow tempo using organic sounds such as the sounds of flowing water, wind or birds (Brown & Muhar, 2004; Nilsson & Berglund, 2006). Some other recent studies have shown very similar results with the use of various emotionally neutral music, speech, and noise (Västfjäll, Kleiner & Larsson, 2002). Annerstedt et al. (2013) discover that a VE without any auditory stimulation can be an uncomfortable or even threatening experience to the user. In their study, they developed a virtual forest. In the first scenario the participants could walk through the forest while listening to organic sounds. The second scenario projected the same visual stimulation without auditory stimulation. Results indicate that participants in the second scenario experienced fear and danger (Annerstedt et al., 2013). These findings support the role of auditory stimulation for a VE to influence affect and presence positively.

More is yet to be discovered as to which auditory stimuli have the most impact on a participant's presence and affect. Different studies found that meditational exercises guided by a slow and calm voice increase the experience of affect and presence within a VE (Peretz, Gagnon & Bouchard, 1998; Balkwill & Thompson, 1999; Gabrielsson & Lindstrom 2001; Freeman, Lessiter, Keogh & Bond 2004; Shaw, Gromala & Song, 2010; Gromala, Tong, Choo, Karamnejad & Shaw, 2015). Shaw, Gromala and Song (2010) developed a VE called the meditational chamber, where subjects participated in three guided meditation and relaxation exercises. They found significant increase in relaxation, even in those participants with little experience with meditational exercises. Gromala, Tong, Choo, Karamnejad and

Shaw (2015) developed a virtual meditative walk through a forest for chronic pain patients and compaired the effect of the relaxation exercises when immersed in the VE and without the VE, thus as a normal audio track. Results show significant reduction in pain level for participants in the VE as opposed to those who listened to the audio track. Further research show that guided meditation can influence an individual's presence within a VE (Freeman, Lessiter, Keogh & Bond, 2004; Villani, Riva & Riva, 2007; Heeter & Allbritton, 2015a; Heeter & Allbritton, 2015b). Freeman, Lessiter, Keogh and Bond (2004) found that a VE that involves a guided relaxation exercise results to a user's higher sense of presence. Heeter and Allbritton (2015b) assume that participants perhaps have an active role while in a VE accompanied guided meditation exercises, as it stimulates them to interact with the VE they are in.

In sum, limited research exists as to the effectiveness of auditory stimulation in virtual realities in inducing presence and positive affect. There is still more to be learned as to which auditory stimulation is the most effective in heightening a user's sense of presence and positive affect while in a VE. Therefore, this study aims to test the effect of different sound sources, particularly natural sounds and a guided meditation, on a participant presence and affect. In doing so, it is important to develop a VE that would influence an individual's positive affect. Based on the studies mentioned above, it is expected that participant's positive affect will increase and negative affect will decrease when placed in a VE accompanied by either natural sounds or a guided meditation. It can be expected that guided meditation would be more effective because participants will feel more involved and immersed in the VE (although this has not yet been exhibited in any scientific study). Also, there is no information as to how the manipulation of the auditory stimulation in a VE can influence the sense of presence. It can be deduced that auditory stimulation enhances the realness of a VE, leading to a stronger sense of presence that could influence a participant's positive affect (see Figure 1).

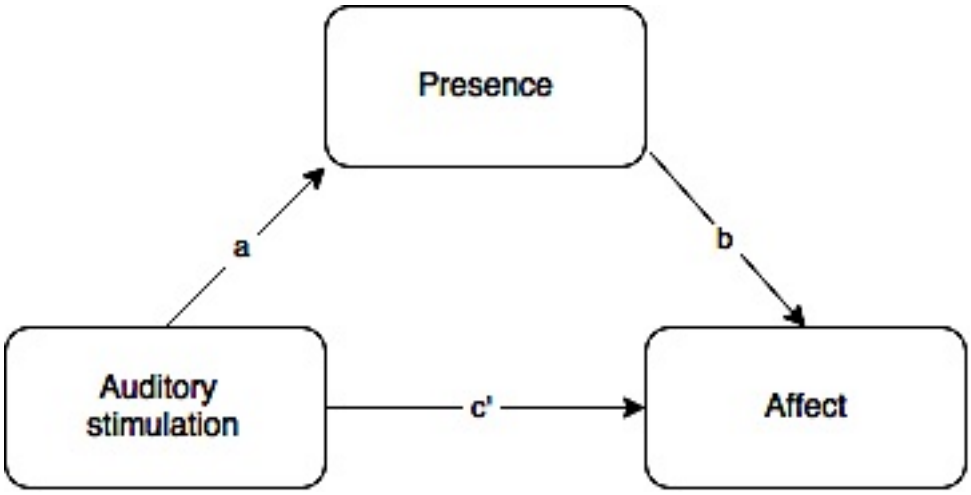

Figure 1 *Model assumption of mediation with presence as predictor*

1. 3. RESEARCH QUESTION AND HYPOTHESES

The main objective of this study is to test the efficacy of a VE in inducing relaxation (positive affect) by comparing the effectiveness of two types of sound sources: 1) natural sounds or a 2) guided meditation in influencing an individual's sense of presence. The established hypotheses are:

- Positive affect will increase significantly and negative affect will decrease significantly in individuals who participate in a VE with both the natural sound and the guided meditation condition.
- Positive affect will increase and negative affect will decrease more for individuals who participate in a VE with a guided meditation condition in comparison to the experience of those who participate in a VE with natural sounds.
- The impact of the auditory stimulation (natural sounds or guided meditation) on the inidividual's positive affect is mediated by presence.

2. METHODS

2. 1. PARTICIPANTS AND DESIGN

Fourteen participants[1] were invited to participate in this study via convenience sampling. The population consists of non-clinical adults who were invited via social media, e-mail or

[1] The small sample size (n=14) was intentional because of the time constraint, regardless of the consequences of reaching a strong conclusion. The study was conducted for a Master degree at a university and was not aimed at collecting data from more than the presented sample size.

personal contact. All enlisted participants were included in the study (response rate = 100%). To ensure a representative sample, inclusion and exclusion criteria were defined. Inclusion criteria were: knowledge of German and English language, normal vision and normal hearing. Exclusion criteria were: clinical symptoms of anxiety, depression or other chronically diseases and severe vision or hearing difficulties. Clinical symptoms of anxiety and depression were measured with the German version of the Hospital Anxiety and Depression Scale (HADS) (cut-off score > 7). Chronic problems were measured by asking the participants if they receive treatment for psychological or physiological problems that impair their daily life, by responding either ''*yes*'' or ''*no*''. If participants answer with a yes, they would be excluded from the study without further questioning. All participants responded with a no.

The sample was made up of seven female (50 %) and seven (50 %) male participants (n = 14). The mean age of the sample was 28.1 years (*SD* = 11.8), ranged from 24 years to 64 years. All participants were of German citizenship and had a high (n = 11) or moderate educational degree (n = 3). Most of the participants were either working full-time (n = 7) or were students (n = 6). The rest reported to be retired (n = 1). Most participants reported to have normal hearing and vision (n = 11). Three participants have moderate hearing/vision difficulties (n = 3). They wore glasses, lenses or a hearing aid during the experiment. An overview including the most important sample characteristics is given in Table 1.

The present study used a quantitative methodology of a randomized pre-posttest between-subject design with one experimental and one control condition. Both conditions have identical visual stimulation but different auditory stimulation. In the control condition, natural sounds were presented and in the experimental condition additional a guided meditational breathing exercise was presented. Participants were randomly assigned to a condition and were assessed at baseline and post-intervention. The study was approved by the Ethics Committee of the faculty of Behavioral Sciences from the University of Twente, the Netherlands.

Table 1 *Demographic data and characteristics*

Characteristic	*Mean*	*Standard Deviation*	*N*	*%*
Age	28.1	11.8	14	
Sex				
Female			7	50
Male			7	50
Education*				
High degree			11	78.6
Moderate degree			3	21.4
Work situation				
Full Time			7	50.0
Student			6	42.9
Other			1	7.1
Hearing/vision**				
Good			11	78.6
Moderate			3	21.4

* There were no participants with low educational degree.

** There were no participants with bad hearing or vision that would affect the study.

2. 2. QUESTIONNAIRE MEASUREMENT

The questionnaires that examined the appropriate cut-off and norm scores, originally in the German language, were used for German-speaking participants. The English questionnaires were translated by the researcher (native-German speaker) into German and translated into English by a native-English speaker who is not further involved in the study. This was to avoid miscommunication and to ensure comprehension of the used questionnaires. All questionnaires are presented in Appendix II.

Hospital Anxiety and Depression Scale (HADS)

The HADS is a 14 item self-report screening questionnaire, using a four-point Likert-type scale response anchor ranking from 0 to 3. It assesses subjective disturbances of one's mood and aims at distinguishing depression from anxiety (Doyle, McGee, De La Harpe, Shelley & Conroy, 2006). The questionnaire consists of a depression and an anxiety scale, each with seven items. An example of a question for depression is: ''*I still enjoy the things I used to*

enjoy'', with response anchors ''*definitely*'', ''*not quite so much*'', ''*only a little*'' and ''*hardly at all*''; and for anxiety: ''*I feel tense or wound up*'' with response anchors ''*most of the time*'', ''*from time to time*'', ''*occasionally*'' and ''*not at all*''. Participants are instructed to answer the questions in the context of the past week. Administration time is between 2 – 5 minutes. In calculating the total score, the scores from the anxiety scale and the scores from the depression scale are summed up individually. For this study, the HADS was used as to identify exclusion criteria. Scores of 0 – 7 indicate normal level of anxiety and depression. Scores above the cut-off (> 7) indicate abnormal levels of anxiety and depression (Herrmann, Kaminsky, Rüger & Kreuzer, 1999) and would lead to the participant's exclusion from the study. Cronbach's α for the anxiety scale measured α = .25 and α = .12 for the depression scale, indicating a low reliability.

Modified Differential Emotion Scale (mDES)

The positive and negative affect in a participant was assessed with the mDES (Fredrickson, Tugade, Waugh & Larkin, 2003). The mDES is a two-factor structured 20-item questionnaire of positive and negative affective states, using mood adjectives as ''*amused, fun-loving, silly*'' or ''*ashamed, irritated, annoyed*''. Participants rate the intensity of their feeling at the moment on a 5-point Likert-scale response anchor from 1 (''*never*'') to 5 (''*most of the time*''). The total score is calculated by summing up the participant's responses for all 20 items. High scores on the positive scale indicate high positive affect and vice versa. Administrative time is between 2 – 5 minutes. The mDES was used as a pre-and post measure to assess the effectiveness of the VE on positive and negative affect. Cronbach's α for the pre-measured positive affect scale was α = .87 and α = .84 for the post-measured positive affect scale, indicating a good reliability. Cronbach's α for the pre-measured negative affect scale was α = .86 and α = .40 for the post-measured negative affect scale, indicating a good reliability for the pre-measured negative affect scale but a low reliability for the post-measured negative affect scale.

Igroup Presence Questionnaire (IPQ)

In order to assess presence experienced in a VE, participants filled in the German version of the IPQ, a 14-item questionnaire (Schubert, Friedmann & Regenbrecht, 2001). Participants indicate their feeling of presence within the VE by rating their answers on a 5-point Likert-scale from 1 (''*not at all/fully disagree*'') to 5 (''*very much/fully agree*''). Items covered in the test include general, spatial presence, involvement and experienced realism. An example

of a general item,*''in the computer generated world I had a sense of being there*''; an example for the spatial presence scale, ''*I did not feel present in the virtual space* ''; an example for the involvement scale, ''*I still paid attention to the real environment*''; and for the experienced realism scale, ''h*ow real did the virtual world seem to you*''. The total score is the sum of all 14 items and by reverse coding items 3, 9 and 11. A higher total score indicates higher sense of presence while immersed in the VE (Schubert, Friedmann & Regenbrecht, 2001). Administrative time is between 2 – 5 minutes. The IPQ has good psychometric properties, however the database is still in progress (Schubert, Friedmann & Regenbrecht, 2001). Cronbach's α in this study was α = .91, indicating a good reliability.

Control Variables

The researcher developed a 13-item self-report questionnaire. It aims to assess the influence of different independent factors (attention, level of difficulty, satisfaction and intention to use) on the effectiveness of the assessed intervention, especially designed for the purpose of this study project for a non-psychiatric/medical population. The questionnaire retrospectively examines the perceived experience of the participant while immersed in the VE by looking at four factors: Attention, level of difficulty, satisfaction and intention to use. In general, the psychometric qualities of the questionnaire were satisfactory with an acceptable reliability. An example of a question about the perceived attention of the participant while immersed in the VE, ''*I had no difficulties to fully concentrate on the virtual experience*''; Cronbach's α = .69. Level of difficulty, a two item scale, measures the subjective evaluation of the participants over the user-friendliness of the VE (''*I could find my way well in the virtual environment*''); Cronbach's α = .86. Satisfaction, a two-item scale also measures user-friendliness of the VE, with regard to the perceived satisfaction of the participant (''*I am satisfied about the experience in the virtual environment*''); Cronbach's α = .83. The scale intention to use measures the participant's intention to make use of VE in the future (''*The used technology in this experiment is something I would like to use more in the future*'') and consists of two items; Cronbach's α = .83. Participants rated their answers on a 5-point Likert-scale from 1 (''*strongly disagree*'') to 5 (''*strongly agree*''). Administration time is about 2 – 5 minutes. To get a total score per scale, the answers for each scale are summed up. High scores indicate high levels on the appropriate scale or in total. English fluency, smartphone use, experience with VE and head-mounted displays were examined for influential effects by asking participants on how experienced they are with usage of these devices. The time each participant took within a VE was measured with a stopwatch and was

notated by the researcher in minutes with two decimal places. This data was also used as control variable.

2. 3. PROCEDURE

Participants were contacted via social media, e-mail or through personal contact. The planned time for the experiment per participant was 1 hour. All participants were tested individually in a calm room without distraction at the researcher or participant's home. Only the participant and the researcher were allowed to enter the room. All participants provided an informed consent (Appendix I) prior to taking part in the study and would then be introduced to the study procedure. First, participants were asked to fill in a survey. Afterwhich, they would follow a training program for a VE and afterwards take part in the experimental VE application. Finally, a second survey was presented to the participants. The introduction is given in Appendix II. Both surveys were presented via Qualtrics Survey Software, a web based tool that enables researcher to design and develop surveys, as well as collect and capture online data.

The German version of the Hospital Anxiety and Depression Scale (HADS) was used in the first part of the survey to assess the demographics of the participants and screen them for mental pathologies. If a participant scores above 7, they would be given a debriefing about their results and would be immediately excluded from the study. The modified Differential Emotion Scale (mDES) was used to measure participants' affect before the intervention. Next, the researcher presented a short training program to the participants. A neutral VE was used in order for the participants to get familiar with the used hardware and the VE perspective in preparation for the actual experimental VE. While participants were undergoing the training VE, the researcher was always available for questions.

The participants were then assigned via block randomization to one of the two conditions: 1) natural sound (n = 7; 3 females, 4 males) and 2) guided meditation (n = 7; 4 females, 3 males). The block randomization process was carried out with help of a free online web-based program, in order to guarantee equal distribution of participants among the conditions. In the first condition, participants listened to natural sounds fitting to a beach environment. The natural sounds were present from the beginning of the VE experience. In the second condition, the natural beach sounds were also present but additional participants were instructed to follow a guided mediation exercise. The researcher turned on the meditational exercise. In both conditions participants were instructed not to change any elements in the VE. The duration of the virtual experience was not pre-determined.

Participants were free to stop at any given moment. If they wanted to stop they gave the researcher a signal by ringing a bell. Participants remain uninterrupted in their VE experience. The researcher notated the duration of use.

After the instructions, participants were asked to put on the head-mounted display and headphones. The researcher would initiate the experimental VE and leave the room. The researcher was always available for questions. After the particapant concludes their VE experience, they would complete the second part of the survey presented via Qualtrics Survey Software. Affect after the intervention was measured with the mDES, presence was measured with the Igroup Presence Questionnaire (IPQ) and the self-constructed questionnaire was used to measure the control variables. An overview of the complete study protocol with further instructions and the test battery with the paper and pencil versions of the given measuring instruments can be found in Appendix II. After the full experiment is complete, participants were debriefed and thanked for their participation (Appendix III).

2. 4. VIRTUAL ENVIRONMENT

Two virtual environments were used in this study. A neutral training VE is the first one in order for the participants to get familiar with a VE and the devices (head-mounted display and headphones). The second VE presented is the experimental intervention.

The training VE consists of a neutral environment, which in this instance was New York City. The initial appearance of the environment is the same for all participants. From the beginning until the end, only natural sounds of a city are audible. The environment changes four times while showing different parts of New York City. Figure 2 shows the four different places of the VE. The participants have 2:04 minutes to explore the environment and feel comfortable with the equipment. The environment was taken from the YouTube channel ND Neutral VE, which offers short freely available neutral virtual environments. The name of the used video is 360NewYork.

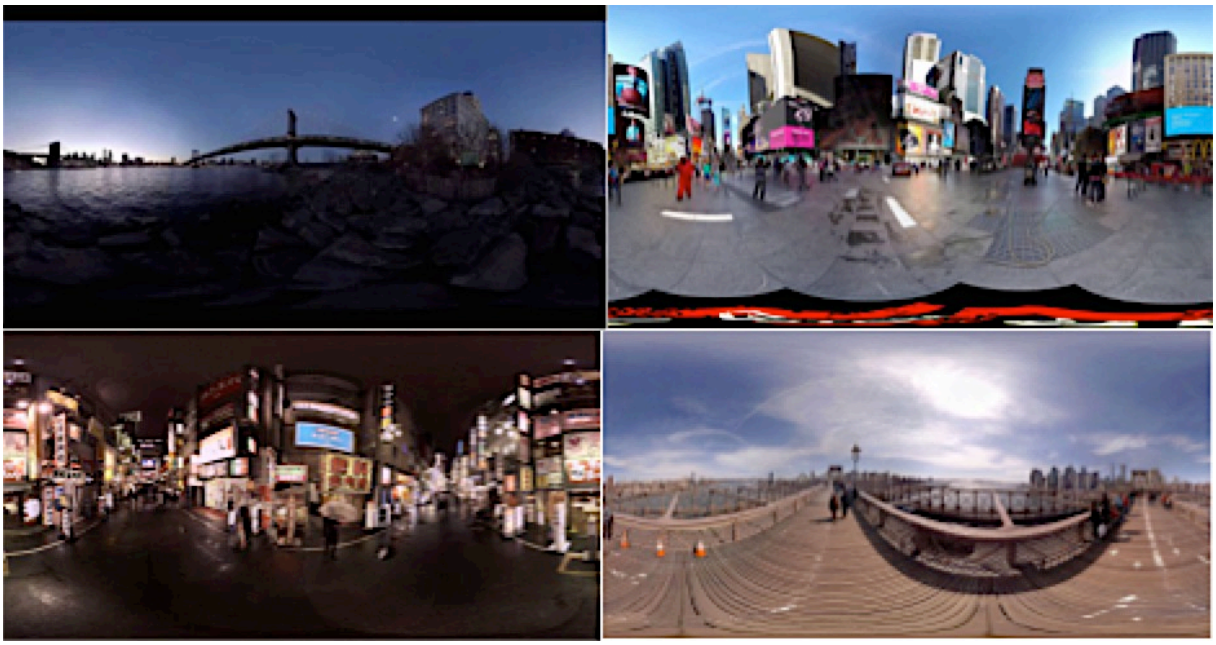

Figure 2 *Training Virtual environment*

For the experimental phase, the APP based VE called ''Perfect Beach'' was used. The VE was developed for use with a head-mounted display, the Google Cardboard. The APP was designed and developed by nDreams and aims to simulate a calm and relaxing environment that is expected to induce positive affect of relaxation. The VE simulates a natural open sand beach with beach like vegetation and waves where participants can relax. Participants can see parts of a male or female body, which is intended to represent their own body. The developers offer variations like changing location from beach to dock, daytime from morning/afternoon to evening, change in gender (female, male) and turn on a guided meditational breathing exercise, relaxing music or an audio bock. In this study, the VE conditions were pre-determined by the researcher to ensure similar conditions among the participant groups. Participants were given instructions beforehand to refrain from changing any settings while immersed in the VE and to inform the researcher if they did. The location and time of day was the same for all participants. They can rest on an open sand beach in the evening and observe the sunset. Gender was pre-adapted to the gender of the participant in real life by the researcher to increase authenticity of the environment. Auditory stimulation is further described in the following paragraph. Fugure 3 shows details of the VE environment.

Figure 3 *Virtual environment "Perfect Beach"*

2. 4. 1. AUDITORY STIMULI

The sound stimulations were integral in the simulation of the ''Perfect Beach''. Sounds consisted of the vocalizations of animals and people (female). The environmental sound appropriate for a beach such as the sound of the crashing waves, blowing wind and sea gull were also audible. These sounds were present in the natural sound conditions. The guided meditation is also included in the APP. It is a guided breathing exercise lasting 5 minutes, narrated by a calm and deep feminine voice. Participants were asked to direct their attention to the sensations of breathing and to notice when their mind wandered away. Participants could adapt volume independently with the headphones.

2. 5. HARDWARE

The workstation for running the VE's was a Samsung GALAXY S 5 mini smartphone SM-G800F 16 GB, 5.1.1 Androind version, a 1.4GHz Quard Core processor and 113.4 mm (4.5'') HD Super AMOLDED display. The interaction device was a head-mounted display, named Google Cardboard and Apple Earphones MB770 with remote and mic (headphones).

For the survey a MacBook Pro, Retina, 13'', with 2.4 GHz Intel Core i5 processor and Intel Iris 1536 MB was used.

2. 6. STATISTICAL ANALYSIS [2]

All statistical analyses were carried out with the statistic package IBM SPSS 22. Means, standard deviations and baseline differences have been computed for all continuous variables. If necessary, negative formulated items were transcoded into positive formulated items. Analysis of variance (ANOVA) was used to test baseline differences. If significant statistical results were found in the baseline differences, the variables would be included as convariate in the further repeated measure analysis of variance (RM – ANOVA). All effects will be reported as significant at $p < .05$.

The first hypothesis, "positive affect will increase and negative affect will decrease significantly after the virtual environment experience in both the natural sound and the guided meditation condition," and the second hypothesis, "positive affect will increase more and negative affect will decrease more in the guided meditation condition," were examined using a repeated measure analysis of variance (RM – ANOVA). Separate analysis for positive affect and negative affect was carried out, with positive affect and negative affect each as two-level (pre measured scores vs. post measured scores) within-subject factor and conditions (natural sound vs. guided meditation) as between-subject factor. A significant effect of positive affect corresponding to negative affect would indicate that the positive affect scores increased and the negative affect scores decreased after the virtual experience in both conditions and thus confirm the first hypothesis. If significant interaction effects are found between positive affect corresponding to negative affect, it would indicate that the increase in positive affect and the decrease in negative affect differs among the natural sound and the guided meditation condition. Furthermore, significant differences between the conditions will be examined using contrasts comparing positive affect/negative affect across the conditions natural sound and guided meditation, to answer the second hypothesis.

To test the third hypothesis, "the association between the independent variable auditory stimulation (condition: natural sounds vs. guided meditation) and der dependent variable affect is mediated through presence," a bootsrap mediation procedure wil be used (Hayes & Preacher, 2014) with auditory stimulation (condition) as an independent variable,

[2] Taking into consideration the consequences of the low sample size (n = 14), a statistical analysis was done to demonstrate the researchers abilities in completing the study.

positive affect and negative affet as dependent variable, and presence as mediator. This method tests the significance of a mediator and is suitable for small samples. Bootstrapping involves repeatedly computing the desired statistic from a series of random sub-samples taken from the data set to generate a reliability interval for the different path-coefficients. The estimate of the indirect effect was derived from the mean of 5000 bootsraps samples, which established a confidence interval for multiple indirect effects. Mediation was established when the confidence interval of the indirect effect did not include zero (Hayes & Preacher, 2014). Separate analysis will be run for positive affect and negative affect.

3. RESULTS

3. 1. DESCRIPTIVES

Table 2 presents the descriptive statistics for positive and negative affect, presence, attention, level of difficulty, satisfaction, intention to use, English fluency, familiarity with Smartphones, Google-Cardboards and virtual realities, and duration of use. It can be seen that the premeasured mean total scores as well as per condition in positive affect are already relatively high (M = 3.66, SD = .69; natural sound: M = 3.33, SD = .80; guided meditation: M = 3.99, SD = .35) and in negative affect relatively low (M = 1.34, SD = .13; natural sound: M = 1.22, SD = .22; guided meditation: M = 1.44, SD = .49). It is also revealed that the post measured mean score for positive affect are higher in the guided meditation condition (M = 3.69, SD = .44) than in the natural sound condition (M = 3.50, SD = .96) but positive affect mean scores decreased in the guided meditation condition while they increased in the natural sound condition, which counters the second hypothesis. Significance of these observations will be tested later on. It is also important to point out that all participants had no experience with the use of head-mounted displays (M = 1.00, SD = .00) and little with virtual environments (M = 2.86, SD = .36) in both conditions. So experience with head-mounted displays will be excluded from further variance analysis.

Analysis of variance (ANOVA) showed no statistically significant baseline differences between the natural sound and the guided meditation condition in scores for presence (F(1,12) = .41, p = .54), attention (F(1,12) = .18, p = .68), difficulty of use (F(1,12) = .38, p = .55), satisfaction (F(1,12) = 1.53, p = .24), intention to use (F(1,12) = .71, p = .42), duration of use (F(1,12) = 1.71, p = .22), English fluency (F(1,12) = .48, p = .50), smartphone use (F(1,12) = 2.89, p = .12), experience with virtual environments (F(1,12) = 2.40, p = .15) and pre-measured scores in positive affect (F(1,12) = 3.94, p = .07), and

negative affect ($F(1,12) = 1.10$, $p = .32$). Considering these findings, all mentioned variables did not differ between the two conditions and therefore no longer need to be included in the repeated measure analysis of variance (RM – ANOVA) as control variables (covariates). A summery of all baseline differences can be found in Table 2.

Table 2 *Descriptive statistics*

	Range	**Total**			**Natural sound**			**Guided meditation**			**Baseline differences**	
		N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*F*	*p*
Positive affect	1-5**											
Premeasure		14	3.66	.69	7	3.33	.80	7	3.99	.35	3.94	.07
Postmeasure		14	3.59	.72	7	3.50	.96	7	3.69	.44	-	-
Negative affect	1-5											
Premeasure		14	1.34	.38	7	1.22	.22	7	1.44	.49	1.10	.32
Postmeasure		14	1.07	.13	7	1.05	.11	7	1.09	.16	-	-
Presence	1-5	14	2.93	.70	7	3.05	.70	7	2.80	.74	.41	.54
Attention	1-5	14	2.80	.46	7	2.75	.29	7	2.86	.61	.18	.68
Difficulty	1-5	14	1.89	.21	7	2.93	.19	7	2.86	.24	.38	.55
Satisfaction	1-5	14	3.18	1.00	7	3.50	1.19	7	2.86	.69	1.53	.24
Use intention	1-5	14	3.39	1.10	7	3.64	1.18	7	3.14	1.03	.71	.42
English fluency	1-5	14	2.57	.76	7	2.43	.79	7	2.71	.76	.48	.50
Smartph. use	1-5	14	4.64	.84	7	4.29	1.11	7	5.00	.00	2.89	.12
Cardboard use	1-5	14	1.00	.00	7	1.00	.00	7	1.00	.00	-	-
VE experience	1-3*	14	2.86	.36	7	3.00	.00	7	2.71	.49	2.40	015
Use duration	mm:ss	14	9:22	3:51	7	8:04	3:17	7	10:41	4:09	1.71	.22

Note. * (1-3): 1-highest range, 3-lowest range; ** (1-5): 1-lowest range, 5-highest range

3. 2. TEST OF STUDY HYPOTHESIS

First hypothesis. Repeated measure analysis of variance (RM – ANOVA) showed no statistically significant effect on the positive affect of participants after undergoing the experimental VE ($F(1,12) = .26$, $p = .62$, indicating that positive affect did not increase significantly after the intervention. For negative affect, a significant shift was found after the virtual environment experience ($F(1,12) = 5.89$, $p = .03$), showing that negative affect in

participants did decrease significantly in both conditions. Results partly support the first hypothesis. Positive affect did not increase. However, negative affect did decrease significantly after the VE experience.

Second hypothesis. Repeated measure analysis of variance (RM – ANOVA) revealed no statistically significant corellation between positive affect and the occurrence of natural sound and a guided meditation ($F(1,12) = 3.44$, $p = .08$). This indicates that the scores in positive affect do not differ significantly in the natural sound condition and the guided meditation condition of the VE experience. No significant between-subject effect for the conditions was found ($F(1,12) = 1.50$, $p = .24$), indicating that the effect of the conditions did not differ for positive affect. Regarding negative affect, no significant interaction between the post-measured negative affect score and the condition presented to the participant was found ($F(1,12) = .73$, $p = .41$). No significant between-subject effect for condition was found ($F(1,12) = 1.26$, $p = .28$). This indicates that the negative affect score after the VE experience does not differ between the two conditions natural sound and guided meditation and that scores in negative affect were similar in both conditions. To conclude, the results do not supprt the second hypothesis. Positive affect did not increase and negative affect did not decrease in the guided meditation condition in a different manner compared to the natural sounds condition.

Third hypothesis. Results of the mediation analysis indicate that there is no statistically significant evidence that presence mediates the association between the two different conditions and positive affect. Both natural sound and guided meditation were not related to positive affect (B = -.06, $p = .13$), nor to presence ($F(1,12) = .41$, B = -.24, $p = .53$), just as presence was not associated with positive affect ($F(2,11) = 2.75$, B = -.41, $p = .11$). The 95% bias-corrected confidence interval for the size of the total indirect effect includes zero [-.40, .09], confirming the non-significant findings for the indirect effect (Hayes & Preacher, 2014). Contradicting the third hypothesis, presence did not mediate the correlation between conditions and positive affect. A summary of the results is presented in Table 5. Mediation analysis for negative affect revealed no statistically significant results for an association between the conditions and negative affect mediated by presence. The natural sound as well as the guided meditation condition was not significantly linked with negative affect (B = -.04, $p = .33$), nor with presence ($F(1,12) = .52$, B = -.24, $p = .54$) and presence was not significantly related to negative affect ($F(2,11) = .89$, B = -.23, $p = .43$). The 95% bias-corrected confidence interval for the size of the total indirect effect includes zero [-.00, .49], thus confirming the non-significant findings (Hayes & Preacher, 2014). Contradicting

the third hypothesis, presence did not mediate the association between the conditions and negative affect. A summary of the found results is presented in Table 6.

Table 5 *Mediation analysis for positive affect*

		Δed^2	Fe	df1	df2	*p*	B	SE_B	LLCI	ULCI
Condition	Presence	0.03	0.41	1	12	0.53	-0.24	0.38	-1.08	0.59
Condition	Positive affect	0.33	2.75	2	11	0.11	-0.41	0.25	-0.96	0.14
Presence						0.20	0.25	0.18	-0.15	0.66
Condition via Presence	Positive affect					0.13	-0.06	0.12	-0.40	0.08

Note: * p < .05, ** p < .01.

Table 6 *Mediation analysis for negative affect*

		Δed^2	Fe	df1	df2	*p*	B	SE_B	LLCI	ULCI
Condition	Presence	0.03	0.52	1	12	0.54	-0.24	0.38	-1.08	0.59
Condition	Negative affect	0.14	0.89	2	11	0.43	-0.23	0.22	-0.71	0.26
Presence						0.32	-0.17	0.16	-0.52	0.19
Condition via Presence	Negative affect					0.33	-0.04	0.13	-0.00	0.49

Note: * p < .05, ** p < .01.

4. DISCUSSION[3]

More and more people are beggining to take interest in self-help programs to enhance their wellbeing and health. This lead to a growth of technical applications for home-use in behavioral healthcare, such as smartphone Apps that simulate a virtual environment (Luxton, McCann, Bush & Mishkind, 2011). Although several developers and research teams have investigated the quality, usefulness and effectiveness of virtual environments in a laboratory

[3] Aware of the low sample size (n = 14) and the possible consequences for the statistical analysis and the found results, still an interpretation of these results will be done with the purpose to demonstrate the researchers abilities in conducting a complete study.

setting, little is known about the actual effectiveness of such applications in enhancing positive mood states such as relaxation for home-use applications. The aim of this study was to analyze the efficacy of the virtual environment based App intervention ''PerfectBeach'' in inducing a sense of presence in the user to create a relaxing experience. In doing so, the intervention's auditory stimulation was manipulated in order to investigate the influence of sound on the effectiveness of the application. In the first condition, natural sounds fitted to the virtual environment were presented and in the second condition, a guided meditation exercise was added to the auditory stimulation.

Firstly, it was tested whether or not positive affect would increase and negative affect would decrease significantly after the virtual environment experience in both auditory stimulations. It was found that negative affect did decrease significantly in both conditions but positive affect remained the same. This outcome agrees and disagrees with the research findings of aforementioned studies (Botella et. al., 2012; Banos et. al., 2013; Banos et. al., 2014; Herrero, García-Palacios, Castilla, Molinari & Botella, 2014; Serrano, Banos & Botella, 2015). Virtual environment applications have demonstrated an ability to induce positive mood states, to foster positive affect and also diminish negative affect in various studies in populations that are already emotionally balanced, as in this study, but also in subjects who show high level of sadness or stress due to a prior experimental sadness or stress induction (Freeman, Lessiter, Keogh & Bond, 2004; Botella et. al., 2012; Herrero, García-Palacios, Castilla, Molinari & Botella, 2014; Serrano, Banos & Botella, 2015). However, this study only found significant results for a decrease in negative affect. Mean scores in positive affect measured after the intervention were higher when participants followed the guided meditational.

One possible explanation is that the induction of positive affect is more difficult than the induction of negative affect because participants usually enter an experiment in a positive mood. It is more difficult to enhance a positive mood than to worsen it (Westermann, Spies, Stahl & Hesse, 1996). Descriptives in the present study showed that premeasured scores in positive affect in participants were alreay high and did not improve further through the virtual environment. For future research, a low positive affect baseline could be chosen and used as an inclusion criteria for participation. Emotional reactions can also be enhanced by the use of more powerful audio stimulations compared to the sounds used in this study. Increased spatialized sound reproduction improves positive affect and presence (Västfjäll, Kleiner & Larsson 2002). Instead of using headphones, using a home theater and hi-fi systems to represent the auditory stimulation could stimulate a more authentic environment.

It was hypothesized that an increase in positive affect and decrease in negative affect would be noticeable after listening to a guided meditation exercise in comparison to natural sounds in the VE. This was not supported by the results. Adding guided meditation to natural sounds did not enhance the positive affect of the participant. This is also not in line with statement from a previous study that stated guided meditational exercises do increase participant's positive affect (Peretz, Gagnon & Bouchard, 1998; Balkwill & Thompson, 1999; Gabrielsson & Lindstrom 2001; Freeman, Lessiter, Keogh & Bond 2004; Shaw, Gromala & Song, 2010; Gromala, Tong, Choo, Karamnejad & Shaw, 2015). However, in this study, both positive and negative affect did not differ significantly in participants that listened to natural sounds or the guided meditation exercise. The user's attention could be an explanation. Kosunen, Salminen, Järvelä, Ruonala, Ravaja and Jacucci (2016) developed a virtual beach with a guided meditation exercise where participants should focus their attention on a point for several minutes. Results revealed that participants easily felt bored and distracted while in the VE. The researchers would then change the focus point during the meditational exercise, so participants stay attentive. This in turn resulted in higher relaxation scores. Guided meditation seems to influence a participant's attention, thereby positively influencing their mood (Kosunen et. al. , 2016). In this study, the virtual environments, either with the guided meditation exercises or the natural sound could capture a participant's attention in a similar manner leading to an increase of positive affect. In this case, further research is needed.

For future research, it would be interesting to investigate the different meditational exercises and their link with attention. The study of Kosunen et. al. (2016) be partially replicated. A guiding narrator will remind the participants to focus their attention on specific parts of the visual environment. It may then be analyzed how affect changes after a more intensive virtual-based guided meditation exercise while comparing it to a virtual environment where only natural sounds are audible. This is the first study that explicitly compared the effectiveness of natural sounds against a guided meditation in a virtual environment. Further research is needed to gain a full understanding of the effect of different auditory stimulations within virtual environments.

Lastly, it was hypothesized that presence mediates the association between the presented auditory stimulation and positive and negative affect. The results did not support this hypothesis. There was no significant relation between auditory stimulation and affect, nor with presence. Presence was not significantly linked with affect, indicating no mediation for positive nor for negative affect. This is not in line with the research mentioned above

(Dinh, Walker, Hodges, Song & Kobayashi, 1999; Västfjäll, 2003; Serrano, Banos & Botella, 2016). Serrano, Banos and Botella (2016) found that relaxation increased after adding auditory stimulation to a visual stimulation, in contrast to only having visual stimuli. Research from Dinh, Walker, Hodges, Song and Kobayashi (1999) showed that auditory stimulation increased participants sense of presence. They discovered that participants experience a stronger feeling of presence in a virtual environment with auditory stimulation in comparison to a visual virtual environment without auditory simulation. Additionaly, Västfjäll (2003) found that presence can be linked with affect when experienced in a virtual environment with auditory stimulation. In his study, participants who reported a strong feeling of presence also experience stronger emotional reactions than participants with a low level of presence in the same visual-auditory virtual environment. However, results of this study did not confirm these findings.

One factor to consider is the participant's arousal in a VE. Freeman, Lessiter, Pugh and Koegh (2005) suggests that the correlation of presence and emotions may be limited to arousing virtual stimuli. They proposed an arousal theory of presence, arguing that arousal leads to alertness, which in turn leads to higher presence ratings. According to Freeman, Lessiter, Pugh and Koegh (2005) alertness increases a participant's readiness to respond to the stimuli within a given virtual environment, thus leading to a greater perceived physical and mental presence in a VE. However, relaxing positive emotions induced by auditory stimulations focused on relaxation are non-arousing in nature, this could be one explanation for the results found in this study. Although, this theory is still insufficiently tested. Further research must attempt to investigate the interaction between auditory virtual environments, presence and emotional reactions in order to gain more insight as to the their complimentary relationship.

LIMITATIONS

This study had certain limitations that may be responsible for the lack of significance results. Firstly, relaxation was the only variable measured. In future studies, it would be interesting to adapt this virtual environment and test its efficacy in induction of arousal and attention. Second, the effectiveness of the virtual environment and auditory stimulation were measured using only self-report questionnaires. Most of the subjective measure instruments are valid and tested in different contexts, but the inclusion of more objective measures, such as physiological or neurofeedback measurements, may help in deriving more insight. The small sample size is a significant limitation of this study. In order to make results more

generalizable to be able to draw robust conclusions, it is necessary to study a greater sample of people. Furthermore, to enhance the sense of presence, it could be helpful if the body position of the participant in the virtual environment is the same body position the participant has in reality. A few participants report that the devices were uncomfortable and to simplistic. After the presentation of the VE, most participants reported that the head-mounted display was uncomfortable to wear and influenced their ability to immerse in the VE. In addition, the poor display resolution of the smartphone used to present the VE could have limited the realness of VE experience. The quality of the device in this study may have lessened the effectiveness of the VE in inducing positive affect. Another factor that may have influenced the results could be the training virtual environment. Although the VE was designed as a neutral VE, it could be that it had a specific meaning for some participants, and thus improved their positive affect before the actualy VE experiment was presented.

CONCLUSION

This is the first study in the field of positive psychology that closely examined the effectiveness of different auditory stimulations in a relaxation-inducing virtual environment. Findings show that negative affect can decrease even after a short period of an individuals placement within the virtual environment, ''Perfect Beach,'' regardless of the type of auditory stimulation presented. This presents the future potential of virtual environments that people can use to reduce negative emotions and improve their well-being in the comfort of their own homes. However, due to the small sample size and other aforementioned limitations within this study, the results should viewed and interpreted with caution. Further research that includes more participants is needed to gain a deeper understanding of the relationship between sensual stimulation, virtual environments and an individuals sense of presence. This is important because virtual environments promise a possibility to improve people's well-being. There is more to be discovered as to how sensual stimulation can improve an individuals overall experience within a virtual environment, and eventually transform the technology of virtual environments into a powerful tool that may drastically improve one's positive affect.

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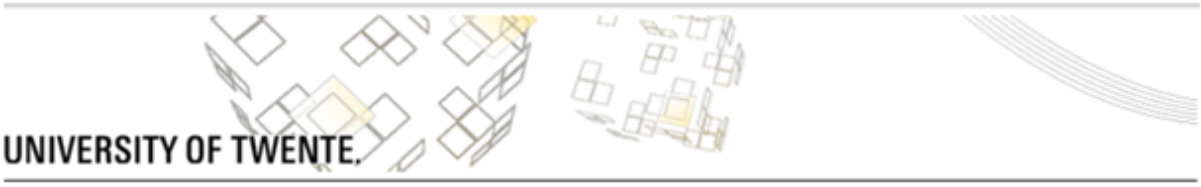
APPENDIX I – Informed Consent



Dear participant,

This letter is to inform you in more detail about the study to which you were invited. This study is part of a Master's thesis at the department of Psychology, Health & Technology (PGT) of the University of Twente and is supervised by Dr. M. Radstaak and Dr. M. Postel. The purpose of this study is to examine the virtual environments, as well as their influence on human emotions. We would like to ask you to help us to gain more insight to the above-mentioned subject by participating in our study, which is described below in more detail.

What comes to you?

The study will take approximately 30-45 minutes. In general, the study consists of three parts: First, you will be asked to fill in a number of questionnaires. You will then use special technology to plung into a relaxing virtual environment, followed by a number of questionnaires again. Please fill out the questionnaires with due diligence and honesty. There are no right or wrong answers; only your personal thoughts, feelings and experiences are central. Finally, you will have the opportunity to express comments and ask questions.

After the end of the research project you can also, if you wish to, be informed about the achieved results. For questions, further information and/ or information about achieved results please contact us. Our contact details can be found at the bottom of this page.

What happens to the collected data?

The evaluation and presentation of the collected data will be summarized in a report for the University of Twente, which is part of a qualification work to obtain the academic degree Master of Science. However, all data will be displayed in a form, which cannot be traced back to individuals. Individuals will thus remain anonymous at all times. In addition, all related data will be kept with confidentiality and will not be disclosed to third parties.

After the trial you can, if you wish to, be informed about the achieved results. For questions, further information and/ or debriefing please contact us.

Best regards,

Anna Dermer
Student Master Psychology
email: a.dermer@student.utwente.nl

Christian Wrede
Student Master Psychology
email: c.wrede@student.utwente.nl

Consent declaration

I was fully informed about the research project. I have read and understood the written information about the study completely. I was given the opportunity to ask questions about the study and my questions were answered to my contentment. I had enough time and information to consider participating in this study. I can withdraw my consent at any time and without giving reasons.

I agree that my answers may be stored and that anonymized values / answers will be used for research purposes. I agree to participate in this study.

[If you have any complaints about this research, please direct them to the secretary of the Ethics Committee of the Faculty of Behavioural Sciences of the University of Twente (Drs J. Rademaker, PO Box 217, 7500 AE Enschede (NL), telephone:. +31 (0) 53 489 4591; email: j.rademaker@utwente.nl)].

_____

DD-MM-YYYY, place, name and signature participant

_____

DD-MM-YYYY,place, name and signature researcher

APPENDIX II – Experimental Protocol

Provide participant with informed consent form. If participant agrees to participate: sign in duplicate.

Check necessary materials:

- ✓ Pen
- ✓ Cardboard
- ✓ Headphones
- ✓ Smartphone
- ✓ Time tracker
- ✓ Bell
- ✓ Laptop/Computer

- ✓ Neutral YouTube Video for training session
    - https://www.youtube.com/channel/UCyXGH4IpKDqu_BLxdJnefJA

- ✓ Questionnaires:
    - Demographic variables
    - HADS
    - MHC-SF
    - PSS
    - mDES
    - IPQ
    - Experiences while immersed in the virtual environment
        - Contains:
            - Perceived autonomy
            - Attention
            - Level of difficulty
            - Satisfaction
            - Intention to use

"Welcome and thank you for participating in our study. As mentioned earlier, this study aims to examine the use of virtual environments, as well as their influence on human emotions.

The study will start by filling in a number of questionnaires that will be presented to you. After that, you will undergo a short training session in order to familiarize yourself with the technology-device that will later present the virtual environment to you. For this purpose, a training program will be run on the device. After the training session, the actual experiment will start and the virtual environment will be presented to you. As a last step, you will be asked to fill in a number of questionnaires again. In case you wish to, you can withdraw your participation at any time. Do you have any questions concerning the study?"

"First of all I would like to ask you to fill in a number of questionnaires. Each questionnaire is preceded by a short instruction about how to fill it in correctly. Some of the questionnaires will be presented again to you after the use of the virtual environment. Please fill them in, in the stated order. It is important for the study that you complete all questionnaires and give honest answers. You have enough time to do so, so you do not have to feel stressed. If you have questions I will do my best to answer them."

Give the participant the questionnaires **package 1**:

1. Demographic variables
2. HADS
3. MHC-SF
4. PSS
5. mDES

''Thank you very much. Before we start with the experiment, I will score your answers. This is important for me, to be sure that you are eligible for this experiment. While I am doing so, you can familiarize yourself with the device. It is called "Google Cardboard" and consists of a head-mounted display that will present the virtual environment to you. The viewer is used by placing a smartphone into the back of it and viewing through the lenses in the front. In the following I will ask you to put on the Cardboard and the corresponding headphones. After that I will start a training program. Then I will leave you for 10 minutes, so you can try to interact with the device. If questions arise, please ring the bell that lays next to you. I will then come back and help you''.

Show the participant how to wear the Cardboard and headphones. Start the training program. Leave the participant alone, but still be available for questions. Score the questionnaires:

1. Demographic variables
2. HADS
3. mDES

Give the participant the information that he/she can/can not start with the experiment.

<u>If participant is not suitable:</u>

''I have scored your answers. I am sorry, but because of specific criteria that I have stated for my study and the scores of the questionnaires, you cannot take part in it. You have:

- *hearing/vision impairments*
- *a high score on the HADS. The HADS is a questionnaire that measures depression and anxiety. Sadly your score on depression/anxiety is too high to participate in my study. This will not mean that you are depressed or have an anxiety disorder. The HADS is not an instrument that is used for diagnostic. It just indicates a tendency, thus it is a screening instrument.*

Still, thank you very much that you were interested in my study and that you have filled in the questionnaires.''

<u>If participant is suitable:</u> assign him/ her to one of the following 3 conditions and note the participants' condition with a code-number (1: condition 1; 2: condition 2; 3: condition 3):

<u>Condition 1: Autonomy + natural sound</u>

''Thank you. I have scored your answers. How was your experience with the Cardboard? Do you have any questions before we start with the experiment?

Please put on the Cardboard again. Now, you will immerse in a relaxing virtual environment. You can freely choose between different options of what you want to see. They all simulate natural places where you can relax and enjoy a calm moment. In all places you can observe different aspects of nature, and enjoy the peace and calm around you with relaxing natural sounds. In addition, you can also change the daytime and alter your virtual body if you wish to.

You are always free to change places or other aspects while you are in the virtual environment. It is important that when you are in the environment you will allow yourself to be immersed in it. If you want to stop because you are feeling not comfortable or not relaxed anymore or can't concentrate on the topic you are free to stop at any given moment. If you

have finished the virtual experience or would like to stop please ring the bell that lays next to you. I will then come back and stop the Cardboard."

Make sure the participant puts on the Cardboard and headphones correctly.
Start the VE-program. Start time tracker.
Leave the participant alone but still be available in case he/ she wants to stop.
In case the participant wants to stop: stop time tracker, note the time.

Condition 2: No autonomy + guided meditation

''Thank you. I have scored your answers. How was your experience with the Cardboard? Do you have any questions before we start with the experiment?
Please put on the Cardboard again. Now, you will immerse yourself in a relaxing virtual environment. This environment simulates a natural place where you can relax and enjoy a calm moment; you can observe different aspects of nature, and enjoy the peace and calm around you with relaxing natural sounds and practice slow breathing rhythms. Do not worry; you will be guided through the breathing exercises. Relax please, and do not chance the environment. It is important that when you are in the environment you will allow yourself to be immersed in it. If you want to stop because you feeling not comfortable, not relaxed anymore or can't concentrate on the topic you are free to stop at any given moment. If you have finished the virtual experience or would like to stop please ring the bell that lays next to you. I will then come back and stop the Cardboard."

Make sure the participant puts on the Cardboard and headphones correctly.
Start the VE-program. Start time tracker.
Leave the participant alone but still be available in case he/ she wants to stop.
In case the participant wants to stop: stop time tracker, note the time.

Condition 3: No autonomy + natural sound

''Thank you. I have scored your answers. How was your experience with the Cardboard? Do you have any questions before we start with the experiment?
Please put on the Cardboard again. Now, you will immerse yourself in a relaxing virtual environment. This environment simulates a natural place where you can relax and enjoy a calm moment; you can observe different aspects of nature, and enjoy the peace and calm around you with relaxing natural sounds. Relax please, and do not chance the environment. It is important that when you are in the environment you will allow yourself to be immersed

in it. If you want to stop because you feeling not comfortable, not relaxed anymore or can't concentrate on the topic you are free to stop at any given moment. If you have finished the virtual experience or would like to stop please ring the bell that lays next to you. I will then come back and stop the Cardboard."

Make sure the participant puts on the Cardboard and headphones correctly.
Start the VE-program. Start time tracker.
Leave the participant alone but still be available in case he/ she wants to stop.
In case the participant wants to stop: stop time tracker, note the time.

After VE-manipulation:

"Thank you. Now I would like to ask you to fill in the last set of questionnaires. One of them is the same you have filled in before the experiment. The procedure is the same. Please fill them in, in the stated order. It is important for the study that you complete all questionnaires and give honest answers. You have enough time to do so, so you do not have to feel stressed. If you have questions I will do my best to answer them.''

Give the participant the questionnaires **package 2**:

1. mDES
2. IPQ
3. Experiences while immersed in the virtual environment
    - Contains:
        - Perceived autonomy
        - Attention
        - Level of difficulty
        - Satisfaction
        - Intention to use

"Thank you, for participating in my study."

Hand out the debriefing form and answer questions if participant has any.

"Are you interested *in getting a report when the data is analyzed?"*

If the participant is interested, than make an agreement about how you will transmit the results (mail, phone, etc.).

"Thank you and good bye."

Questionnaires – Package 1

1. Demographic variables

This questionnaire is about general questions about you. Please answer the questions honest and correctly.

Your gender is?

- O Male
- O Female

How old are you? _____

What is your nationality?

- O German
- O Dutch
- O Other: _____

What is your highest educational degree?

- O Hauptschule
- O Realschule (Sekundarstufe II)
- O Allgemeine Fachhochschulreife (Fachabitur)
- O Allgemeine Hochschulreife (Abitur)
- O Hochschulabschluss (Universität, Fachhochschule)
- O Other degree
- O No educational degree

What is your current working situation?

- O Work (full/part time)
- O Pension
- O Disability pension

- O Student
- O Housman/women
- O Unemployed/ seeking work

How would you rate your english fluency?

- O Very good
- O Good
- O Average
- O Moderate
- O Bad

Do you have visual/auditory impairments?

- O Yes
- O No

If yes, please check the statement that is true for you:

- O I see/hear bad
- O I need glasses/hearing aid

How often do you use a smartphone?

- o Never
- o Once to twice a month
- o Once to twice a week
- o Every day, less than one hour
- o Every day, more than one hour

How often do you use a Cardboard or similar devices?

- o Never
- o Once to twice a month
- o Once to twice a week
- o Every day, less than one hour
- o Every day, more than one hour

If yes: How much experience do you have with Virtual environment?

O A lot
O Average
O Little

Have you been or are you in a treatment because of psychological problems?

O Yes
O No

If yes: How long was/is the treatment?

_____

Have you been or are you in treatment because of other (chronically) diseases/problems that impair/influence your daily life?

O Yes
O No

2. HADS

Thick the box besides the reply that is closest to how you have been feeling IN THE PAST WEEK. Don't take too long over your replies: your immediate is best.

I feel tense or "wound up":	**I feel as if I am slowed down:**
O Most of the time, a lot of the time	O Nearly all the time
O From time to time	O Very often
O Occasionally	O Sometimes
O Not at all	O Not at all

I still enjoy the things I used to enjoy:	**I get sort of frightened feeling like "butterflies" in the stomach:**
O Definitely	O Not at all
O Not quite so much	O Occasionally
O Only a little	O Quite often
O Hardly at all	O Very often

I get a sort of frightened feeling as if something awful is about to happen:	**I have lost interest in my appearance:**
O Very definitely and quite badly	O Definitely
O Yes, but not too badly	O I don´t take as much care as I should
O A little, but it doesn´t worry me	O I may not take quite as much care
O Not at all	O I take just as much care as ever

I can laugh and see the funny side of things:	**I feel restless as I have to be in move:**
O As much as I always could	O Very much indeed
O Not quite so much now	O Quite a lot
O Definitely not so much now	O Not very much
O Only occasionally	O Not at all

Worrying thoughts go through my mind:	**I look forward with enjoyment to things:**
O A great deal of the time	O As much as I ever did
O A lot of the time	O Rather less than I used to
O From time to time, but not too often	O Definitely less than I used to
O Only occasionally	O Hardly at all

I feel cheerful:	**I get sudden feeling of panic:**
O Not at all	O Very often indeed
O Not often	O Quite often
O Sometimes	O Not very often
O Most of the time	O Not at all
I can sit at ease and feel relaxed:	**I can enjoy a good book or radio or TV program:**
O Definitely	O Often

O Usually	O Sometimes
O Not often	O Not often
O Not at all	O Very seldom

Please check you have answered all the questions.

3. mDES (pre)

The questionnaire consists out of different words that describe different emotions and feelings. Please use the scale below to indicate the greatest amount that you experience each of the following feelings AT THE MOMENT.

	Never	**Rarely**	**Some of the time**	**Often**	**Most of the time**
Amused, fun-loving, silly	1	2	3	4	5
Angry, irritated, annoyed	1	2	3	4	5
Ashamed, humiliated, distracted	1	2	3	4	5
Awe, wonder, amazement	1	2	3	4	5
Contemptuous, scornful, disdainful	1	2	3	4	5
Disgust, distaste, revulsion	1	2	3	4	5
Embarrassed, self-conscious, blushing	1	2	3	4	5
Grateful, appreciative, thankful	1	2	3	4	5
Guilty, repentant, blameworthy	1	2	3	4	5
Hate, distrust, suspicion	1	2	3	4	5

Hopeful, optimistic, encouraged	1	2	3	4	5
Inspired, uplifted, elevated	1	2	3	4	5
Interested, alert, curious	1	2	3	4	5
Joyful, glad, happy	1	2	3	4	5
Love, closeness, trust	1	2	3	4	5
Proud, confident, self-assured	1	2	3	4	5
Sad, downhearted, unhappy	1	2	3	4	5
Scared, fearful, afraid	1	2	3	4	5
Serene, content, peaceful	1	2	3	4	5
Stressed, nervous, overwhelmed	1	2	3	4	5

4. Duration of use

Measure with a stopwatch how long the participant really uses the device.

"If you want to stop because you are feeling not comfortable or not relaxed anymore or can't concentrate on the topic you are free to stop at any given moment. If you have finished the virtual experience or would like to stop please ring the bell that lays next to you. I will then come back and stop the Cardboard."

Sec.
Actual use

Questionnaire - Package 2

1. mDES (post)

The questionnaire consists out of different words that describe different emotions and feelings. Please use the scale below to indicate the greatest amount that you experience each of the following feelings AT THE MOMENT.

	Never	Rarely	Some of the time	Often	Most of the time
Amused, fun-loving, silly	1	2	3	4	5
Angry, irritated, annoyed	1	2	3	4	5
Ashamed, humiliated, distracted	1	2	3	4	5
Awe, wonder, amazement	1	2	3	4	5
Contemptuous, scornful, disdainful	1	2	3	4	5
Disgust, distaste, revulsion	1	2	3	4	5
Embarrassed, self-conscious, blushing	1	2	3	4	5
Grateful, appreciative, thankful	1	2	3	4	5
Guilty, repentant, blameworthy	1	2	3	4	5
Hate, distrust, suspicion	1	2	3	4	5
Hopeful, optimistic, encouraged	1	2	3	4	5
Inspired, uplifted, elevated	1	2	3	4	5
Interested, alert, curious	1	2	3	4	5

Joyful, glad, happy	1	2	3	4	5
Love, closeness, trust	1	2	3	4	5
Proud, confident, self-assured	1	2	3	4	5
Sad, downhearted, unhappy	1	2	3	4	5
Scared, fearful, afraid	1	2	3	4	5
Serene, content, peaceful	1	2	3	4	5
Stressed, nervous, overwhelmed	1	2	3	4	5

2. IPQ

This questionnaire deals with the feeling to be present in the virtual environment. Please indicate what is true for you.

		Not at al				**Very much**
G1	**In the computer generated world I had a sense of being there**	1	2	3	4	5
		Fully disagree				**Fully agree**
SP1	**Somehow I felt that the virtual world surrounded me**	1	2	3	4	5
		Fully disagree				**Fully agree**

SP2	**I felt like I was just perceiving pictures**	1	2	3	4	5
		Did not feel				**Did felt present**
SP3	**I did not feel present in the virtual space**	1	2	3	4	5
		Fully disagree				**Fully agree**
SP4	**I had a sense of acting in the virtual space, rather that operating something from outside**	1	2	3	4	5
		Fully disagree				**Fully agree**
SP5	**I felt present in the virtual space**	1	2	3	4	5
		Extremely aware		**Moderately aware**		**Aware at all**
INV1	**How aware were you of the real world surrounding while navigating in the virtual world ? (i.e. sounds, room, temperature, other people, etc.)**	1	2	3	4	5
		Fully disagree				**Fully agree**
INV2	**I was not aware of my real environment**	1	2	3	4	5
		Fully disagree				**Fully agree**
INV3	**I still paid attention to the real environment**	1	2	3	4	5
		Fully disagree				**Fully agree**

INV4	**I was completely captivated by the virtual world**	1	2	3	4	5
		Completely real				**Not real at all**
REAL1	**How real did the virtual world seem to you??**	1	2	3	4	5
		Not consistent		**Moderately consistent**		**Very consistent**
REAL2	**How much did your experience in the virtual environment seem consistent with your real world experience?**	1	2	3	4	5
		About as real as an imagined world				**Indistinguishable from the real world**
REAL3	**How real did the virtual world seem to you?**	1	2	3	4	5
		Fully disagree				**Fully agree**
REAL4	**The virtual world seemed more realistic that the real world**	1	2	3	4	5

3. Experiences while immersed in the virtual environment

The following questions are about your experience while being immersed in the virtual environment. Indicate how much you agree with each statement.

	Strongly disagree	**Disagree**	**Neither agree nor disagree**	**Agree**	**Strongly agree**

A1	**I had no difficulties to fully concentrate on the virtual experience**	1	2	3	4	5
A2	**I did not feel distracted during the virtual experience**	1	2	3	4	5
A4	**It was difficult to keep my attention on the virtual experience**	1	2	3	4	5
A4	**I was distracted because I mull about all kind of things**	1	2	3	4	5
D1	**The interaction with the virtual environment was difficult for me**	1	2	3	4	5
D2	**I could find my way well in the virtual environment**	1	2	3	4	5
S1	**I am satisfied about the experience in the virtual environment**	1	2	3	4	5
S2	**I am satisfied about the equipment used during the experience in the virtual environment**	1	2	3	4	5
I1	**Assuming that I would have access to a virtual environment, I would use it**	1	2	3	4	5
I2	**The used technology in this experiment is something I would like to use more in the future**	1	2	3	4	5

APPENDIX III – Debriefing

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Thank you for your co-operation during this study! This study was an investigation into the efficacy of virtual environments to induce positive emotions. Existing evidence supports the importance of adressing positive emotions in order to enhance people´s mental and physical health. Virtual environment systems like the "Google Cardboard" might be a useful tool that can be used for this purpose. The costs for the aquisition of Virtual environment systems have dropped significantly in recent years so that a wider distribution in both the private and health care sector is expected. However, there is still little known about the efficacy of those systems to induce positive emotions.

In our study, we tested the efficacy of a virtual beach to induce relaxation and other related positive emotions. We also investigated wether the stimulation of the senses of hearing and the degree of autonomy perceived by the user improves the efficacy of the virtual environment in inducing positive emotions. To gain a deeper understanding about your usage experience, we also measured your user-satisfaction, attention while using the system, the duration of use, the perceived level of difficulty, the feeling of being in the virtual world and your intention to use the system.

In this study, you were randomly assigned to one of three conditions, that differed regarding auditory stimuli and the degree of autonomy.

The results from this study will provide more insights in the efficacy of virtual environments to induce positive emotions. A better understanding of the role of autonomy and auditory stimuli can moreover result in more effective and evidence-based Virtual environment systems.

If you have further questions about the study, please feel free to contact us.

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