Effects of nature on stress and anxiety during invasive diagnostic procedures: using virtual reality environments.

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Abstract

Based on earlier research, which demonstrated that patients in a hospital can profit from nature, the present research studied the effects of nature views during an invasive procedure. It aimed to study the effects of different types of nature views on psychological well-being during a bronchoscopy. Recent research found that nature with elements of soft-fascination restores the attention processes and activates automatic attention. The attention restoration theory claims that psychological well-being improves when people are able to restore attention. Furthermore, based on the literature, it was suggested that nature views also had to contain the element of water, blue sky and spaciousness to increase the restorative effect of nature views. It was expected that the nature views high on soft-fascination have a stronger restorative effect on psychological well-being than the nature views low on soft-fascination. A pre-selection of nature videos was done based on the elements found in the literature, followed by a pre-test (N = 17) to test the degree of soft-fascination in the two pre-selected nature videos. In the main study patients were given VR glasses through which the selected nature videos were shown. It was chosen to use VR glasses because it strengthens the sense of presence in an environment. The intervention included two conditions without a no-VR nature control group. Participants (N = 10) were allocated in the two conditions from which one condition (n = 5) received the intervention with nature videos high on soft-fascination and the other condition (n = 5) received the intervention with nature videos low on soft-fascination during the bronchoscopy. Participants filled in a short Dutch questionnaire including a pre-test and post-test on mood, and scales to measure stress, discomfort and experienced pain relief. Quantitative analysis were done to analyze the effect of nature videos on psychological well-being and to compare the two nature conditions. Results from the quantitative analysis showed no significant effect of nature on psychological well-being and also no significant difference in restorative effect of the two nature conditions. To complete the findings, a qualitative analyses was done because of the small sample size (N = 10). Qualitative analyses found a potential stronger restorative effect of nature videos high on soft-fascination compared to nature videos low on soft-fascination. Participants in the high on soft-fascination condition seemed to feel more relaxed and less stressed after the bronchoscopy than before the bronchoscopy. However, it is not certain whether it was a real improvement or a relative improvement. Finally, it is highly recommended to increase the sample size and to include an intervention control-group in further research to study whether or not nature videos have a restorative effect on psychological well-being for patients undergoing a bronchoscopy.

Introduction

Nowadays, some examination procedures in hospitals have become very invasive for the patients. An example of these invasive procedures is a bronchoscopy. Research showed that 68% of patients undergoing a bronchoscopy experienced high levels of anxiety during the days before and the day of the bronchoscopy (Poi, Chuah, Srinivas & Liam, 1998). Anxiety in patients undergoing a bronchoscopy can be related to several causes. For example, the fear of the unknown, the uncertainty of the diagnosis or fear about the physical discomfort caused by the procedure (Colt, Powers, & Shanks, 1999). Additionally, the fear and anxiety that patients experience before an appointment can increase the possibility of a no-show (Lacy, Paulman, Reuter, & Lovejoy, 2004). No-shows will waste valuable time of the medical staff and could be avoided by reducing the anxiety in patients. Research found that anxiety could be reduced by preparing the patients for potential sensations that may be felt during the bronchoscopy (Poi, et al., 1998) or through relaxation with the aid of music (Robb, Nichols, Rutan, Bishop, & Parker, 1995). Furthermore, a supportive environmental design can also positively influence health outcome of patients in healthcare environments (Ulrich, 1984). Ulrich (2001) found that healthcare environments are psychologically hard. These environments do not meet the psychological needs of patients and could be a source of stress and anxiety. Stress and anxiety could induce an increase in blood pressure which indirectly causes patients to ask for stronger pain medication (Ulrich, 2001). The meta-analyse of Devlin & Arneill (2003) studied the effect of the healthcare environment on psychological health of patients and showed that patients prefer it when nature is incorporated in the hospital interior design (Devlin & Ameill, 2003). It is important to identify how the hospital can provide natural environments to patients to reduce their anxiety without compromising the sterile environment. In the present study the focus lays on reducing stress and anxiety in patients undergoing an bronchoscopy with the aid of nature view.

Nature

In the present study the Attention Restoration Theory by Kaplan and Berman (2010) and the stress reduction model by Ulrich (1981; 1984) are used to explain the effects of nature on patients.

Attention Restoration Theory. Patients undergoing a bronchoscopy will have to regulate their emotions and anxiety. The positive or negative reactions to events can be seen as their emotions. Such emotions arise whenever a person is concerned about an event. Emotions can be self-regulated by deploying their attention somewhere else than on the

ongoing event (Vohs & Baumeister, 2016). The concept of directed attention plays a role in deploying attention elsewhere. Directed attention is the process of forcing oneself to pay attention to information (Kaplan & Berman, 2010). Human beings are constantly processing information (Kaplan, 1995) and using directed attention which causes fatigue (Kaplan & Berman, 2010). The effort required for directed attention is high and may be depleting because the process is not automatically activated by the brain (Kaplan & Berman, 2010). In his integrative framework of the benefits of nature, Kaplan (1995) emphasized the importance of nature in recovery from fatigue. Fatigue is defined as effects of stress. Nature plays an important role to restore the directed attention to cope with challenges (Kaplan, 1995; Kaplan & Berman, 2010).

The stress and anxiety experienced by patients on the day of the bronchoscopy (Poi et al., 1998) is suggested to decrease when patients redirect their attention to distract themselves (Vohs & Baumeister, 2016). A way to facilitate and restore directed attention is by viewing a nature environment. Nature environments limit the need for directed attention and relaxes people (Kaplan & Berman, 2010). When directed attention is restored, it can be used again to deploy attention elsewhere than on the anxiety that patients might experience.

Stress and anxiety reduction. Ulrich (1981; 1984) used the calming effect of nature views to decrease anxiety and stress. Ulrich's study (1984) showed that nature can help in the healing process of patient by looking at nature through the hospital windows. The view of nature through a window positively influenced recovery from surgery. Patients benefited from nature on psychological well-being. It reduced anxiety and improved the emotional states of the patients (Ulrich, 1984). However, these days a lot hospitals are situated inside an urban environment with little nature around it and procedure rooms, like the bronchoscopy room, have no windows. A solution is, bringing nature inside healthcare environments.

Several studies have proved the importance of nature inside healthcare environments. Firstly, Park & Mattson (2009) found that indoor plants in the recovery room of patients enhanced recovery from surgery. The plants produced significantly positive physiological responses like lower systolic blood pressure and less pain. Patients laying in a room with plants or flowers also experienced less anxiety, fatigue and stress than patients without plants or flowers (Park & Mattson, 2009). Secondly, in the meta-analyses from Velarde, Fry and Tveit (2007) it was concluded that nature had a greater positive effect than urban environments on health in general (Velarde, Fry & Tveit, 2007). Thirdly, research about the psycho-physiological effects of natural environment versus urban environments has also been done. In the study heart rate and emotional states were measured while subjects viewed a slide

show of nature with water, nature dominated by vegetation or urban environments with neither water nor vegetation in it (Ulrich, 1981). Ulrich (1981) found that nature environments could have a positive influence on emotional state and on psycho-physiological states. The immediate effects of direct exposure of nature view on psycho-physiological states studied by Ulrich's (1981) are similar to the effects that are studied in the present research. Another research very similar to the present research is the study by Diette, Lechtzin, Haponik, Devrotes and Rubin (2003). Diette et al. (2003) were the first to study the effect of nature views and sounds during a bronchoscopy. Patients were provided with nature scene murals and a tape with nature sounds. Results showed that experienced pain and discomforts significantly decline (Diette et al., 2003). However, not all natural settings are the same and might have different effects on psychological health.

Water. Firstly, "Water has been described in a large body of intuitive literature as a visual element that is high in aesthetic value, and that also evokes positive feelings such as tranquility (Ryback and Yaw, 1976)." (Ulrich, 1981, p. 525). Ulrich (1981) found that the slides of nature with water had a greater effect on psycho-physiological states than slides of nature dominated by vegetation. Slides of nature with water caused the patients to hold attention and interests longer towards the scenes (Ulrich, 1981). Kaplan and Kaplan (1989) also pointed out how people are fond of water and want to be near water in any circumstances.

Open blue sky. Secondly, compatibility of the nature setting with a person's needs is suggested to increase the restorative effect of nature environments (Szolosi et al., 2014). Lung patients often experience breathlessness and dyspnea (Brack, Jubran & Tobin, 2002). Taking the compatibility of the setting and the breathlessness of lung patients in consideration, it is suggested that lung patients can benefit from nature with the element of open blue sky in it. Moreover, patients undergoing a bronchoscopy in particular might profit from this element because those patients often experience breathlessness and the fear of choking (Poi, Chuah, Srinivas & Liam, 1998).

Spaciousness. Thirdly, another important element of nature is "the spaciousness" of a nature setting. By providing patients with a nature environment with an open blue sky, spaciousness is also created. A study conducted by Annerstedt (2011) found that spaciousness was important for nature views because it creates a restful feeling of a coherent whole. Results showed that the risk of mental health problems were significantly reduced when women were provided with spaciousness nature settings (Annerstedt, 2011). Creating a restful feeling in patients is suggested to facilitate stress relief.

Soft-fascination. Finally, consider a view where partly a forest and partly an open space is visible. This gives the impression that there is more behind the trees (Szolosi, Watson & Ruddell, 2014). The curiosity in people about what might be beyond the trees makes them fascinated. Fascination can enable the patients to keep looking at the nature environment without getting bored (Van den Ber, Joye, & Koole, 2016). Fascinating nature will also help to hold the interest effortlessly through automatic attention (Szolosi, Watson & Ruddell, 2014). The component "soft-fascination" of nature environments is suggested to be able to effortlessly capture the attention of people (Van den Berg et al., 2016) and to enable involuntary, automatic attention (Kaplan & Berman, 2010). With the aid of nature environments a person will turn the forced attention into automatic attention which restores the direct attention (Kaplan & Berman, 2010).

Nature sounds. The present study uses the sounds of nature to increase the restorative effect of nature views. In the VR study with nature environments of Annerstedt and colleagues (2013) the effects of nature sounds was studied and results showed that sound of nature had extra effect on stress reduction. The combination of VR nature environment and nature sounds activated the parasympathetic system which suggests that stress recovery is enhanced (Annerstedt et al., 2013). Nature based sounds are proven to lower the blood pressure, anxiety and agitation levels of patients in hospitals (Saadatmand, Rejeh, Heravi-Karimooi, Tadrisi, Zayeri, Vaismoradi & Jasper, 2013) and also facilitates recovery from psychological stressors (Alvarsson, Wiens and Nilsson 2010).

Virtual Reality

With technology becoming more important in everyday life and also in hospitals, it is interesting to consider how technology could ease the provision of nature to patients. De Kort, Meijnders, Sponselee and IJselsteijn (2006) pointed out the importance of the perceived presence in mediated environments. The quality of the simulation of the environment plays an important role on the effectiveness of the mediated environment. Perceived presence is explained as the amount of immersion someone experiences (De Kort et al., 2006). The study showed that people felt more immersed in the environment if the screen size increased. The higher the level of immersion was, the higher the restorative value of the nature environment became (De Kort et al., 2006). The feeling of "presence" studied by De Kort and colleagues can be described as telepresence when using virtual reality (VR) for the mediated environment. Telepresence describes the presence that a person experiences when looking through VR glasses at a VR environment (Steuer, 1992). VR increases the telepresence and

the restorative value of the nature environment (De Kort et al., 2006; Steuer, 1992). It is used more and more by psychiatrists or therapists and can be defined as technology that forms interaction and immerses the senses of the user (Schuemie, Van Der Straaten, Krijn & Van Der Mast, 2001). Virtual reality environments can be formed with VR glasses and offers us a ways to "be" in virtual environments or go through information-rich cyberspaces (Biocca & Levy, 20013). The use of VR in hospitals for patients can be very effective in creating healing environments. However, little research has been done about the effect of VR environments in health care settings. A pilot research was done by Annerstedt and colleagues (2013) to study the effect of a virtual environment on stress. The VR environment was created by projecting the nature environments on three walls, creating the feeling for participants as if they were standing in nature. Participants consisted of healthy acquaintances of the students and colleagues and psycho-physiological parameters were measured. Results from the pilot study showed that natural environments used in VR facilitated the recovery from stress. However, results should be interpreted with caution because the results of the pilot study have a restricted generalizability (Annerstedt, Jönsson, Wallergård, Johansson, Karlson, Grahn, Hansen & Währborg, 2013). The VR environment can also be provided by video glasses which have the ability to show three-dimensional images or videos (Bentsen, Scensson, & Wenzel, 2001). Nature sounds in combination with videos of nature might have an even stronger effect than only nature videos. It was found that the combination of VR nature with nature sounds actively relaxed the body and relieving stress (Annerstedt, 2011). VR nature with sounds is assumed to create a stronger feeling of presence because more sensory impressions provide a better experience of nature. It increases attention restoration because a person will feel more connected to nature (Mayer, Frantz, Bruehlman-Senecal & Dolliver, 2009). In the present research, the effect of nature videos in combination with corresponding nature sounds on stress and anxiety, will be studied.

Present research

Inpatients vs. outpatients. The mentioned studies describe the effect that nature can have on stress, anxiety and physiological health. Most of these studies investigated the effect of nature on the mental health of inpatients. However, the present study examines the effect of nature on outpatients coming to the hospital for a diagnostic procedure. Outpatients are assumed to be less ill and only briefly exposed to the invasive procedure. The brief exposure is suggested to cause temporary and high peaks of stress (Poi et al, 1998). Mostly, anesthesia is used in outpatients undergoing a bronchoscopy to reduce discomfort, anxiety and stress

(Matot & Kramer, 2000). However, the present study is investigating how to reduce stress and anxiety while only using local sedation in the throat. Providing nature environments to outpatients might help to improve psychological health of patients undergoing a bronchoscopy (Ulrich, 1981; Ulrich, 1984; Park & Mattson, 2009; Diette et al., 2003)

In the present study modern day technology will be used to provide outpatients undergoing a bronchoscopy with simulated nature. With the aid of VR nature environments it will be tested how nature can improve the mental and physical state during the bronchoscopy. Patients undergoing a bronchoscopy will be divided in 2 groups, namely a nature group receiving VR nature environments consisting of nature *high* on "soft-fascination" and nature *low* on "soft-fascination". During the research nature sounds will be added because nature sounds also have a restorative strength (Saadatmand et al., 2013; Annerstedt et al., 2013; Alvarsson et al., 2010). The patients receiving VR nature environments should both receive nature with water because it is proven to have a stronger restorative effect (Ulrich, 1981; Kaplan & Kaplan, 1989) and to be more fascinating (Van den Berg et al., 2016). However, nature low on "soft-fascination" will have little water in it and high on "soft-fascination" will have more water in its view. Also the sound of running water appears to be effective to enhance restoration (Diette et al, 2003). All the patients viewing VR nature will experience less stress and anxiety during the procedure (De Kort et al., 2006; Steuer, 1992). It is hypothesized that the nature setting *high* on "soft fascination" will have a stronger restorative strength than nature *low* on "soft fascination (Van den Berg et al., 2016). The present research is a pilot study with no-intervention control group prior to further research including a control group. A pre-test was done to test whether or not the two nature scenes selected, differed in level of soft-fascination and the main study was done to explore the effects of the different nature views on psychological well-being. Finally, the main study also investigated the feasibility of the intervention in clinical practice.

Methods

Pre-test of the nature videos

Design. A within-subject design was used for the pre-test and participants were randomly assigned.

Participants. The participants (N = 17) for the pre-test of the 2 different nature scenes consisted of high-school teachers from the high-school Het Noordik with an age range of 30 until 64 years old. The participants all mastered the Dutch language which was necessary for the questionnaire.

Material and Apparatus. A Lenovo laptop was used to play the two nature videos with sound. The nature views were pre-selected by the researcher and the mentor. Firstly, the nature views that zoomed-in on rivers, with elements of blue sky, spaciousness and a lot of movement were pre-selected for the high on "soft-fascination" (SF) condition (see figure 1). Secondly, the nature views consisting of a helicopter-view, water, spaciousness and little movement were pre-selected in the low on SF condition (see figure 2). The movement in nature might be an element that creates the "soft-fascination".

A questionnaire was used, consisting of two times 4 items about the two different videos (Appendix A.). The items were 5-point scales (fully disagree until fully agree) about how long participants could watch the video, perceived fascination, perceived boredom of the video, and how appealing the video was. These items were self constructed by the researcher and a supervisor. The items were made to test the manipulation of the videos based on the attention restoration theory. The videos high on SF are assumed to restore attention better than the videos low on SF.

Figure 1. A screenshot from a nature video fragment of the high on SF condition. Copyright 2017 by Beter door Beeld.

Figure 2. A screenshot from a nature video fragment of the low on SF condition. Copyright 2017 by Beter door Beeld.

Procedure. All participants were met in the canteen of the high-school and were free to sit down and participate to the pre-test. Once a participant sat down, information was given about the pre-test and the participants signed an informed consent. Following, the participants watched the first video (high on SF) and answered 4 short items (5 point scale) about this video. Once answered the 4 items, participants watched the second video (low on SF) and answered again the same 4 items about this video. Finally, after the participants finished the questionnaire, the participants were informed about the reason of the pre-test and the possible difference between the 2 videos.

Analyses. The normal distribution was analyzed for each item and a paired sample t-test was done to analyze the difference of nature view. Moreover, Wilcoxon paired test was done to analyze the effect of nature on each of the 4 items because 2 items were not normal distributed.

Main study

Design. During the pilot study a quasi-experimental design was used with perceived anxiety and stress as the primary outcome parameters. A 2 (between-subject) x 2 (within-subject) design was used. Firstly, the between-subject design was used to compare the effect of the nature between the two nature conditions. Secondly, a within-subject design was used to compare the pretest and posttest of the Mood-Arousal scale and the Mood-Feeling scale. Participants were non-random allocated to the different conditions.

Participants. The participants (N = 10) for the pilot study consisted of people visiting the lung function department of the hospital MST (Medisch Spectrum Twente) in Enschede. The participants were allocated in two groups, the high on SF condition (n = 5, M(age) = 72.2) and the low on SF condition (n = 5, M(age) = 70.0). The patients were able to decide to participate with the study after receiving an overall information letter about the pilot. Exclusion criteria were reduced vision of more than -4 myopic, when dormicum (a sedative drug) was used during the procedure, insufficient mastery of the Dutch language and/or a visual handicap what could strongly hinder reading or watching videos. The 2 groups (n = 5 and n =5) were included through alternation in one of the 2 nature-conditions.

Material and Apparatus. The used material included the VR glassed, called the RelaxMaker (Beter door Beeld, 2017) with an LCD display, 1280 x 720 (HD) pixels, aspect ratio 16:9, 24-bit RGB colors, 26° sight and 98 inch screen. Furthermore, ear plugs coming with the VR glasses were used and a short Dutch questionnaire consisting of different scales (Appendix B.). Additionally, the E4 Empatica wristband (Empathica Inc., 2017) was used to measure variability in heart rate, skin conductance levels (SCL) and skin conductance response (SCR). A computer was used to log the physiological data on that was measured by the E4 Empatica wristband (Empathica Inc., 2017). Physiological data was measured for a follow-up research and results of the physiological measures will not be discussed in the present research.

Mood scales. The first and the second scale measured the mood of the patients and consisted of Mood_Arousal scale and Mood_Feelings scale. The Mood_Arousal scale consisted of 1 item using an seven-point scale ranging from aroused/restless (-3) to

relaxed/calm (3). Participants had to answer the question *"How do you feel at this moment?"* by drawing a circle around one of the numbers on the scale. Originally, the Mood_Arousal scale consisted of a seven-point scale continuum (0-6) (Svebak & Murgatroyd, 1985). The Mood_Feelings scale (e.g. *"What is your state of mind?")* also consisted of 1 item using a eleven-point scale ranging from very bad (-5) to very good (5) (Hardy & Rejeski, 1989). The two items were filled in before the bronchoscopy as pre-test (α = .76) and again after the bronchoscopy as post-test (α = .37).

Profile of Mood States. The third scale used in the short questionnaire was the tension dimension of the shortened version of the Profile of Mood States (POMS) using a five-point scale. The tension dimension consisted of six items which measured perceived stress and the validity of all scales of the POMS was also good (Baker, Denniston, Zabora, Polland, & Dudley, 2002). An example of an item is "Nervous". Participants were asked to circle the number that indicated to which extent that item was applicable on their personal state. The numbers ranged from 0 to 5 (absolutely not to very strongly). The participants completed the six items post-procedure. The reliability of the POMS was α = .73.

Procedural discomfort. Two additional VRS on comfort were added to the questionnaire to measure perceived procedural discomfort. The first scale (Discomfort_insertion_scope) measured how uncomfortable or comfortable participants experienced the insertion of the scope (e.g. *"How uncomfortable or comfortable did you think the insertion of the scope was?")*. The second scale (Discomfort_after_insertion) measure how uncomfortable or comfortable participants experienced the procedure after the bronchoscope was inserted (e.g. *"How uncomfortable of comfortable did you think the whole procedure was?")*. Both items were measure with a scale ranging from very uncomfortable (0) to very comfortable (10). The reliability of the 2 items as one scale was low (α = .41). These 2 items were answered by the participants after the procedure.

Experienced pain relief. To measure the perceived experienced pain relief by sedation a five-point scale item was added to the questionnaire ranging from poor (0) to excellent (10) (Diette et al., 2003). Participants were asked: *"How good or bad did the sedation work that you received against pain during the bronchoscopy?"*. This item was also answered after the procedure.

Fascination. Finally, 3 items about the fascination of nature coming from the pre-test has been added to the questionnaire as an extra manipulation check on the two different kind of nature views. The first item measured the perceived fascination of the video using a 5-point

scale ranging from fully disagree until fully agree. The second measured how interesting the participants thought the video was and the third measured if patients could look for a long time at the video. Together the items had a Chronbach's alpha of $\alpha = .57$. Participants filled in the items after the procedure.

Observations. Furthermore, non-verbal and verbal information was gathered and written down to measure the feasibility of the intervention.

Procedure. A researcher met the participants in the treatment room on the pulmonary department at the MST. After participants were asked to sit down in the chair and the doctor introduced himself/herself, the doctor introduced the researcher to the participant. First some general information about the procedure was given by the doctor. Then, the researcher gave general information about the pilot study and participants were asked to participate. The patients who decided to participate, were given further explanation about the procedure of the research in the information letter before the start of the bronchoscopy. After the participants read the information letter, there was an opportunity to ask questions. Finally, the participants were asked to sign the informed consent form and to fill in the short pre-test. Once the informed consent form was signed the procedure started and participants were asked to wear the glasses as long as possible. Participants were allowed to take off the video glasses if they wished so or signaled the researcher to do it. In case the video glasses were taken off, the researcher noted the exact time on the observation file.

To measure physiological data, the researcher installed a wristband on the wrist of the participant. After turning on the wristband, the wristband signaled a green light for about 40 seconds. At the exact moment that the light turned to red, the stopwatch had be started to synchronize the time of the wristband and the stopwatch. Once the procedure of the bronchoscopy started, the nurse inserted an anesthetic spray in the throat of the patient. Next, the doctor dripped local sedation into the airway. Exact mid times of each insertion of the anesthetic spray and the local sedation were registered on the stop watch and written down. The exact time registered of big movements as standing up or lying down. Once all sedation were administered, the researcher installed the video glasses and the earplugs, and turned on the nature video. After the video glasses were installed, the doctor started to insert the scoop. Exact times of the start of the insertion as well as the moment the bronchoscope was in position, were registered. During the bronchoscopy the researcher took note of any non-verbal and verbal communication about the video glasses. The exact times of the start as well as the completion of the removal of the bronchoscope were registered. Once the patient sat up, the video glasses were turned off and taken off by the researcher.

Afterwards, participants were given the time to relax and once participants were ready, the participants filled in the short Dutch questionnaire and additional questions to gather information about the participant. Additionally, the participants had the possibility to give feedback about his or her experience of the bronchoscopy and the VR glasses with nature views. At a later moment the physiological data registered by the wristband was logged on a computer.

Analyses. Descriptive statistics were used to compare the average scores between people and to analyze the distribution of average age and gender in the population. Descriptive statistics were also used to compare the between-subject ratings and the within-subject ratings between pre-test - post-test. One way ANOVA was used to analyze the average score of the POMS of the two nature groups and the two groups were compared with each other. Cronbach's alpha was analyzed for the 6 items of the POMS to measure the reliability. To analyze the main effect of time between the pre-test and the post-test of the Mood-arousal and the Mood-feeling items Repeated Measures were used. Pearson correlation was used to analyze whether or not the 2 items on procedural discomfort were one construct and One way ANOVA was used to measure average scores. The interaction effect of the between-nature condition on the change in the outcome measure over time was plotted. It was chosen to not check for a normal distribution of the data before analyzing the interaction effect because of the exploratory nature of this Pilot study. Finally, manipulation check was done for the fascination-item of the pre-test to verify if the high on SF group thought the video was more fascinating than the low on SF group. For all analysis $p < .10$ is considered significant and $p < .20$ as marginally significant because of the small sample size.

Due to the small sample size ($N = 10$) a qualitative analysis on individual level was done to complete the findings of the study. Results per participants were written down and the psychological state of each individual participant was analyzed by comparing scores on each item (Appendix C.). Furthermore, the psychological states of each group were compared to analyze whether or not a difference could be found. Moreover, the difference between pre-test and post-test scores per participant were plotted to see the changes of Mood_Arousal and Mood_Feelings during the bronchoscopy. No change between pre- and post-test was equal to 0. The scores of the conditions were compared to detect the suggested difference between the conditions. Finally, mean scores on the POMS of each individual was plotted and scores on Experienced pain relief, Discomfort_insertion_scoop and Discomfort_after_insertion were also plotted to compare the conditions.

Results

Pre-test of the nature videos

The within-subject differences in the ratings of both videos (high on SF vs. low on SF) were analyzed. Average scores for each item were calculated and examined with a (high on SF x low on SF) paired samples t-test. Only *fascination* was significantly scored higher for the video high on SF, $t = 2.72$, $p = .02$. The other items were not significant but observed means were consistently in favor of the HSF video. A summary of the results are visible in table 1. However, the item "Appealing" and the item "Fascination" for high on SF were not normally distributed (see figure 3 and 4) so a Wilcoxon paired test was done. Results from the Wilcoxon showed that only the item *fascination* was significantly scored higher for the video high on SF, $Z = -2.31$, $p = .02$

Table 1.

Two tailed t-test for the within-subject difference in the ratings of both videos (HSF vs. LSF).

	HSF		LSF			
Variable	*M*	*SD*	*M*	*SD*	t(17)	*p*
Long exposure	3.11	1.11	2.76	1.03	1.38	.18
Fascination	3.41	0.80	2.88	0.86	2.73	.02
Boring	2.88	1.17	3.29	1.05	-1.38	.17
Appealing	3.35	0.93	3.06	0.97	1.10	.29

Table 2.

Wilcoxon paired test for the within-subject difference in the ratings of both videos (high on SF vs. low on SF).

Variable	*Z*	*p*
Long exposure	-1.29	.20
Fascination	-2.31	.02
Boring	-1.31	.19
Appealing	-1.07	.28

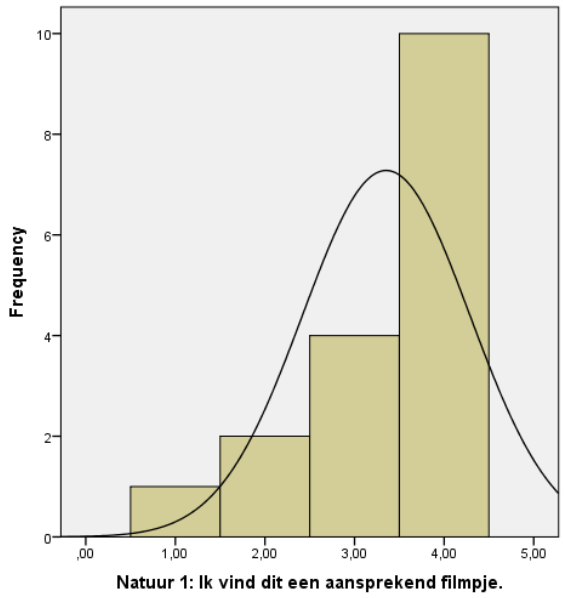

Figure 3. Normal distribution curve of the item "Appealing" on the video with nature high on SF.

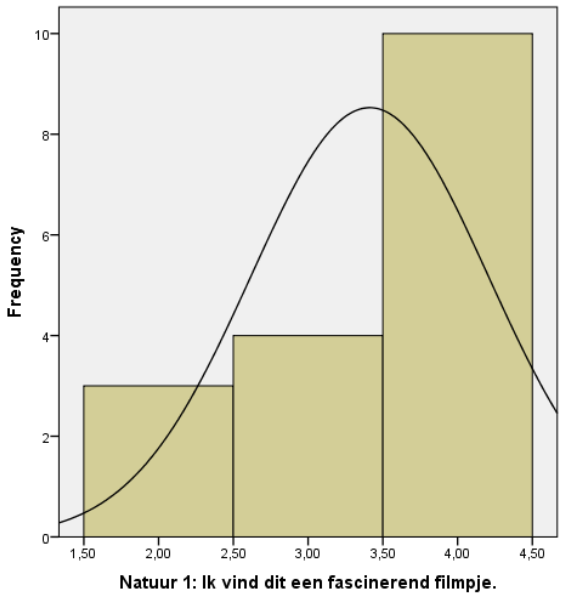

Figure 4. Normal distribution curve of the item "Fascination" on the video with nature high on SF.

Main Study

The average age was 72 years old in the high on SF on condition (n = 5, M = 72.2, SD =15.16). No missing values were found in the high on SF condition. Participants in the low on SF group had an average age of 70 (n = 5, M = 70.0, SD = 13.66). Two missing values were found in the low on SF group, one for the item "Interesting" and one for the item "Presence" (see table 3).

Table 3.

Descriptive statistics.

	High on SF		Low on SF		Full Sample	
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*
Age	72.2	15.61	70.0	13.66	71.1	13.88
Pre-test						
Mood_Feelings-before	1.60	1.34	2.40	1.95	2.00	1.63
Mood_Arousal-before	-.40	1.95	1.20	2.05	.40	2.07
Post-test						
Mood_Feelings-after	1.00	2.00	1.80	2.17	1.40	2.01
Mood_Arousal-after	.60	1.67	1.40	.90	1.00	1.33

POMS_nervous	-2.20	.84	-.80	1.10	-1.50	1.18
POMS_panic	-1.40	1.14	-1.00	1.73	-1.20	1.40
POMS_aroused	-1.40	1.14	-1.80	1.30	-1.60	1.17
POMS_restless	-1.20	1.30	-1.40	1.95	-1.30	1.57
POMS_anxious	-1.00	.71	-.40	.55	-.70	.67
POMS_insecure	-.60	.89	-.40	.55	-.50	.71
POMS_Mean	-1.30	.73	-.97	.83	-1.13	.76
Discomfort_insertion_ scope	5.00	1.22	3.60	2.19	4.30	1.83
Discomfort_after_ insertion	3.60	1.67	4.20	1.30	3.90	1.45
Experienced pain relief	9.00	1.00	8.00	1.87	8.50	1.51
Manipulation check						
fascination	.00	.71	.00	.71	.00	.67
Interesting[a]	-.40	1.14	.00	.82	-.22	.97
Presence[a]	-.60	1.14	.00	1.41	-.33	1.22

Note. [a]*n* = 4 in the low on SF condition.

Quantitative analysis. Firstly, the two Mood items were found to be one construct (Spearman correlation of .63, $p = .05$). A significant main effect of time was found for the Mood_Feelings ($F(1, 8) = 4.82$, $p = .059$) with $M = 2.00$ for the pre-test and $M = 1.40$ for the post-test. However, the decrease in Mood_Feelings indicated more negative Mood_Feelings at the post-test. This also indicated that VR nature was not effective. Furthermore, no significant interaction effect was found of time with condition for Mood_Feelings ($F(1, 8) = .19$, $p = .67$). The decrease on Mood_Feelings for the high on SF group was equal to decrease of the low on SF group (see figure 5). Secondly, no significant main effect of time was found for Mood_Arousal ($F(1, 8) = .00$, $p = 1.00$). This also applies for the interaction of Mood_Arousal with condition ($F(1, 8) = .37$, $p = .56$). Mood_Arousal increased slightly for the low on SF group and increased also for the high SF group (see figure 6). This indicated that both conditions experienced less arousal at the post-test as expected. Mood_Arousal increased more over time for the high on SF condition indicating that nature high on SF might have an stronger effect than nature low on SF.

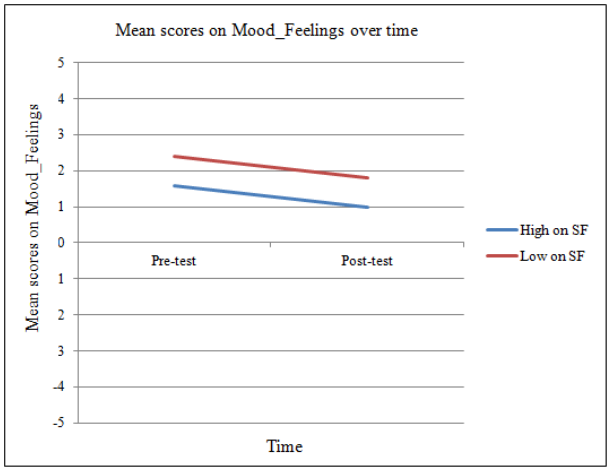

Figure 5. The effect of the two nature conditions on time for Mood_Feelings. Ranging from very bad (-5) to very good (5).

Figure 6. The effect of the two nature conditions on time for Mood_Arousal. Ranging from very aroused (-3) to very relaxed (3).

Secondly, no significant difference in scores on the POMS between the nature conditions was found (M = -1.13, $F(1, 8)$ = .46, p = .52). For the item Nervous (M = -1.50, $F(1, 8)$ = 5.16, p = .05) a significant difference between the groups was found and a possible trend was discovered for the item Anxious (M = -.70, $F(1, 8)$ = 2.25, p = .17). Participants in the high on SF condition scored -2.20 on Nervous compared to -.80 in the low on SF. Moreover, participants in the high on SF condition scored -1.00 on Anxious compared to -.40 in the low on SF condition. These results were not as expected.

Thirdly, before running the ANOVA for the final 6 items, the Spearman correlation for the 2 discomfort items were analysed for the high on SF condition (n = 5) and the low on SF condition (n = 5). No unequivocal answer was found whether or not the 2 items measured the same construct. Spearman correlation was .74 for the low on SF condition and .00 for the high on SF condition. Furthermore, no main effect was found for Nature (see table 4).

Table 4.

Main effect of Nature on POMS, Discomfort_insertion_scope, Discomfort_after_insertion, Experienced pain relief, Fascination, Interest and Presence.

	High on SF	Low on SF		
Variable	*M*	*M*	F (1, 8)	*p*
POMS_Mean	-1.30	-.97	.46	.52
Discomfort_insertion_scope	5.00	3.60	1.56	.25

Discomfort_after_insertion	3.60	4.20	.40	.55
Experienced pain relief	9.00	8.00	1.11	.32
Fascination	.00	.00	.00	1.00
Interesting	-.40	.00	.35	.58
Presence	-.60	.00	.50	.50

Nature groups. Firstly, qualitative analysis found that only 2 of the 5 participants in the high on SF condition showed a potential effect of nature. Secondly, no effect was found of nature for the low on SF condition. Only 4 of the 5 participants of the low on SF fascination condition were taken in consideration in the qualitative analysis because the participant pointed out that she did not look at the video glasses during the bronchoscopy. These results might indicate that nature high on SF potentially has a stronger effect than nature low on SF.

All scores of the Mood_Feelings item were plotted to compare groups (see figure 7) and also for Mood_Arousal (see figure 8). The difference between the pre- and post-test scores per participant were plotted for both groups for which no change is equal to 0. The high SF condition show more negative changes in resilience over time. Interestingly, individuals of the high SF condition show a stronger average resilience for Mood_Arousal than individuals in the low SF condition. Results for Mood_Feelings do not support the hypothesis but scores on Mood_Arousal do support the hypothesis. Difference of mean scores on the POMS between high and low on SF were also plotted (figure 9). Average scores on the POMS of the high SF condition scored slight lower than the low SF condition. This is in accordance with the expectations. For each group the items Discomfort 1 and 2, and experienced pain relief were plotted (see figure 10 and 11). As expected, participants in the low on SF condition experienced slightly less pain relief than participants in the high on SF condition. The scores on Discomfort 1 were also as expected, participants in the high on SF condition experienced slightly less discomfort than participants in the low SF condition. Interestingly, scores on Discomfort 2 showed no effect for nature conditions because scores for the low on SF and the high on SF condition were equal.

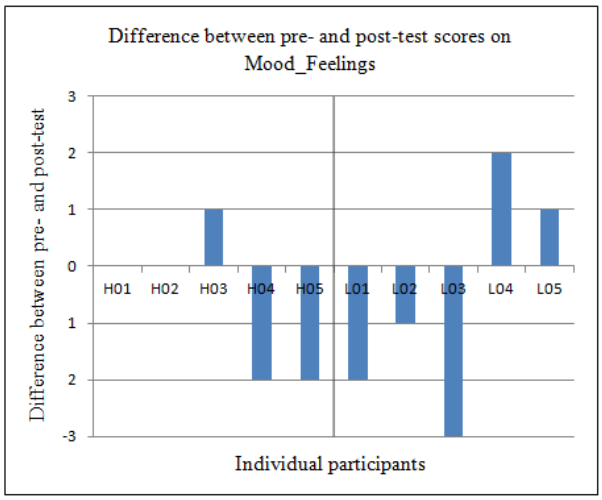

Figure 7. Individual difference between the pre-and post-test scores on Mood_Feelings per participant.

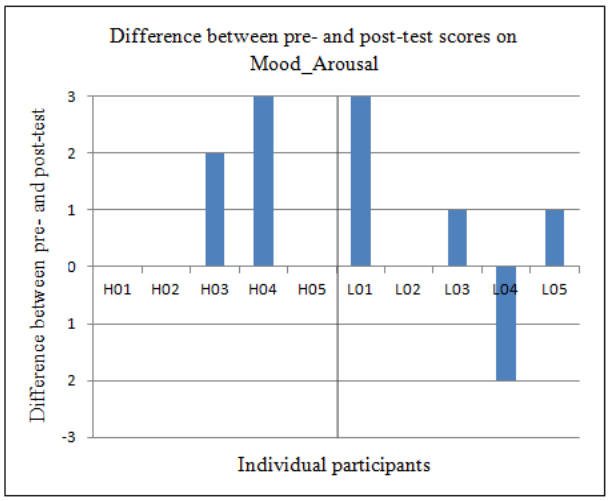

Figure 8. Difference between the pre- and post-test scores on Mood_Arousal per participant.

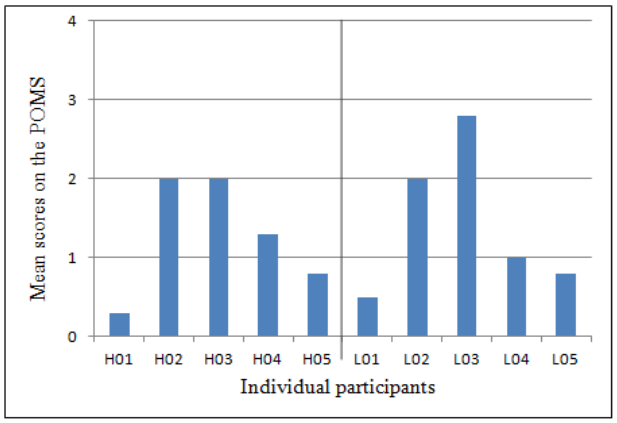

Figure 9. Mean scores on the POMS per participant.

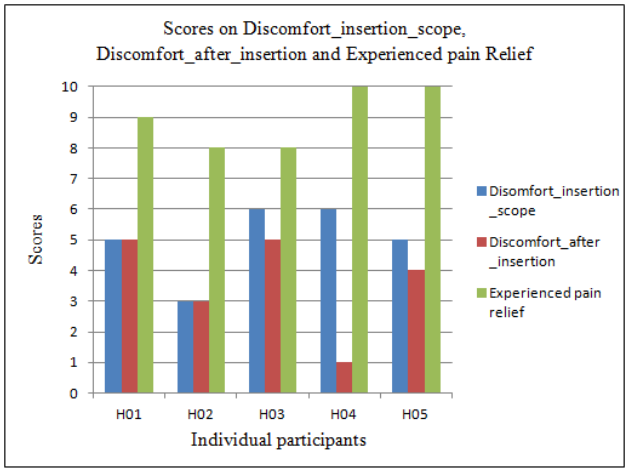

Figure 10. Individual scores of high SF conditions on the Discomfort items (0 = very uncomfortable; 10 = very comfortable) and experienced pain relief item (0 = very poor pain relief; 10 = excellent pain relief).

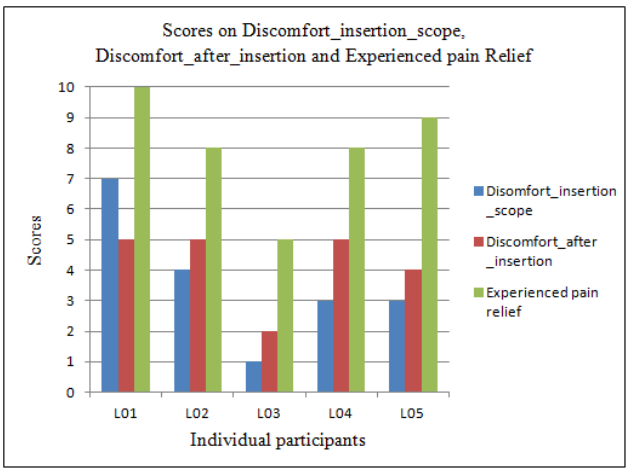

Figure 11. Individual scores of low SF conditions on the Discomfort items (0 = very uncomfortable; 10 = very comfortable) and experienced pain relief item (0 = very poor pain relief; 10 = excellent pain relief).

Discussion

Inspired by previous research on the restorative effects of nature views and quickly developing technology, the present research studied how health care can be improved with the aid of VR. Based on the processes of the attention restoration theory (Kaplan & Berman, 2010) and the restorative effect between nature high on SF and nature low on SF (Szolosi et al., 2014; Van den Berg et al., 2016), nature videos with sounds varying between high and low on SF were provided with the aid of video glasses to patients undergoing a bronchoscopy. First, a pre-test was done to confirm the degree of SF in the pre-selected nature videos. Following, in the main study perceived stress in patients undergoing a bronchoscopy were measured. Stress was expected to decrease more in the high on SF condition than in the low on SF condition.

Findings

Overall, a potential restorative effect of nature views was found based on qualitative analysis. Firstly, it is suggested that the nature views high on SF might decrease experienced arousal and experienced stress. Secondly, the findings of some participants in the high on SF condition showed a potential restorative effect of the nature views. Combining the results of the qualitative analysis, a trend exist that participants in the high on SF condition can potentially profit more from the nature views than participants in the low on SF condition. A stronger restorative effect for the high on SF condition might be found in further research

because nature views high on SF are suggested to have a stronger attention restorative effect (Kaplan & Berman, 2010) and reinforce effortless, automatic attention (Szolosi, et al., 2014; Van den Berg et al., 2016). Although the qualitative analysis suggested a potential effect of nature view, quantitative analysis found no effect of direct exposure of nature videos on psychological state as found by the study of Ulrich (1981; 1984). Results indicated that the pilot study failed to find significant differences in self-reported stress between the two nature groups.

Considering the results in more detail, the following has to be taken in account. Firstly, it was expected that experienced Mood_Feelings would improve relatively more for high on SF but instead Mood_Feelings worsened. It is suggested that nature views showed relatively no effect on Mood_Feelings over time because a slightly worsened mood can be expected after an invasive procedure. Secondly, Mood_Arousal increased for the high on SF condition but it is not certain whether or not the increase is a real improvement or a relative improvement. Against all expectations, for the whole sample Mood_Arousal significantly worsened, showing that participants were more aroused after the bronchoscopy than before. Thirdly, quantitative analysis failed to show an effect of nature view between high on SF and low on SF views on the average scores of the POMS. Overall, it is suggested that most participants did not experience extreme stress. This could indicate that nature views do have a possible effect on recovery from acute stress (Van den Berg & Custers, 2011). Moreover, as expected, qualitative analysis did suggest that individuals viewing nature high on SF experienced less stress than individuals viewing nature low on SF. Fourthly, looking at item level of the POMS, against expectations, participants experienced more nervousness in the high on SF condition compared to participants in the low on SF condition. Furthermore, a potential trend was found for anxiousness but also against expectations. The majority of the participants in the high on SF condition experienced more anxiety than participants in the low on SF condition. Finally, for discomfort and experienced pain relief the main study revealed no effect of nature conditions. The experienced pain relief in both nature groups indicated that most people did not experience a lot of pain. This could be caused by the effect of nature views because nature views are suggested to decrease pain and discomfort during bronchoscopy (Diette et al., 2003). However, it is not clear to what extent the local sedation or the nature views contributed to the experienced pain relief. Relatively, most patient experience discomfort during the bronchoscopy which is not in line with the results found by Diette et al. (2003).

Comparing results of the pre-test with the main study. Firstly, the results of the pre-test showed that the nature videos pre-selected in the high on SF condition were thought to be more fascinating than the nature videos pre-selected in the low on SF condition according to the participants. In contrary to the pre-test, results on the item Fascination in the main study failed to show a stronger fascination score for nature high on SF than for nature low on SF. This may explain the lack of consistent findings in favour of nature high on SF. Secondly, in the pre-test participants did not experience nature high on SF as less boring or more appealing than nature low on SF which indicated that both nature videos contained the element of soft-fascination (Kaplan & Berman, 2010). This may also explain the lack of consistent findings in favour of nature high on SF. Finally, in the main study one participant in the low on SF condition did not fill in the items Presence and Interesting. It was chosen to ignore these missing values because the main purpose was to test the degree of fascination in the nature views. Results showed that participants in the high on SF condition did not feel more immersed in the nature environment and did not consider the nature videos as more interesting than participants in the low on SF condition.

Limitations

Firstly, while interpreting the results it is important to consider that the main study is a pilot of a follow up study that will investigate the effect of VR nature with sounds. The main study was not a 'true' experiment because the research design did not include a control group and the participants were not randomly assigned (Walker, 2005). This may limit the external validity of the findings because it does not take in consideration whether or not the VR nature significantly improves mood and reduces stress compared to a no-VR nature control group. Secondly, during the three weeks of data collection 10 participants were enrolled. With a sample size of $N = 10$, the planned analysis did not have enough power to report significant results. Thirdly, in the present research Repeated Measures were used to analyze the mood items and to report a potential interaction between time and nature condition. To perform a Repeated Measures the data of the two groups must have a normal distribution. In the present research it was chosen not to check for the normal distribution because of the exploratory nature of this pilot study and the small sample size ($N = 10$). This also applies on the ANOVAs. Finally, it is important to consider that the results of both the pre-test and the main study are based on self-reported measures. A variety of biases can influence the outcome of self-reported data. An example of a bias that was likely to occur in the present study is the influence of the researcher. The presence of the researcher might have elicited participants to score the items more positive than their real psychological state (Watson & Clark, 1991).

Moreover, self-report measures of a pre- and post-tests might also be biased by the response-shift bias. The response shift bias indicates that the interpretation of the items might be contaminated by the intervention and change the way participants responds to the post-test (Howard, 1980). This may lower the validity of the given responses and influence the findings of the effect of nature. To confirm if the self-report measures are not contaminated by these biases, the follow up research should also analyze the physiological data measured during the research.

Feasibility. Another objective of the pilot study was to investigate the feasibility of the intervention and to explore the possible effects of the intervention. The slow data collection and the small sample size were due to the following regularly occurring exclusion criteria's. Firstly, people undergoing a bronchoscopy were mostly above the age of 50 which increased the chance of having hearing aid or impaired vision. The earplugs used during the research were not suitable for participants with hearing aid. Besides, the effect of nature sounds could not be measured effectively because the ear plugs provided with the glasses failed quickly and the nature sounds were not very audible through the ear plugs. Secondly, the video glasses could only be used for people with impaired vision who had small glasses, otherwise the video glasses could not be implemented. In some cases the glasses did not stay in a good position on the nose while patients laid down, forcing the patients to roll their eyes upwards to be able to watch the video. Thirdly, the participant flow also depended on the hospitals schedule. The bronchoscopy was only executed in the morning with a maximum of 6 patients in the morning. The amount of 6 patients in a morning was never reached because some of the potential participants received full sedation or did not master the Dutch language sufficiently. These two exclusion criteria caused the number of possible participants drop to 1 to 3 patients a day.

The potential feasibility of this intervention in clinical practice is an important issue. In case the intervention appears to be effective, the intervention is easy to implement in the protocol of the bronchoscopy and the video glasses are very easy to use by hospitals personnel or researchers. Further limitations of the feasibility of the intervention were that observations during this pilot suggested that many participants prefer to look at the monitor of the bronchoscopy rather than focussing their attention on the video glasses. In several cases participants stated that looking at the images of their lungs is more interesting than looking at the nature video. Others who did seek relaxation preferred to close their eyes rather than looking at the nature scenes.

Future research

Firstly, it is recommended for the follow up research to use a randomized controlled trial to confirm the effect of the intervention because direct comparison between the intervention and control groups should be used when measuring the effect of the intervention (Bucher, Guyatt, Griffith & Walter, 1997). Secondly, future research should randomly assign participants and participants should not know in which group they are allocated. Therefore, all participants should be provided with video glasses but the control group should watch other than nature videos. This will tackle possible distraction effect of using video glasses that many studies found (Bentsen, Svensson & Wenzel, 1999) and it will enable to measure only the effect of the nature videos without any systematic differences between participants being the reason for the outcome (Sibbald, Roland, 1998). Thirdly, future research should gather more participants to investigate whether or not the two nature groups have different effects on anxiety and stress. Recent research, using a more participants ($N = 70$), found that VR nature reduced pain and made the experience of invasive procedures during dental treatment a less negative experience (Tanja-Dijkstra, Pahl, White, Auvray, Stone, Andrade, May, Mills & Moles, 2017). This indicates that research with a bigger sample size could find an effect of nature view. To reach the minimum necessary amount of participants, it is suggested to plan at least 24 week for data collection to reach $N = 80$. Finally, it is important to consider the mood items as one construct to measure average mood of the participants. Moreover, future research should also examine whether or not the two discomfort items measure one construct because a good reliability was found in the low SF conditions.

To increase the feasibility of future research the following things are recommended. Firstly, the exclusion criteria of hearing-aid should be omitted so these patients can still profit of the nature views without using the earplugs. Secondly, to measure the effect of nature sounds effectively, it is recommended to use high quality earplugs or let patients take their own earplugs if patients agree to participate in the intervention. Thirdly, to take full advantage of the videos glasses, the glasses should be adjustable to provide a good fit for the patient so they won't slid up the nose. To eliminated the exclusion criteria about impaired vision, the video glasses should also be adjustable to the visual impairment of the participants. An example of adjustment could be glasses with length-adjustable arms to decrease or increase the distance of the glasses from the eyes. Finally, it is suggested that the intervention may need to be targeted to participants' preferences because certain patients prefer to relax by closing their eyes or to look at the monitor of the bronchoscopy.

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Appendix

A. Pre-test questionnaire

Filmpje 1:

Ik zou lang naar het filmpje kunnen kijken.

Helemaal mee oneens	Mee oneens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Ik vind dit een fascinerend filmpje.

Helemaal mee oneens	Mee oneens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Ik vind dit filmpje saai.

Helemaal mee oneens	Mee oneens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Ik vind dit een aansprekend filmpje.

Helemaal mee oneens	Mee oneens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Filmpje 2:

Ik zou lang naar het filmpje kunnen kijken.

Helemaal mee oneens	Mee oneens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Ik vind dit een fascinerend filmpje.

Helemaal mee oneens	Mee oneens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Ik vind dit filmpje saai.

Helemaal mee oneens	Mee oneens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Ik vind dit een aansprekend filmpje.

Helemaal mee oneens	Mee oneens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

B. Dutch questionnaire

Voorafgaand aan de bronchoscopie

Algemene vragen

1 Bent u een man of een vrouw?

- ❑ Man
- ❑ Vrouw

2 Wat is uw geboortedatum?

Dag *Maand* *Jaar*

☐☐ - ☐☐ - ☐☐☐☐

Mood-feelings

Wat is uw stemming op dit moment?

Heel slecht		Slecht		beetje slecht	Neutraal	beetje goed		Goed		Heel goed
-5	-4	-3	-2	-1	0	1	2	3	4	5

Mood-arousal scale:

De volgende schaal meet hoe ontspannen/kalm ofwel gespannen/onrustig u zich voelt. Omcirkel het nummer dat het best weergeeft hoe u zich voelt op dit moment.

Ik voel me op dit moment:

Ontspannen, kalm			Neutraal			gespannen, onrustig
-3	-2	-1	0	1	2	3

Na de bronchoscopie
Mood-feelings (stemming van patiënt)
Wat is uw stemming op dit moment?

Heel slecht		Slecht		beetje slecht	Neutraal	beetje goed		Goed		Heel goed
-5	-4	-3	-2	-1	0	1	2	3	4	5

Mood-arousal scale:

De volgende schaal meet hoe ontspannen/kalm ofwel gespannen/onrustig u zich voelt. Omcirkel het nummer dat het best weergeeft hoe u zich voelt op dit moment.

Ik voel me op dit moment:

Ontspannen, kalm			Neutraal			gespannen, onrustig
-3	-2	-1	0	1	2	3

POMS:

Hieronder staan een aantal woorden die verschillende emoties en gevoelens beschrijven. Geef bij elk woord aan in hoeverre het beschrijft hoe u zich voelde tijdens de bronchoscopie.

Gebruik de volgende schaal en zet het kruisje in het vakje dat van toepassing is.

---

0 = absoluut niet 1 = zwak 2 = matig 3 = sterk 4 = heel sterk

1. ZENUWACHTIG

   0 1 2 3 4

2. PANIEKERIG

   0 1 2 3 4

3. GESPANNEN

   0 1 2 3 4

4. RUSTELOOS

   0 1 2 3 4

5. ANGSTIG

   0 1 2 3 4

6. ONZEKER

   0 1 2 3 4

Procedureel ongemak: verbale rating schaal:

Hoe prettig of onprettig vond u het inbrengen van de bronchoscoop?

Zeer onprettig	1	2	3	4	5	6	7	8	9	10	Zeer prettig

Hoe prettig of onprettig vond u het verloop van de bronchoscopie na het inbrengen van de bronchoscoop?

Zeer onprettig	1	2	3	4	5	6	7	8	9	10	Zeer prettig

Hoe goed of slecht werkte de verdoving die u heeft gekregen tegen pijn tijdens de bronschoscopie?
Om cirkel het cijfer wat het meest van toepassing is voor u.

Zeer slecht, ik vond de procedure erg pijnlijk	1	2	3	4	5	6	7	8	9	10	Zeer goed, ik vond de procedure geheel niet pijnlijk.

Ik vind dit een fascinerend filmpje.

Helemaal mee oneens	Mee oneens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Dit filmpje bleef me boeien tijdens de operatie

Helemaal mee oneens	Mee oneens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

Ik had het gevoel echt in de omgeving aanwezig te zijn.

Helemaal mee oneens	Mee oneens	Neutraal	Mee eens	Helemaal mee eens
☐	☐	☐	☐	☐

C. Qualitative analysis per participant

H01

Firstly, the participant H01 (high on SF, participant 1) showed no effect on both Mood_Feelings and Mood_Arousal over time and scored both items 3 on the pre-test and post-test (figure 1). The participant on average did not experience stress during the procedure with only moderate nervousness and the score of 0 of the other items. Despite low scores on the POMS, the participant experienced the whole procedure as a little uncomfortable with both discomfort items scored 5. Finally, experienced pain relief had a score of 9 out of ten.

H02

No effect over time on Mood_Arousal and Mood_feeling was found. Mood_Arousal was scored -1 before and after the procedure, and Mood_Feelings was scored 3 before and afterwards (figure 2). The participant showed consistency on the items Mood_Arousal and the item "Arousal" of the POMS with both scores equal to moderately aroused. The average score of the POMS was 2 which indicates that the participant experienced moderate stress levels. Moreover, the consistency of the Mood_Arousal and Arousal of the POMS is also visible in the scores on the discomfort items which were scored a 3 out of 10. This indicated that the bronchoscopy was experienced as very uncomfortable. Despite the low score on discomfort indicating high discomfort, experienced pain relief through local sedation was good with a score of 8 out of 10.

H03

An evident a positive effect was found for Mood_Feelings item and also for Mood_Arousal. Mood_Arousal increased from a little aroused (-1) to a little relaxed (1) (see figure 3). The participant was aroused during the bronchoscopy, scoring 3 on the item "Aroused" of the POMS. The average scores of the POMS were between 2 and 3. This indicates that the participant was moderate to strongly stressed. Furthermore, the participant scored 6 on discomfort for the insertion of the bronchoscope and 5 on discomfort from the whole procedure. Finally, the experienced pain relief was scored 8.

H04

Mixed results were found for time on the 2 Mood items. Mood_Arousal showed a positive effect with an increase from -2 to 1, and Mood_Feelings showed a negative effect with a decrease from 1 to -1 (see figure 4). During the procedure the participant experienced moderate stress with an average score of 2 on the POMS. The item "Restless" from the POMS was scored strongly (3) and scores on discomfort of the full procedure were scored 1 (very uncomfortable). Finally, the discomfort of insertion of the scoop was scored 6 and no pain has been experienced with a score of 10 on experienced pain relief.

H05

Interestingly, the participant showed a negative effect on Mood_Feelings over time from 1 to -1 but Mood_Arousal showed no effect (figure 5). The average score on the POMS was weak with a stress score of 1. Discomfort scores were low with a score of 5 on discomfort of insertion of the scoop and 4 on the whole procedure. However, the participant scored 10 on experienced pain relief.

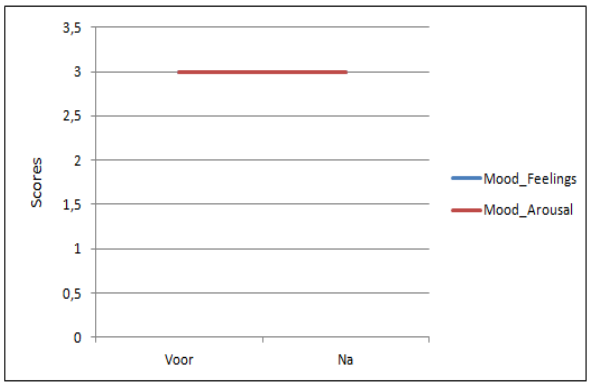

Figure 1. Scores on the pre-test and post-test of the two Mood items of participant H01.

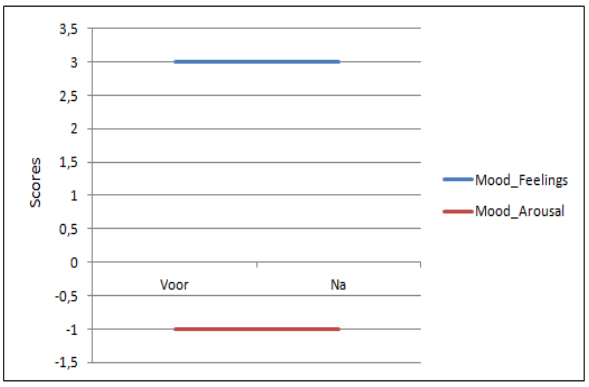

Figure 2. Scores on the pre-test and post-test of the two Mood items of participant H02.

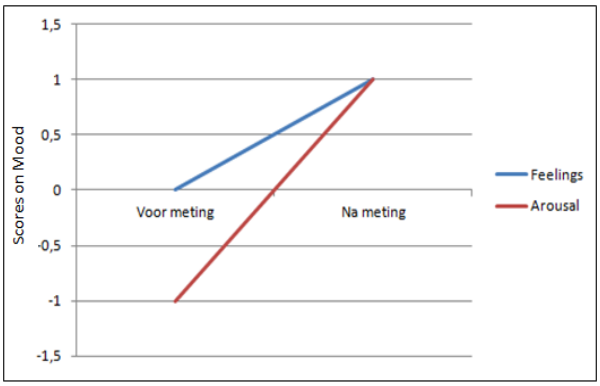

Figure 3. Scores on the pre-test and post-test of the two Mood items of participant H03.

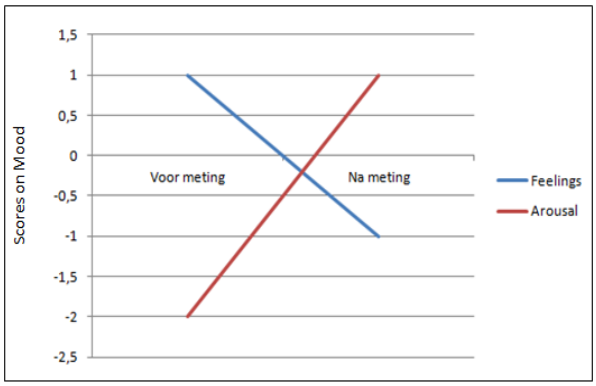

Figure 4. Scores on the pre-test and post-test of the two Mood items of participant H04.

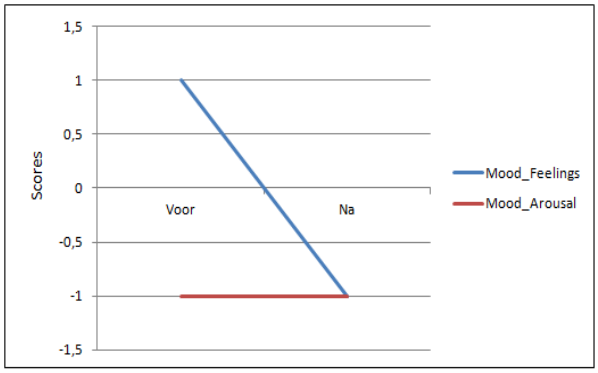

Figure 5. Scores on the pre-test and post-test of the two Mood items of participant H05.

L01

For participant L01 (Low on SF, participant 1) a negative effect was found for Mood_Arousal with a higher score on the post-test than on the pre-test but a positive effect was found for Mood_Feelings with a lower score on the pre-test than on the post-test (see figure 6). Very little stress was indicated by the POMS with a moderate score (2) on "Nervous", weak (1) on "Aroused" and 0 on the other 4 items. The participant experienced little discomfort during the insertion of the scoop (7) and discomfort of the whole procedure was scored 5. Finally, the participant scored 10 on experienced pain relief, indicating he had no pain during the bronchoscopy with the aid of the local sedation.

L02

Despite that the participant scored "relaxed" on Mood_Arousal over time (see figure 7), the participant indicated that he felt moderately tensed (2) on the "Aroused" item of the POMS. The average score of the POMS did not indicate that the participant was stressed during the procedure with a score close to 0. Discomfort of the insertion of the scoop was scored 5 and the whole procedure 4 showing that the participant experienced the procedure as quite uncomfortable. Experienced pain relief was score 8 so the local sedation worked good and the participant did not experience pain.

L03

Firstly, the overall a negative effect for Mood was found during the bronchoscopy. Mood_Feelings decreased the strongest for the participants from 3 to 0 and Mood_Arousal decreased slightly from 3 to 2 (see figure 8). This decrease in Mood is also visible in the average stress score of the POMS which was moderate stressed (4). The score of Mood_Arousal also matched with the score "very strongly" (4) on the item "Aroused" of the

POMS. Moreover, the discomfort of the insertion of the scoop was scored very uncomfortable (1) and the whole procedure was experienced as very uncomfortable too with a score of 2. Finally, the participant experienced some pain during the procedure with a score of 5 on experienced pain relief.

L04

The scores on the Mood items were contradictory with a positive effect of Mood_Feeling over time and a negative effect of Mood_Arousal (see figure 9). Also the item "Aroused" of the POMS was scored moderately. Moreover, the items "Restless" was strongly experienced and "Anxiety" was moderately experienced. On average the participant was moderately stressed during the procedure, scoring 2 on the POMS. Furthermore, the insertion of the scoop was scored 3 on discomfort and the full procedure 5. Finally, the participant scored experienced pain relief an 8 out of 10.

L05

This participant did not see a lot of the video during the bronchoscopy and indicated that she had her eyes closed. On Mood_Arousal and on Mood_Feelings a positive effect was found with scores increasing from -1 to 0 over time (see figure 10). The participant experienced weak stress levels during the bronchoscopy on the POMS. The score on the item "Aroused" on the POMS was in accordance with the score on Mood_Arousal and was scored weakly (1). Overall the participant experienced the procedure as uncomfortable with a 3 on the insertion of the scoop and 4 on the whole procedure. Finally, the local sedation against pain worked correctly with a 9 out of 10 on experienced pain relief.

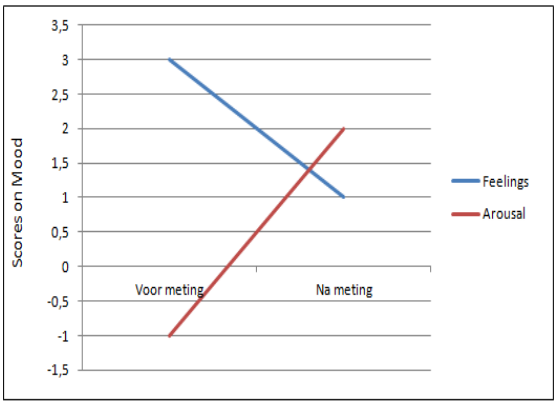

Figure 6. Scores on the pre-test and post-test of the two Mood items of participant L01.

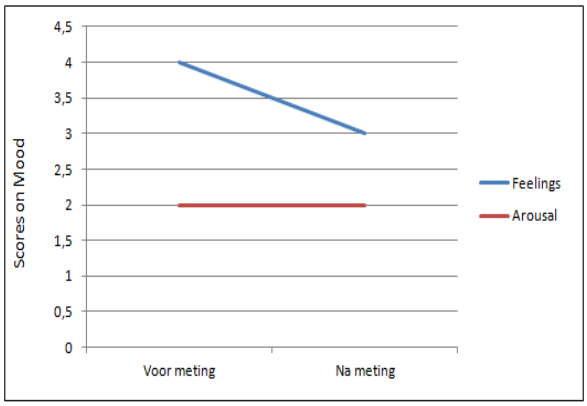

Figure 7. Scores on the pre-test and post-test of the two Mood items of participant L02.

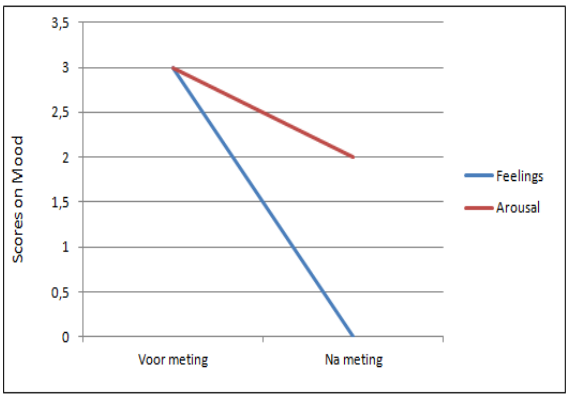

Figure 8. Scores on the pre-test and post-test of the two Mood items of participant L03.

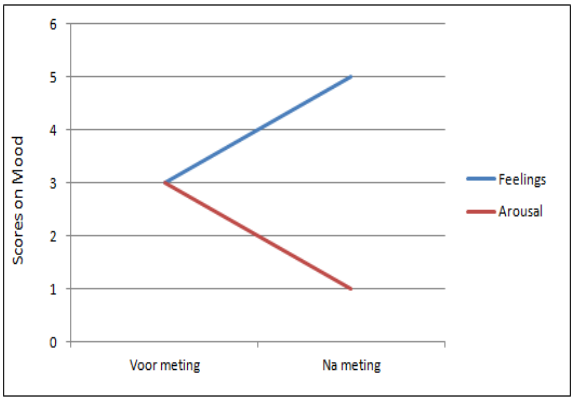

Figure 9. Scores on the pre-test and post-test of the two Mood items of participant L04.

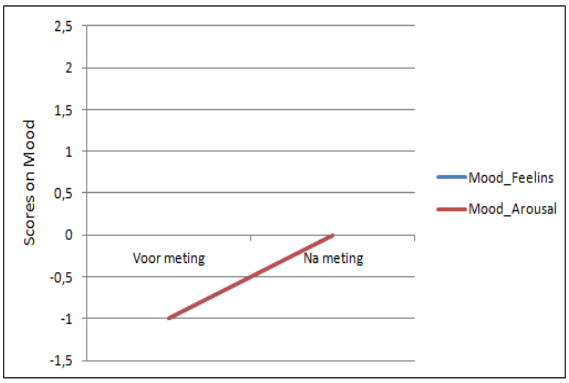

Figure 10. Scores on the pre-test and post-test of the two Mood items of participant L05.