Psychological and Physiological Effects of Virtual Nature Environments on Well-Being of Bronchoscopy Patients

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Abstract

Background. Inspired by research demonstrating positive effects of nature on well-being of patients, the present research aimed to examine the psychological and physiological effects of virtual nature environments varying in 'soft-fascination' (SF) on stress, anxiety, and pain. **Method**. Participants (*N* = 19) undergoing bronchoscopy, a highly stressful invasive procedures, were exposed by a head-mounted display and headphones to nature images and sounds. Effects of these virtual nature envinroments high (*n* = 9) and low (*n* = 10) on SF elements were compared during the procedure. Questionnaires measured mood and arousal at pretest, posttest, and follow-up. The posttest questionnaire also included mood states, discomfort, pain relief, fascination and distraction. The follow-up questionnaire a week after bronchoscopy measured recalled experiences with the procedure. Heart rate during bronchoscopy was recorded in beats per minute by Empatica E4.

Results. Results showed no conclusive evidence, although results suggested beneficial effects of nature exposure. Single-case analyses of heart rate showed damped peaks during insertion and faster decreases after insertion during nature exposure, especially for participants low on SF. Furthermore, quantitative and qualitative results seemed to indicate more beneficial effects of nature low on SF elements on mental well-being and physiological recovery. Participants low on SF experienced less nervousness and discomfort after insertion. Recalled experiences a week later were more positive in the low on SF condition.

Discussion. These findings demonstrate the potential beneficial impact of virtual nature exposure on improving well-being during medical procedures, especially by nature low on SF. Future research might further clarify the role of nature exposure and soft-fascination to improve mental and physical well-being of health care patients.

Keywords: virtual nature, well-being, soft-fascination, heart rate, bronchoscopy.

Effects of Virtual Nature Environments on Well-Being of Bronchoscopy Patients

Anxiety, stress, and pain are frequently experienced by patients in healthcare settings. These experiences are not restricted to moments before and after medical procedures, as these negative feelings are also experienced during medical practices. Especially patients undergoing invasive procedures experience adverse psychological reactions (Poi, Chuah, Srinivas, & Liam, 1998). An invasive medical procedure is bronchoscopy, which is an endoscopic technique to create an image of the inside of the airways (Chadha, Kulshrestha, & Biyani, 2015). This procedure can be painful and frightening and therefore negatively influence well-being (Lechtzin et al., 2000; Mori et al., 1993; Poi et al., 1998). Research shows that 68 percent of bronchoscopy patients experiences anxiety, stress and pain before and during the procedure (Mendes de Leon, Bezel, Karrer, & Brandli, 1986). This can impair willingness to undergo treatment and thus it is important to reduce these experiences (Redelmeier, Katz, & Kahneman, 2003).

Moreover, stress and anxiety can have additional negative effects on well-being of patients. Stress is a response to a potentially negative event provoked by a sense of psychological or physical harm or by a sense of possessing insufficient resources (Baum, Fleming, & Singer, 1985). Negative manifestations of stress include worrisome thoughts, feelings of helplessness and anxiety, sleeplessness, and avoidance (Gatchel, Baum, & Krantz, 1989; Ulrich, 1999; Ulrich et al., 1991). Through these manifestations, the individual is mobilized for coping with the stressful situation which requires energy and increases fatigue (Ulrich, Zimring, Quan, & Joseph, 2006). Furthermore, stress and anxiety can impede medical procedures by complicating these procedures. Reducing stress and anxiety is therefore beneficial for the healthcare system, by means of quicker procedures, reduced costs, and increased healthcare quality (Anderson & Masur, 1983). Additionally, stress and anxiety can result in anticipatory fear for future medical procedures. This can lead to no-shows, cancelled appointments, and treatment non-compliance (Kleinknecht & Bernstein, 1978).

In addition to anxiety and stress, many patients experience pain during bronchoscopy, despite use of anesthesia (Lechtzin et al., 2000; Prakash, Offord, & Stubbs, 1991). Increased anxiety and stress levels can lead to more intense pain experiences. Consequently, reducing anxiety and stress can attenuate pain (Arntz & Claassens, 2004). Results of Johnson, Morrissey, and Leventhal (1973) show that little or no sedation is needed for patients undergoing endoscopy if their fears are reduced. This decrease in anesthesia is beneficial, as sedation has possible side-effects including a risk of bradycardia, hypotension, and cardiovascular instability (Chadha et al., 2015). Unsedated bronchoscopy can reduce complications and improve procedures, which can lead to quicker procedures and increased cost-efficacy (Anderson & Masur, 1983; Pickles, Jeffrey, Datta, & Jeffrey, 2003). Therefore, it is important to reduce negative manifestations of stress, anxiety, and pain during bronchoscopy to decrease the psychological impact. For this reason, the present study examines patients' bronchoscopy experiences to improve negative effects of the procedure on well-being.

Healing Environments and Nature

To improve well-being of these patients, the physical environment can be influential by reducing negative and increasing positive emotions (Malkin, 2008). These psychologically supportive healthcare settings are referred to as healing environments, which indicates well-being enhancement and recovery improvement (Sternberg, 2009; Watts, Khan, & Pheasant, 2016). Therefore, environmental design is important in influencing experiences by exposure to physical characteristics with stress-reducing and well-being improving effects (Arneill & Devlin, 2002). Research has found many features influencing well-being, for instance low sound levels, sunlight exposure, and art (Daykin, Byrne, Soterioud, & O'Connor, 2008; Walch et al., 2005; Watts et al., 2016).

Of particular interest to the present context, a considerable research shows that natural elements can be useful in settings where individuals experience high levels of stress, like healthcare settings. Park and Mattson (2009) found that plants and flowers in rooms of patients recovering from thyroid gland removal were shorter hospitalized, required less anesthesia, experienced less pain, fatigue and anxiety and more positive emotions. In addition, Ulrich's (1984) findings show that window nature views after gallbladder removal affected the experiences of patients positively, resulting in shorter hospitalizations and less anesthesia compared to viewing a brick wall.

Psychological Effects of Nature

Nature can thus positively affect well-being of healthcare patients. The underlying mechanism of nature responsible for this influence is explained differently by theories on stress reduction, distraction, and attention restoration.

Stress reduction theory. Ulrich (1983) explains the stress reducing effect of nature by the stress reduction theory (SRT). According to this theory, viewing nature stimulates positive affective responses and physiological recovery of arousal. Exposure to nature results in positive affective responses which initiate restoration of stress, by reduced arousal levels and negative feelings as anxiety (Hartig, Nyberg, Nilsson, & Gärling, 1999; Ulrich, 1983). According to Ulrich (1983), this effect is caused by aesthetic and affective preferences for nature settings. Environments containing aesthetic preferred properties, like depth and water, elicit positive emotions, decrease physiological arousal, and inhibit negative affect (Barton & Pretty, 2010; Ulrich, 1983).

Distraction. Distraction is another possible mechanism underlying positive effects of nature exposure on mental and physical health. Distraction by means of nature can positively influence well-being by reducing pain, stress, and anxiety before, during, and after medical practices (Diette, Lechtzin, Haponik, Devrotes, & Rubin, 2003; Lang et al., 2000). This is because distraction diverts attention from unpleasant experiences towards a more pleasant experience, the nature environment. As a result, pain and stress are perceived as less intense

(Terkelsen, Andersen, Mølgaard, Hansen, & Jensen, 2004). Therefore, nature can be influential in improving well-being.

Attention restoration theory. Besides reinforcing positive affect by stimulating physiological recovery and diverting attention, nature can be effective in reducing stress and anxiety by restoring attention (Diette et al., 2003; Fernandez, 1986; Gidlow et al., 2016). The attention restoration theory (ART) of Kaplan (1995) divides attention into involuntary and voluntary attention. Involuntary attention is drawn bottom-up by intriguing or important stimuli. Voluntary or directed attention is allocated by top-down cognitive control processes, which suppress distracting stimuli (Gregory, 1970; James, 1892). Therefore, directed attention requires effort and is therefore susceptible to fatigue. This can lead to less effective focusing, mental fatigue, stress, and anxiety (Kaplan, 1995; Kaplan & Berman, 2010).

According to the ART, nature environments are restorative through restoration of directed attention in interaction with nature. Nature environments contain inherently fascinating stimuli that modestly capture involuntary attention. These stimuli are effortlessly engaging and automatically attracting (James, 1892). This minimalizes required directed attention and allows directed attention to restore. This replenishment of directed attention is crucial for effective cognitive functioning, which can reduce stress and anxiety (Kaplan, 2001; Kaplan & Kaplan, 1981, 1989). Consequently, nature environments can be effective in stress and anxiety reduction by attention restoration. However, not every nature setting contains these restorative effects.

Soft-fascination. In order to be restorative, nature environments need to contain 'soft-fascination' (SF) elements. Fascination intensity varies along a 'soft-hard' dimension (Kaplan, 1995). Soft-fascination has a moderate intensity, contains attractive stimuli and allows attention restoration by capturing attention without effort. This type of fascination is common in nature, for instance as sunsets and movement of trees, plants, and water (Felsten, 2009; Herzog, Black, Fountaine, & Knotts, 1997; Kaplan, 1995). In contrast, hard-fascination elements capture attention dramatically, as in a traffic situation. This overloads the attentive system. As a result, it does not allow restoration of attention resources (Berto, 2014).

Depth and spaciousness. In addition to soft-fascination, depth and spaciousness are important features. Positive relations are identified between depth and aesthetic preference for nature environments (Craik, 1970; Ulrich, 1983). Spaciousness is influential by providing feelings of being able to wander into the nature setting. Moreover, open views provide overview over the environment. This can result in feeling able to anticipate potential threat, which can make people feel comfortable (Appleton, 1975). Therefore, nature views containing depth and spaciousness are preferred to narrow views with restricted depth (Brush, 1978). As a result, these elements might decrease stress and elicit positive affect.

Water. Furthermore, water is important in evoking interest and positive affect (Hubbard & Kimball, 1967). Nature scenes containing water are generally highly preferred and evaluated as pleasant (Kaplan & Kaplan, 1989; Shafer, Hamilton, & Schmidt, 1969). This corresponds to findings of Barton and Pretty (2010), showing that water is influential in improving mood and reducing stress and arousal.

Nature sounds. Besides nature views, nature sounds are effective in improving well-being. Diette et al. (2003) found that adding sounds to nature scenes reduces pain during bronchoscopy. Results of Alvarsson, Wiens, and Nilsson (2010) show that nature sounds facilitate stress recovery. In addition, findings of Annerstedt et al. (2013) indicate that nature sounds elicit positive reactions and stimulate recovery.

Artificial nature

However, real nature exposure is not always possible in healthcare. Due to architectural difficulties, window nature views cannot be present in every room. Bringing in real nature in healthcare can also result in infections and thus be discouraged for hygienic concerns (Kates, McGinley, Larson, & Leyden, 1991). Artificial nature is a solution, as it can be present in every room without infection risks of plant bacteria. Compared to effects of real nature, artificial nature can also improve well-being. Beukeboom, Langeveld, and Dijkstra (2012) found that stress was reduced by both real plants and posters of plants in hospital waiting rooms. Findings of Heerwagen (1990) show patients visiting a dental fears clinic experienced less stress when viewing a painted nature scene on the waiting room wall. In another study, heart surgery patients exposed to nature photographs experienced less postoperative anxiety compared to abstract and no photographs (Ulrich & Lundén, 1990). These findings show that simulated nature is influential in shortening of hospitalizations, decreasing need for anesthesia, and reducing pain, stress, and anxiety. Therefore, this study will apply simulated nature to examine effects of nature exposure on well-being of patients by using nature videos and sounds.

Nature in the present study

In the present study, effects of two virtual nature environments varying in soft-fascination will be compared. Based on previous research, it is expected that exposure to natural environments distracts patients from the unpleasant bronchoscopy, reduces stress by reinforcing positive affective states, and enhances positive emotion by attention restoration. Both nature videos possess these capacities. Therefore, the following hypothesis is formulated:

Less negative responses are experienced after exposure to the high and low on SF nature environments.

However, the environments differ in soft-fascination elements. Depth is created in the video high on SF by viewing nature scenes from the front. In the video low on SF, nature is viewed from above which results in limited depth. In addition, in the video high on SF a larger part of the total view consists of water and water is present more on the foreground, compared to the video low on SF. This because water elements are aesthetically important and effective in restoring attention (Kaplan & Kaplan, 1989; Ulrich, 1983). Moreover, water in the high on SF video flows faster and more intense than in the low on SF video, in which water is almost stagnant. Wind is also more present in the video high on SF, which results in more movement of trees and plants. This flowing water and waving of plants are influential soft-fascination elements (Felsten, 2009; Herzog et al., 1997). Therefore, sounds of water and wind are also louder in the video high on SF. These factors contribute to the expectation that experiences with bronchoscopy of patients watching the video high on SF will be less negative and result in the hypothesis:

Participants will experience less negative responses during bronchoscopy when being exposed to the nature environment high on soft-fascination, compared to participants exposed to the environment low on soft-fascination.

Moreover, willingness to undergo further treatment based on expectations of future treatment is influenced by recollections of previous experiences (Kent, 1985; Redelmeier et al., 2003). In addition to improvement of well-being during medical procedures, it is thus important to reduce negative recollections of the procedure. Research of Tanja-Dijkstra et al. (2014) shows reduced vividness and intrusiveness of memories one week after the medical procedure with virtual nature exposure. According to the Elaborated Intrusion theory, mental imagery is crucial in determination of behavior. Virtual nature might interrupt development of negative mental images, which can result in better experiences and more positive treatment recollections in retrospect (Boomsma, Pahl, & Andrade, 2016; Kavanagh, Andrade, & May, 2005). Therefore, it is expected that:

Patients evaluate the bronchoscopy in retrospect more positively, compared to the posttest evaluation.

Additionally, it is hypothesized that the nature environment high on SF is more restorative:

Participants exposed to the nature environment high on soft-fascination report a more positive retrospect a week after the bronchoscopy, compared to low on SF exposure.

Physiological Effects of Nature

In addition to psychological effects, nature exposure has physiological effects. Physiological and psychological reactions are connected and do not occur independently (Fisher, Bell, & Baum, 1984). Therefore, both physiological and psychological data will be examined in the present study. Stress and anxiety are not restricted to psychological expressions. These states influence the antagonistic autonomic sympathetic (SNS) and parasympathetic (PNS) nervous system, which control nerves that stimulate the heart. Sympathetic nerve stimulation controls activation and mobilization and increases heart rate. Parasympathetic vagal nerve stimulation controls recovery and relaxation and decreases heart rate (Andreassi, 2007; Guyton & Hall, 2006). Anxiety and stress are characterized by SNS activation and PNS inhibition, which lead to an increased heart rate (Hansson & Jönsson, 2006; Tarvainen et al., 2014). On the contrary, release from anxiety and stress results in SNS deactivation and PNS activation, which causes a decreased heart rate (Kreibig, 2010). Therefore, heart rate analysis is efficient to obtain information about the physiological state of patients.

Studies show that nature views and sounds activate the PNS and thus nature exposure results in higher PNS activity, lower SNS activity and therefore a lower heart rate compared to exposure to urban environments (Annerstedt et al., 2013; Laumann, Gärling, & Stormark, 2001; Tsunetsugu, Park, & Miyazaki, 2010). Nature exposure resulted in quicker physiological recovery after experiencing stressful events like surgery (Park & Mattson, 2009). These findings imply that nature environments contain physiological calming and stress-reducing effects.

To examine this tranquilizing nature effect based on physiological data, the present study conducted heart rate measurements during bronchoscopy. This data is analysed to obtain additional information about effects of nature exposure. Research suggests that nature has stress and anxiety reducing effects (Kaplan, 1995; Ulrich, 1983), thus it might be expected that heart rate decreases when exposed to nature at the start of the bronchoscope insertion. However, insertion is a stressful event and leads to significant physiological reactions, resulting in increased heart rate (Antonelli et al., 2002; Rolo et al., 2012). Therefore, a heart rate peak is expected during insertion, despite of nature exposure. Nevertheless, previous research found stress, pain, and anxiety reducing nature effects, which might result in damping of this peak. In addition, these effects are expected to result in faster return to baseline heart rate levels after peaking. This contributed to the hypothesis:

The peak in heart rate during insertion of the bronchoscope is damped and returned faster to baseline levels by exposure to the nature environment.

Both conditions include nature exposure, thus this effect is expected for both nature videos. However, research found more tranquilizing effects for elements present in the high on SF nature environment (Barton & Pretty, 2012; Brush, 1978; Felsten, 2009). Results of Annerstedt et al. (2013) show that dynamic nature environments are effective in PNS activation. Views of water, depth, and nature sounds are also influential elements (Alvarsson et al., 2010; Annerstedt et al., 2013). The nature video high on SF is more dynamic due to soft-fascinating movement, contains more water, depth, and louder nature sounds, compared to the video low on SF. Therefore, it is expected that parasympathetic activity is higher for patients high on SF:

Participants exposed to the nature video high on soft-fascination show a faster and larger decrease in heart rate after insertion compared to the low on soft-fascination video.

Method

Design

A quasi-experimental 2 (between-subjects) x 2 (within-subjects) design was used. Primary outcome measures were perceived stress and anxiety, both self-reported and physiological recorded. The between-subject design was used to compare the effect of soft-fascination (SF) elements of nature between the two conditions (high on SF, low on SF). The within-subject design was used to compare the differences in stress and anxiety before and after the bronchoscopy.

Participants

Participants were patients (N = 19, 15 men, 4 women, M(age) = 68.16, SD = 13.45) who had an appointment for a bronchoscopy in the hospital MST (Medisch Spectrum Twente) in Enschede. Participants were divided into two groups: high on SF condition (n = 9, 7 men, 2 women, M(age) = 68.00, SD = 14.78) and low on SF condition (n = 10, 8 men, 2 women, M(age) = 68.30, SD = 12.94). Exclusion criteria were reduced vision of more than -5 myopic, the administration of a dormicum during bronchoscopy, insufficient mastery of the Dutch language and/or a visual handicap that could strongly hinder reading or watching videos. Researchers selected the participants based on their willingness to participate in the study. The participants were alternately allocated to one of the two conditions, first one to condition high on SF, and then the next participant to the condition low on SF, and so on. The study was approved by the medical ethical committee, code K17-34.

Materials and Apparatus

Hardware. First of all, video glasses (RelaxMaker) were used. The RelaxMaker has two LCD displays, with both 1280 x 720 (HD) pixels, an aspect ratio of 16:9, 24-bit RGB colors, 26° sight and 98 inch screen (Beter door Beeld, 2018). Second, headphones were used that belonged to the RelaxMaker. Third, the Empatica E4 wristband was used to record physiological data (Empatica Inc., 2018). Last, a laptop was used to upload the Empatica E4 data to a server.

Videos. Two nature videos were used. The video high on soft-fascination consisted of large water parts with flowing water. Movement of water, trees, and plants was clearly present.

Sounds of the video were sounds of water and wind. The nature scenes were viewed from the front (see Figure 1). The video low on soft-fascination consisted to a lesser extent of water, compared to the video high on SF. Water was more stagnant and less displayed in the foreground. Presence of movement was limited, and the level of nature sounds was low. The nature scenes in the video were viewed from above (see Figure 2).

Figure 1. Scene of the video high on SF. Copyright 2017 by Beter door Beeld.

Figure 2. Scene of the video low on SF. Copyright 2017 by Beter door Beeld.

Measures. Three short Dutch questionnaires were used (Appendix A, B, C). The first questionnaire was conducted before the bronchoscopy, the second directly after the procedure, and the third questionnaire during the follow-up appointment with the physician. Within the three Dutch questionnaires several scales have been included.

In the first questionnaire, two scales were used to measure mood before bronchoscopy. The first scale was Mood, which consisted of one item ("what is your mood at this moment?") on a 7-point scale ranging from very bad (1) to very good (7). This scale is originally answered on an 11-point scale (-5 to 5) (Hardy & Rejeski, 1989). The second scale was Arousal, which also consisted of one item ("how relaxed/calm or aroused/restless are you at this moment?") on a 7-point scale ranging from aroused/restless (1) to relaxed/calm (7). Originally, this scale was filled in on a 7-point scale ranging from 0 to 6 (Svebak & Murgatroyd, 1985).

In the second questionnaire, which was filled directly after the bronchoscopy, these two scales were used again. In addition, two scales about procedural discomfort were included. The first one was Discomfort Insertion and consisted of one item ("how comfortable or uncomfortable did you think the insertion of the scope was?"). The second scale was Discomfort After Insertion and also had one item ("how comfortable or uncomfortable did you think the bronchoscopy was after the insertion of the scope?"). Both items were answered on a scale ranging from very uncomfortable (1) to very comfortable (10). Thereafter the scale Experienced Pain Relief was used, which consisted of one item as well ("how good or bad did the sedation worked that you received against pain during the bronchoscopy?") (Diette et al., 2003). This item was answered on a 10-point scale ranging from 'very bad, the procedure was very painful' (1) to 'very good, the procedure was not painful at all' (10). In addition, the tension dimension of the Profile of Mood States Short Form (POMS-SF) was used (Baker, Denniston, Zabora, Polland, & Dudley, 2002), measuring perceived stress (α = .856). The tension dimension had six items consisting of single adjectives: Anxious, Nervous, Restless, Uncertain, Tense, and Panicky. The participants had to indicate how well an adjective described their feelings during bronchoscopy ranging from absolutely not (0) to very strong (4). Moreover, three items about fascination of the nature videos were included as a manipulation check of the different nature views, namely Fascination, Interesting, and Presence. These three items had a 5- point scale, ranging from completely disagree (1) to completely agree (5). An example is the item fascination: "I think this is a fascinating video". Finally, perceived distraction was measured with the item Distraction ("I had the idea that I was distracted from the bronchoscopy because of the video"). This item also had a 5-point scale, ranging from 'completely disagree' (1) to 'completely agree' (5).

The third questionnaire consisted of seven items in total and were all formed with the idea that participants had to recall their experiences with the bronchoscopy or had to indicate what they would choose next time. The first two items are identical to the first items of the first and second questionnaire and involved questions about mood and arousal. The third item involved the question: “how much would you dread if you had to undergo another bronchoscopy?”. This question was answered on a seven-point scale ranging from 1 (I dread very much), to 7 (I do not dread at all). The fourth and fifth item corresponded to the procedural discomfort items of the second questionnaire and the sixth item was the same as the experienced pain relief item of the second questionnaire. The last item was about whether one would again choose to put on the video glasses at another bronchoscopy and is answered on a 5-point scale ranging from “absolutely yes” to “absolutely not”. This item considered a behavioral intention and can therefore be considered as a proxy of the overall experience with the video glasses.

Procedure

The researcher approached the participants with some information about the study in the waiting room of the lung department at the MST. Participants received an information letter. After reading the information letter, participants had the opportunity to ask questions to the researcher. Those who wanted to take part signed the informed consent. After some time, the participants were called in by the nurse and went to the treatment room. In the treatment room, some information was given about the bronchoscopy procedure. The researcher put on the Empatica E4 on the wrist of the participant to measure physiological data. After the E4 Empatica was turned on, a flashing green light was shown for forty seconds. The moment the light turned red the E4 started to record physiological values. At the same time, participants answered the two questions of the first questionnaire. Then the usual bronchoscopy procedure started. First, the nurse sprayed the anesthesia Xylocaine in the throat of the patient. This procedure was repeated several times, depending on the state of participant. Second, the physician sprayed local sedation into the trachea. Then the RelaxMaker was installed. After the nature video started, participants were asked to lie down, and the physician inserted the bronchoscope. At the end of the bronchoscopy the RelaxMaker was taken off. Then the participant was given five minutes to relax and filled in the second questionnaire. After that, the E4 wristband was taken off and the researcher asked when the participant had the next appointment, or at what department of the hospital they were staying. At the end, the participant had the opportunity to give feedback about their experience with the RelaxMaker.

During bronchoscopy, several things were written down: exact UTC times of all anesthesia insertions, when E4 Empatica started (when the light turned red) and stopped recording, when video glasses were put on and off, when the bronchoscope was inserted and in position, when the removal of the bronchoscope was started and completed. There were also noted other important observations during the procedure, for instance whether the participant watched the nature video or not, and whether the participant had to change position. The physiological data recorded by the E4 wristband was uploaded to a computer at a later moment.

At the follow-up appointment, roughly a week later, the third questionnaire was filled in five minutes before the appointment. When a participant stayed in the hospital, they were visited approximately one week after their bronchoscopy and filled in the same questionnaire.

Data analysis

Descriptive statistics were used to compare the scores of the participants on the psychological and physiological data with available norm scores of patient and non-patient populations. Results of the descriptive analysis were also used to examine the differences on the posttest and follow-up questionnaire to test the hypothesis regarding a more positive retrospect evaluation on the follow-up. Nature conditions were also compared on posttest and follow-up differences for the hypothesis stating a more positive retrospect a week after the bronchoscopy in the condition high on soft-fascination.

Missing values are imputed by using condition mean imputation. Four missing values were found in the high on SF condition on the items fascination, interesting, presence, and distraction of the manipulation check. In the low on SF condition, two missing values were found on the items interesting and presence. Condition means are imputed for these values.

To test the hypothesis that heart rate will decrease due to exposure to the nature environment, a GLM repeated measures analysis was conducted with heart rate as variable. Three time levels were used, namely the period five minutes before the insertion, during insertion, and after insertion until the bronchoscope was removed. Nature condition (high versus low SF) was used as between-subjects factor to test the hypothesis stating more reduction in heart rate in the condition high on soft-fascination.

The hypothesis of an improvement or stabilization of well-being after nature exposure during bronchoscopy was also tested with GLM repeated measures analyses. The analyses were conducted with the variables mood and arousal on the levels pretest and posttest. Nature condition was used as between-subjects factor to test the hypothesis stating less negative responses in the nature condition high on soft-fascination.

Three analyses were conducted by using one-way ANOVA. First, it was executed to analyse the scores of the six individual POMS-items and mean POMS-score between the high and low on SF condition. Second, it was used to compare the scores of the high and low on soft-fascination conditions on discomfort during and after insertion of the bronchoscope and experienced pain relief. Third, it was used as a manipulation check by comparing the scores of the distraction and fascination items between the two conditions. For all analyses, a significance level of .05 was used. *P*-values below .10 were considered marginally significant.

A single-case analysis was conducted for five participants to find evidence for beneficial effects of the virtual nature environment. These participants were chosen based on their exposure to the nature video and sounds. The amount of difficulty and complications during the bronchoscopy were also considered, because these factors influenced the physiological reactions of participants. Plots of the heart rate of these participants were studied in detail by using observations made during the bronchoscopy procedure.

Results

Descriptive Statistics

Participants in the total sample scored below the patient sample norm score of the POMS-SF tension dimension (*M* = 8.64) (Shacham, 1983). Compared to scores of the normative non-patient sample on the item arousal (*M* = 4.10, *SD* = 1.00) (Svebak & Murgatroyd, 1985), the total sample scored on average higher on the pretest, posttest, and follow-up questionnaire (see Table 1). Norm scores were not available for the other items. Table 1 presents mean heart rate before, during, and after insertion. Table 2 displays scores on the pretest, posttest, and follow-up questionnaire.

Table 1

Descriptive Statistics of Physiological Data of Heart Rate in Beats per Minute

	Low on SF (n = 10)		High on SF (n = 9)		Total sample (N = 19)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Before insertion	78.93	13.31	77.68	12.01	78.34	12.37
During insertion	77.56	12.61	82.18	14.67	79.75	13.44
After insertion	81.18	16.15	89.02	18.90	84.89	17.47

Table 2

Descriptive Statistics of the Pretest, Posttest, and Follow-Up Questionnaire

		Low on SF (n = 10)		High on SF (n = 9)		Total sample (N = 19)	
	Range	*M*	*SD*	*M*	*SD*	*M*	*SD*
Pretest							
Mood	1-7	5.50	1.31	4.67	0.79	5.11	1.15
Arousal	1-7	5.20	1.18	4.22	0.91	4.74	1.15
Posttest							
Mood	1-7	5.54	1.44	4.61	1.45	5.05	1.47
Arousal	1-7	5.25	0.98	4.39	1.58	4.84	1.33
POMS	0-4						
Nervous		1.00	1.15	1.89	0.78	1.42	1.07
Panicky		0.90	1.29	1.78	1.30	1.32	1.34
Tense		1.60	1.26	1.89	1.17	1.74	1.19
Restless		1.40	1.58	1.33	1.12	1.37	1.34
Anxious		0.80	0.92	1.33	1.22	1.05	1.08
Uncertain		0.90	1.10	1.22	1.39	1.05	1.22
Mean POMS		1.32	0.92	1.57	0.94	1.32	0.92
Total POMS		6.60	5.40	9.44	5.61	7.95	5.54
Discomfort 1[a]	1-10	3.80	2.15	3.44	2.13	3.63	2.09
Discomfort 2[b]	1-10	4.80	1.69	3.00	1.66	3.95	1.87
Pain relief	1-10	7.10	2.33	7.11	2.71	7.11	2.45
Manipulation check	1-5						
Fascination		3.30	0.95	3.02	0.71	3.17	0.83
Interesting		2.77	1.23	2.63	0.86	2.71	1.04
Presence		2.85	1.29	2.17	1.06	2.53	1.21
Distraction[c]		3.00	1.22	2.15	0.30	2.62	0.99
Follow-up[c]							
Mood	1-7	5.20	1.64	3.50	1.00	4.44	1.59
Arousal	1-7	4.80	1.30	3.75	0.96	4.33	1.22
Dread	1-7	4.00	1.58	2.50	1.29	3.33	1.58
Discomfort 1[a]	1-10	3.80	2.49	1.75	1.50	2.89	2.26
Discomfort 2[b]	1-10	5.20	2.05	2.00	0.82	3.78	2.28
Pain relief	1-10	7.10	1.75	4.00	1.41	5.72	2.22
Experience	1-5	4.00	1.00	3.25	1.50	3.67	1.22

[a] Discomfort during insertion. [b] Discomfort after insertion. [c] n = 5 in low on SF, n = 4 in high on SF, N = 9 in total sample.

Repeated Measures

Physiological data. For heart rate data, Mauchly's Test of Sphericity indicated no violation of the assumption of sphericity, $\chi^2(2) = 0.90$, $p = .638$. Therefore, sphericity was assumed. The effect of time was marginally significant, $F(2, 34) = 2.77$, $p = .077$. Both nature conditions showed an increase in heart rate over time. The interaction effect between time and nature condition was not significant, $F(2, 34) = 1.16$, $p = .325$ (see Figure 3).

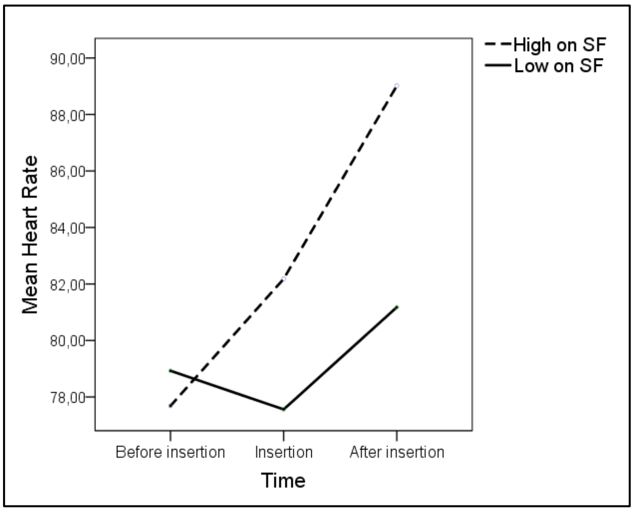

Figure 3. Interaction-analysis between time levels (before, during, after insertion) and soft-fascination (SF) condition for mean heart rate in beats per minute.

Mood and arousal. For mood, Mauchly's Test of Sphericity indicated violation of the assumption of sphericity ($\chi^2 = 0.00$, $p < .005$), therefore a Greenhouse-Geisser correction was used. There was no significant effect of time on mood, $F(1, 17) = 0.05$, $p = .832$. Thus participants showed no significant difference in mood on the pretest and posttest questionnaire. Interaction between time and nature condition was also not significant, $F(1, 17) = 0.00$, $p = .991$.

For arousal, Mauchly's Test of Sphericity also indicated violation of the sphericity assumption ($\chi^2 = 0.00$, $p < .005$) and thus a Greenhouse-Geisser correction was conducted. There was no significant main effect of time, $F(1, 17) = 0.13$, $p = .726$. Therefore, no significant difference in arousal was found before and after the bronchoscopy procedure. The interaction effect between time and nature condition was also not significant, F (1, 17) = 0.04, p = .850.

Analysis of Variance

POMS. The difference in mean total score on the POMS-SF at posttest between the two nature conditions was not statistically significant, F(1, 17) = 1.27, p = .276. Additionally, no significant effects were found for the six individual POMS-items (see Table 3). No evidence was found that participants in the high on SF condition experienced less negative mood states than participants in the low on SF condition. However, a marginally statistical effect was found for the item nervous. Condition means show that participants high on SF scored on average higher on this item, which indicted more nervosity in this condition. Furthermore, one can notice that the observed differences between the conditions were consistent in direction on four of the non-significant items, namely higher scores for the condition high on SF.

Table 3

Main Effects of Nature Condition on Individual POMS-SF Items

POMS-SF Item	Low on SF *M* (*SD*)	High on SF *M* (*SD*)	*F* (1, 17)	*p*
Nervous	1.00 (1.15)	1.89 (0.78)	3.77	.069
Panicky	0.90 (1.29)	1.78 (1.30)	2.18	.158
Tense	1.60 (1.26)	1.89 (1.17)	0.27	.613
Restless	1.40 (1.58)	1.33 (1.12)	0.01	.918
Anxious	0.80 (0.92)	1.33 (1.22)	1.17	.295
Uncertain	0.90 (1.10)	1.22 (1.39)	0.32	.581

Discomfort and pain relief. Analysis of variance showed a significant difference between nature condition on discomfort after insertion, F(1, 17) = 5.48, p = .032. For participants in the low SF condition, the mean score on discomfort after insertion was 4.80 (*SD* = 1.69). The mean score was 3.00 (*SD* = 1.66) in the condition high on SF. This implied that on average participants watching the low soft-fascination video experienced less discomfort after insertion. No significant differences between the two nature conditions were found on discomfort during insertion [$F(1, 17) = 0.13$, $p = .722$] and experienced pain relief [$F(1, 17) = 0.00$, $p = .992$].

Manipulation check. Analysis of variance showed no significant effects of nature condition on fascination and distraction items (see Table 4). Thus the self-reported scores on fascination, interest, presence, and distraction did not differ between the two conditions. Results were the same without mean imputation. However, observed means were consistently more negative in the condition high on SF, especially on presence and distraction.

Table 4

Main Effects of Nature Condition on Fascination and Distraction Items

Item	Low on SF *M* (*SD*)	High on SF *M* (*SD*)	*F* (1, 17)	*p*
Fascination	3.30 (0.95)	3.02 (0.71)	0.60	.450
Interesting	2.77 (1.23)	2.63 (0.85)	0.10	.760
Presence	2.85 (1.29)	2.17 (1.06)	1.98	.178
Distraction	3.00 (1.22)	2.15 (0.30)	2.59	.151

Effects at Follow-Up

Follow-up questionnaires were filled in by a subsample of nine participants and compared with the posttest questionnaire. This subsample consisted of five participants in the low on SF condition and four in the high on SF condition. Five items were administered in both questionnaires. The analyses regarding the follow-up questionnaire are only conducted qualitatively. Mean scores and standard deviations are displayed in Table 5. For mood, the low on SF subsample reported a minimal difference between the posttest and follow-up questionnaire. Compared with this sample, the high on SF subsample scored lower on mood on both questionnaires. The high on SF subsample also reported lower mood scores on the follow-up than on the posttest. This reduction indicated a small decrease in reported mood over time among high SF participants. For arousal, both subsamples scored higher on the posttest than the follow-up. This implied a reduction in recalled arousal experienced during the bronchoscopy, reported a week after the procedure. The low on SF condition scored the same on posttest and follow-up on discomfort during insertion. Results of high on SF participants showed a reduction over time of the mean score on this item and thus a decrease in recalled pleasantness of the insertion. For discomfort after insertion, both conditions showed contrasting patterns of responses. The low on SF participants showed a small increase in recalled pleasantness, and high on SF participants a decrease. On recollected experienced pain relief, posttest scores equalled scores on the follow-up questionnaire in the low on SF condition. The high on SF condition obtained the same mean score on the posttest as condition low on SF. However, the score on the follow-up questionnaire for this subsample was lower, which implied more painful evaluation of the bronchoscopy a week later.

The items regarding dread and experience with video glasses were only administered in the follow-up questionnaire. Participants in the low on SF condition showed less dread than high on SF participants on dreading a new bronchoscopy. The same pattern was found for the experience with the video glasses, which indicated more willingness in the low on SF condition to wear the glasses during a next bronchoscopy. These effects, although qualitatively, seem consistent with quantitative analyses in finding more positive effects for the video low on SF.

Table 5

Mean and Standard Deviation of Items of the Posttest and Follow-Up Questionnaire

	Low on SF posttest	Low on SF follow-up	High on SF posttest	High on SF follow-up
Mood	5.45 (1.44)	5.20 (1.64)	4.61 (1.45)	3.50 (1.00)
Arousal	5.25 (0.98)	4.80 (1.30)	4.39 (1.58)	3.75 (0.96)
Discomfort insertion	3.80 (2.15)	3.80 (2.49)	3.44 (2.13)	1.75 (1.50)
Discomfort after insertion	4.80 (1.69)	5.20 (2.05)	3.00 (1.65)	2.00 (0.82)
Experienced pain relief	7.10 (2.33)	7.10 (1.75)	7.11 (2.71)	4.00 (1.41)
Dread		4.00 (1.58)		2.50 (1.29)
Experience with glasses		4.00 (1.00)		3.25 (1.50)

Single-Case Analyses

Single-case analyses are conducted to provide additional insights on how heart rate develops during the bronchoscopy procedure. This information might present further indications about the effectivity of nature exposure and soft-fascination nature conditions. Three participants were exposed to the high on SF nature environment and two participants to the video low on SF.

Participant HiSF02. Figure 4 presents the heart rate of participant HiSF02, which displays the insertion was conducted twice. The mean heart rate before the first insertion was 62 beats per minute (bpm). During the first insertion, the heart rate increased to a maximum of 96 bpm until the bronchoscope was entirely removed due to complications. The heart rate decreased to 73 bpm after this removal. At the beginning of the second insertion, the heart beat of the participant started to increase again to 96 bpm and then the graph shows a decline again. The participant evaluated the insertion as painful, so the procedure of inserting the bronchoscope can thus be a possible explanation for the increase in heart rate. During both insertions, the participant's eyes were closed. For this reason, the nature view could not be a reason for the decreases. A possible explanation is exposure to the nature sounds resulting in reducing heart rate. Another explanation is the stabilization of the bronchoscope, so the participant could recover from the insertion. Three minutes after the scope was inserted for the second time, the participant's eyes were opened. Before this moment, the heart rate increased for the third time to 93 bpm. No special observations were made for this increase. After the participant started to watch the high SF video at 08:48, the heart rate decreased again. Therefore, the reducing heart rate could be a result of watching the nature video. The heart rate remained stable for the rest of the procedure. At the end, the bronchoscope was removed, and this action resulted in another increase.

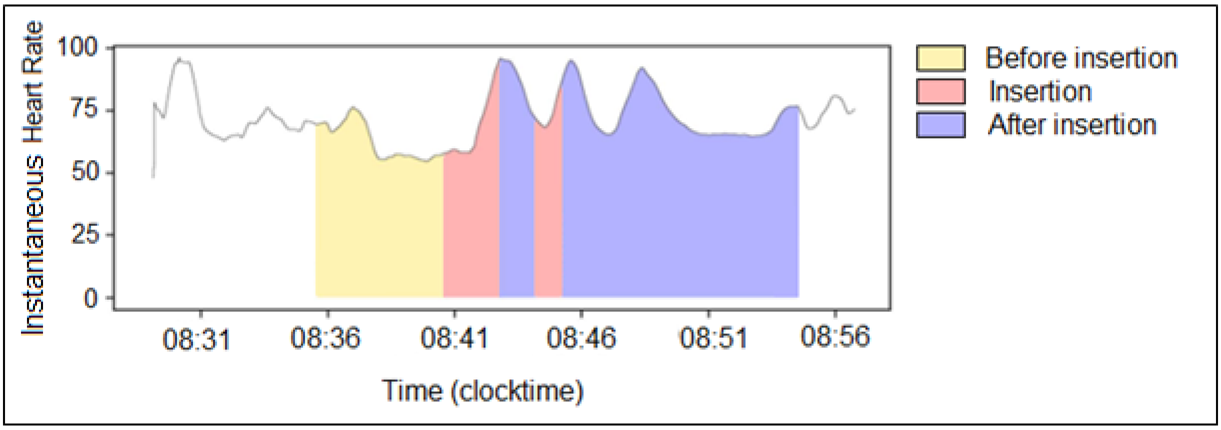

Figure 4. Instantaneous heart rate in beats per minute of participant HiSF02 during.

Participant HiSF07. The physiological data of participant HiSF07 is plotted in Figure 5. Before insertion, heart rate was relatively stable with only small fluctuations and a mean of 92 bpm. The heart rate started to increase at the beginning of the bronchoscope insertion to a maximum of 100 bpm. The process of inserting the scope was complicated due to difficulty of the participant with the insertion. Afterwards, the participant evaluated the insertion as very uncomfortable. This difficulty might have resulted in the increase in heart rate during insertion.

Shortly before the end of the insertion, the heart rate decreased back towards 90 bpm. Then the graph shows a second increase in heart rate to a maximum of 127 bpm, with a gradual decline after this peak to 117 bpm at the end of the bronchoscopy. Hence, heart rate of the participant remained high during bronchoscopy compared to the other four participants, with a mean heart rate of 116 bpm. Also, heart rate did not return to baseline level. Observations showed the participant's eyes were closed during the entire procedure. Afterwards, the participant reported not having watched the video and not having heard the sounds. Therefore, it is possible that the high heart rate sustained due to absence of exposure to the nature environment.

This could be illustrated by the scores of participant HiSF07 on discomfort and pain relief items on the posttest and follow-up questionnaire. These experiences were mostly more negative compared to the other four participants in the explorative analysis. In combination with the highest mean heart rate during the procedure and the least nature environment exposure of all five participants, this suggested absence of an effect of the nature video and sounds due to low exposure.

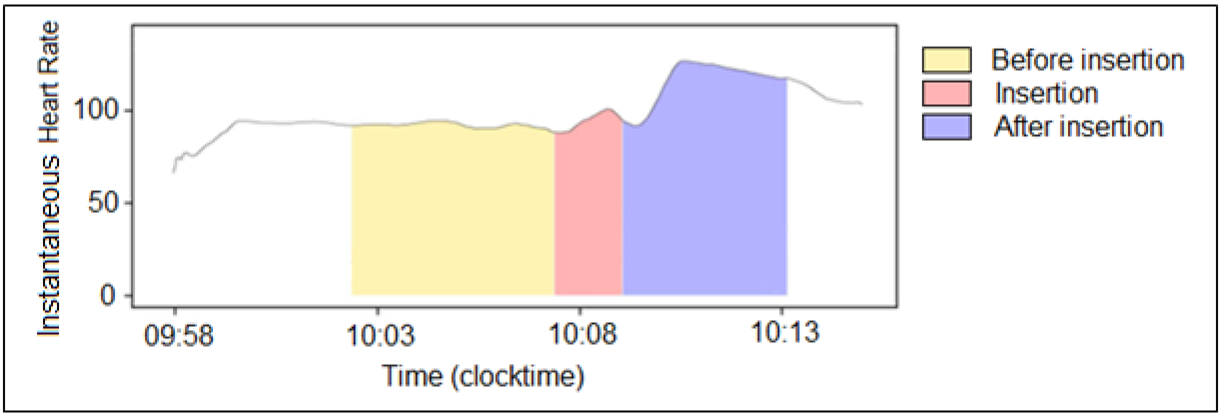

Figure 5. Instantaneous heart rate in beats per minute of participant HiSF07.

Participant LoSF05. In addition to participant HiSF02 and HiSF07, participant LoSF05 was also minimally exposed to the nature environment. Heart rate is plotted in Figure 6. The mean heart rate before the insertion was 101 bpm and shortly before the insertion started a maximum peak of 110 bpm was registered. Immediately at the start of the insertion, the heart rate began to decline. Around this time, the video glasses were activated, and nature exposure started. However, the participant was not exposed to the video at all due to closed eyes during the complete bronchoscopy. Nevertheless, nature sounds might have calmed the participant as headphones played these sounds during the entire bronchoscopy. This might have reduced the heart rate towards 60 bpm. No observations were made afterwards about consciousness of the exposure to the nature sounds. Observations reported the insertion was complicated and the participant had a difficult time during insertion. Self-reported data supported these observations, since the participant evaluated discomfort during and after insertion as painful. Despite these difficulties, the heart rate was nearly halved. This supports the possible positive effects of nature sounds, as the decrease started after the virtual nature environment was turned on, even though the following insertion was painful. After the moment the bronchoscope was in place, the heart rate remained varying around this heart rate with small fluctuations, with an average of 62 bpm. At the end of the procedure the heart rate started to increase again, probably due to removal of the bronchoscope. Simultaneously, the nature simulation was turned off. This deactivation can also have contributed to the increasing heart rate.

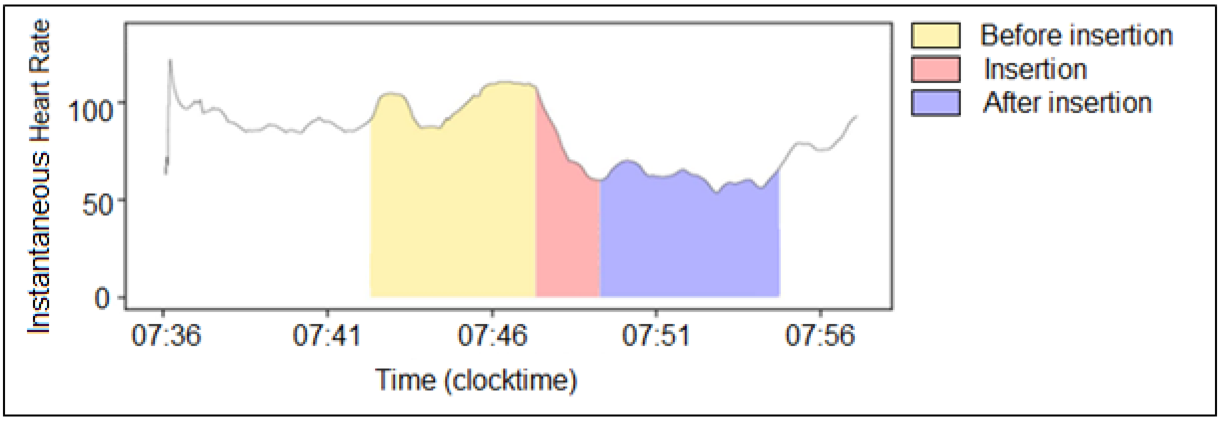

Figure 6. Instantaneous heart rate in beats per minute of participant LoSF05.

Participant HiSF03. Observations made during the bronchoscopy of participant HiSF03 were in contrast with participants HiSF02, HiSF07, and LoSF05, for whom low to no exposure and difficult insertion were reported. For participant HiSF03, insertion was without complications and fast, and the participant behaved calmly. Self-reported posttest data also showed the participant experienced less discomfort than the other four participants. Before insertion, mean heart rate was 74 bpm and increased to 83 bpm during insertion (see Figure 7). This increase continued after insertion to a maximum of 110 bpm. This showed that a physiological reaction was not restricted to participants experiencing a complicated insertion and further bronchoscopy. The peak in heart rate might still be caused by the insertion. After this peak, the heart rate started to decrease towards 80 bpm. One explanation for this might be physical adaptation from insertion. Possibly the participant needed time to recover from this invasive procedure. The increasing heart rate towards the end of the procedure might support this argument, as the physiological reaction heightened by removing the bronchoscope. Another explanation of the decreasing heart rate after insertion is exposure to the nature environment. Participant HiSF03 watched the video continuously, which resulted in high exposure. However, the reduction started approximately two minutes after insertion. This decrease is delayed compared to participant LoSF05. This delay might becaused by differences between the two nature videos. Possibly the low on SF nature condition was more beneficial, resulting in a faster decrease in heart rate as shown by participant LoSF05. The delay might also be explained by the self-reported data of participant HiSF03, which indicated low levels of fascination, interest, and presence. This lack of fascination could have affected the rate of heart rate recovery.

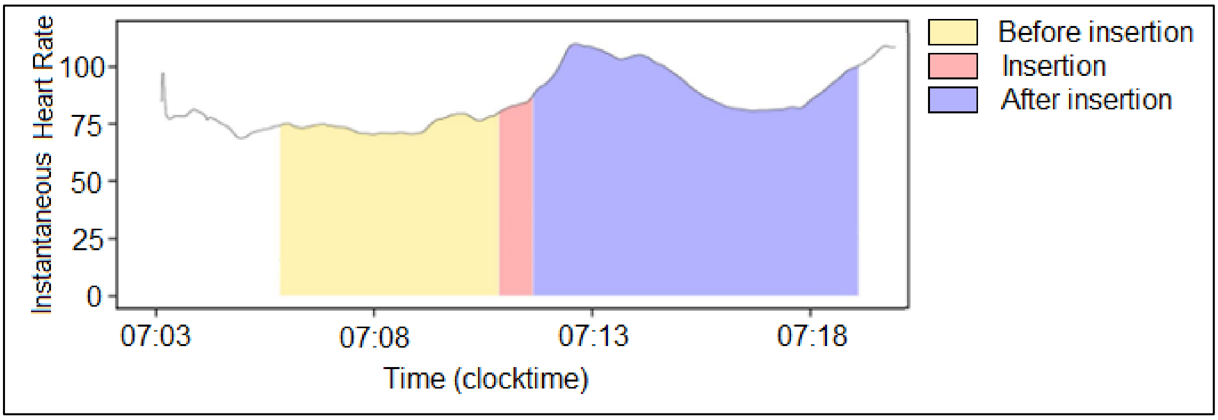

Figure 7. Instantaneous heart rate in beats per minute of participant HiSF03.

Participant LoSF09. The participants described above did wear a different version of the video glasses and headphones than participant LoSF09. The video glasses of this participant were more covering, had integrated speakers and superior sound experience. Therefore, it is possible that the nature exposure was more intense. Figure 8 shows the heart rate data and illustrates that heart rate was stable during the bronchoscopy, with small fluctuations. No observations were made for events that could have caused these fluctuations. The mean heart rate both before and during insertion was 65 bpm. The insertion was conducted easily, and data on experienced discomfort showed that participant LoSF09 experienced less discomfort compared to the other participants. This might be a reason for the absence of an increasing heart rate after insertion, which is seen in the graphs of most participants (HiSF02, HiSFiSF03, H07). Observations reported participant LoSF09 watched the nature video continuously and self-reported data showed the participant was really fascinated by the video. Hence, it is possible that the virtual nature environment was beneficial for the participant and thus the expected increase in heart rate during the procedure was minimal.

Thus, the absence of a peak in heart rate after the insertion might argue for an effect of the nature environment. The different type of video glasses might also have played a role in this, by means of more immersive exposure. Another possibility is that the low on soft-fascination video was more beneficial for well-being than the video high on SF. Data of participant LoSF09 and LoSF05 showed no increase in heart rate after the insertion, but it remained constant (LoSF09) or decreased (LoSF05). All three participants in the high on SF condition did experience a rising heart rate, however two were minimally exposed. The unresponsiveness and constancy in heart rate of LoSF09 might also be a result of resistance to stress or being physiologically a low-responder.

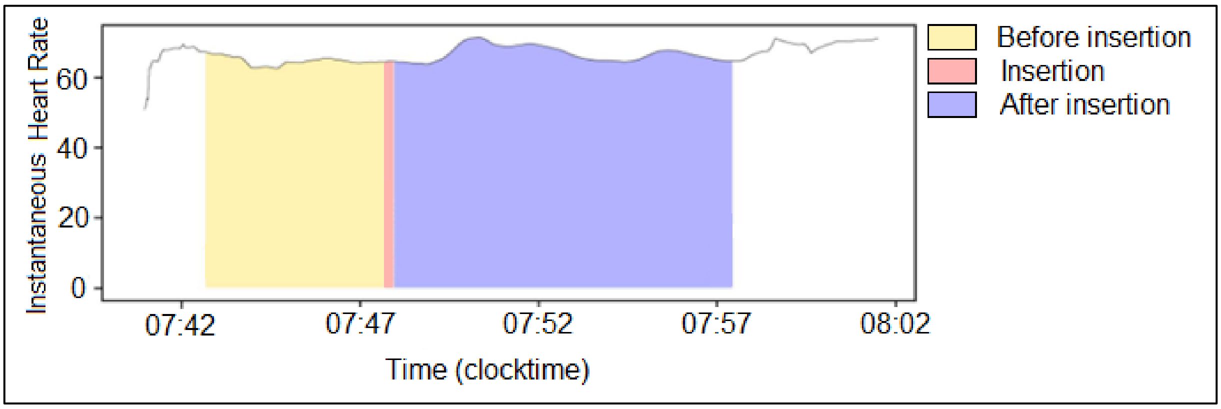

Figure 8. Instantaneous heart rate in beats per minute of participant LoSF09.

Discussion

In the present study, virtual nature environments were used during bronchoscopy to examine the effect of nature exposure to improve the experience of this invasive procedure and well-being of health care patients. A nature video high on soft-fascination elements was compared to a virtual nature environment low on soft-fascination by means of physiological and self-reported psychological data. In contrast to expected findings, results showed overall no significant differences in mental well-being and heart rate over time and between nature conditions. The small sample size contributed to the absence of significant findings.

Based on the attention restoration theory, distraction and stress reduction theory (Diette et al., 2003; Kaplan, 1995; Ulrich, 1983), it was hypothesized that less negative psychological responses were experienced by both nature conditions after exposure to virtual nature. However, results of the present study showed no convincing evidence for a beneficial effect of nature exposure during the procedure by improving mood and reducing arousal. The duration of the exposure can have contributed to this. Research showing well-being improving effects of exposure to nature settings were conducted on postoperative recovering patients exposed for days or weeks (Park & Mattson, 2009; Ulrich, 1984; Ulrich & Lundén, 1990). The relatively short nature exposure in the present study compared to this might account for the absence of mood improvement and arousal reduction. Nevertheless, there still might be a positive effect of the nature exposure. Bronchoscopy can be painful and uncomfortable (Lechtzin et al., 2000;

Poi et al., 1998), which is supported by the self-reported scores on experienced discomfort and pain relief on the posttest questionnaire. Mood and arousal remaining stable despite experiencing this distressing procedure might also be a desired effect of the nature environment.

Further, analysis of physiological measurements showed no significant decrease in heart rate after nature exposure. Heart rate data showed expected increases during insertion and removal of the bronchoscope, indicating validity of the heart rate measurements. Contrary to the expectation, increases in heart rate were found in both nature conditions after insertion of the bronchoscope. This increase over time was equal in both conditions. These results are contrary to the expected decrease in heart rate after insertion, which would indicate no effect of nature exposure. However, compared to ranges of heart rate before, during, and after insertion reported in previous research (Antonelli et al., 2002; Breuer, Charchut, & Worth, 1989; Rolo et al., 2012; Tenholder, Ewald, Smith, & Brown, 1995), heart rate found in the present study was below the lower limits of the ranges in all three phases of the bronchoscopy. These studies did not include nature exposure, and this might have resulted in higher heart rates during bronchoscopy. To test this, it is important to add a control condition. Compared to a control condition undergoing bronchoscopy without nature exposure, lower insertion peaks and faster heart rate reduction after insertion might be present. Then, a relative improvement is indicated if the increase in heart rate peaks faster and higher and decreases less and slower in the control condition. Moreover, the same effect can be found in the absence of improvement of psychological well-being over time. It might be that well-being of patients undergoing bronchoscopy without exposure to the nature environment is lower compared to well-being of exposed participants. Based on the current study, these comparisons can not be made and adding a control condition is therefore recommended for future research.

Despite the lack of a control condition, results can be compared with previous research. Previous research showed physiological calming and stress-reducing effects and therefore a reduction in heart rate when exposed to both real and virtual nature (Annerstedt et al., 2013; Laumann et al., 2001; Tsunetsugu et al., 2010). However, these studies did not conduct a bronchoscopy during the nature exposure. Instead, participants were exposed to nature during stress-inducing laboratory tasks. Thus, the contrasting finding might be explained by effects of bronchoscopy procedure itself. Bronchoscopy has a great impact on the body of patients (Lechtzin et al., 2000; Prakash et al., 1991) and this is supported by findings of the explorative analysis, that showed higher and longer enduring peaks in heart rate for participants experiencing a difficult and complicated bronchoscopy. Therefore, the intervention might be more effective for procedures less impacting, invasive and intense for patients. For bronchoscopy, more immersive exposure might be effective. The head-mounted display used in the present study enabled patients look over and under the video glasses easily. Using a more covering display might result in stronger exposure and thus more well-being improvement. Results of the single-case analyses may support this, by showing absence of peaks in heart rate for the participant exposed to nature with a more immersive video glasses. Therefore it is recommended to use a more immersive head-mounted display in future research to test whether this might improve well-being during bronchoscopy.

Furthermore, results of the physiological analysis showed no effect of nature condition on heart rate. This is in contrast with findings of Annerstedt et al. (2013) that showed stress recovery due to activation of the parasympathetic nervous system is mainly caused by dynamic nature environments and sounds and views of water, which are mostly present in the video high on soft-fascination. The contrasting results might be due to sensitivity of the autonomic nervous system, as interindividual variability in thresholds of stress, pain, and anesthesia is great between patients (Brennum, Kjeldsen, Jensen, & Jensen, 1989). This variability in heart rate between patients was also found in the explorative analysis, which showed a variation from approximately 60 to 130 beats per minute. In the present study, baseline measurements of heart rate were executed during five minutes before insertion. However, participants were probably already stressed and anxious during this measurement. True baseline data was therefore not available. For this is reason, it is recommended to collect physiological data from participants when being at home. By this method, data cannot be distorted by tension experienced due to the hospital environment and upcoming procedures. The baseline data can be used as covariate to control for differences in sensitivity of the autonomic nervous system between patients.

Besides differences in heart rate between the two nature conditions, it was expected that participants exposed to the nature video high on soft-fascination would show less negative responses on well-being measurements compared to participants in the condition low on SF. Quantitative results of the psychological data showed no different effects on mood, arousal, mood states, discomfort during insertion, and pain relief of the two SF nature conditions. For discomfort after insertion and nervousness, opposite effects were found. Participants exposed to the nature environment low on SF experienced less discomfort after insertion and less nervosity compared to high on SF participants. Less discomfort can be experienced due to differences in sedation during bronchoscopy. The amount of anesthesia administered to the patient was not observed. Therefore, it might be that patients in the low on SF condition received more anesthesia. For future research, it is recommended to control for the administered amount of sedatives during the bronchoscopy.

Moreover, qualitative analysis of recalled experiences with the bronchoscopy reported a week after the procedure also showed more positive effects of the nature environment low on SF. Participants exposed to the low on SF video reported an increase in pleasantness after insertion, less dread regarding a new bronchoscopy, and more willingness to wear the video glasses again. In contrast, participants high on SF evaluated their experience with the bronchoscopy a week after the procedure as more painful, more unpleasant and reported having experienced a lower mood compared to a week earlier. Both decreased in recalled arousal during the bronchoscopy. These findings on soft-fascination are in contrast with findings in previous studies, which found positive effects of soft-fascination elements on mental well-being which are mainly present in the high on SF video (Berto, 2014; Felsten, 2009). Therefore, it is possible that other factors contribute to improvement or stabilization of well-being during bronchoscopy than considered in this study.

One explanation for the unexpected possible advantage of the nature environment low on soft-fascination and is the small sample size in this study. Due to this sample size, randomization was deficient, and this might have resulted in unequal groups. It is possible that this inequality led to distortion of the data and low statistical power (Button et al., 2013). In addition, the small sample size also contributed to the absence of significant results due to a lack of power. Another effect of this small sample size was conduction of intention to treat analyses instead of per protocol analyses. Observations during bronchoscopy showed that not all participants were exposed to the nature environment by closing their eyes or removal of headphones. This resulted in including participants in analyses that were not exposed to the video and this could have distorted the data. The single-case analyses also showed different patterns in heart rate for participants exposed and not exposed to the nature environment. Exposed participants showed lower peaks and larger decreases in heart rate compared to participants minimally exposed. However, eventhough these factors might distort data of this study in testing efficacy, these distortions are present in clinical environments. Therefore, this is also a strength of this study, to test the effectiveness of the treatment in practice.

In addition, results of the single-case analyses suggested other indications that nature might be effective, in spite of previous null findings. Comparing heart rate of participants considering observations made during the procedure showed the potential impact of exposure on efficacy of the nature video. Participants not exposed at all hardly showed tranquilizing effects of nature compared to participants continuously or partly exposed, showing faster and steeper declines in heart rate after a peak. Additionally, heart rate of some participants started to decrease after opening their eyes, which implies start of the video exposure. This finding suggested a positive influence of the nature video. Especially the video low on SF seemed effective based on the single-case analyses. The participants in this nature condition did not show a peak during insertion, which might be explained by the start of the nature video and sounds at the moment of insertion. The single-case analysis of heart rate thus indicated a positive effect of nature exposure and in particular of the low on soft-fascination video.

Content of the virtual nature environments is also an influencing factor in the unexpected possible advantage of the video low on soft-fascination. In the present study, elements of soft-fascination, depth, spaciousness, and water were selected based on previous findings showing positive effects of these elements (Barton & Pretty, 2010; Brush, 1978; Herzog et al., 1997; Ulrich, 1983). However, alternative elements might also be effective in influencing well-being. These nature features might be more present in the nature video low on soft-fascination, explaining the opposite findings. For instance, 'deflected vistas' formulated by Appleton (1975) can be influencing. Deflected horizons elicit preference reactions and indicate that additional information is beyond the visual boundaries (Ulrich, 1983). This arouses curiosity to what scene will be seen at the end of the horizon (Cullen, 1961). The nature environment low on soft-fascination contained views from above instead of frontviews present in the video high on soft-fascination. This resulted in clearer views of deflected horizons, which might have led to preference reactions and more curiosity. This can have resulted in opposite results. Therefore, future research should examine different nature features to determine the most effective elements concerning enhancement of well-being.

Another factor to consider is the effect of practitioners during bronchoscopy. The physicians and nurses executing the bronchoscopy differed between participants and all have personal methods to treat and tranquilize the participants. This was not notated and thus not considered in analyses. It is possible that different results would be obtained when controlling for the effect of practitioners. Therefore, it is recommended to control for practitioning physicians and nurses as covariates in analyses.

As invasive medical procedures like bronchoscopy can negatively affect mental and physical well-being of patients, it is important to reduce the negative impact of this procedure. A lot of research focused on the effects of nature exposure in health care waiting rooms and hospital rooms, but less information was known about the effects of virtual nature on well-being of patients during distressing bronchoscopy procedures. No conclusive evidence was found, although results suggested some beneficial effects of nature exposure, namely reduced increases in heart rate during insertion, and faster and more decline after insertion when exposed to the nature. In addition, virtual nature environments high on soft-fascination seemed not to be more restorative in reducing stress, pain, and anxiety of patients than nature environments low on soft-fascination. In contrast, results seemed to indicate more beneficial effects of nature low on soft-fascination elements on mental well-being and physiological recovery. This present study indicated thus possible advantageous impacts of exposure to virtual nature videos and sounds during bronchoscopy. Knowledge about these specific effects of virtual nature exposure can contribute to improvement of well-being improving techniques to reduce the negative mental and physical impact of medical procedures like bronchoscopy. Besides alleviating negative feelings of patients during medical procedures, the health care system might also benefit from developments regarding the virtual nature technique. It might for instance reduce need for anaesthesia, no shows, costs, and lead to quicker procedures. The present study contributed to the knowledge regarding this subject. Nevertheless, more research including the recommendations is necessary to gain more insight in the effects of virtual nature environments on well-being of bronchoscopy patients.

References

Alvarsson, J. J., Wiens, S., & Nilsson, M. E. (2010). Stress recovery during exposure to nature sound and environmental noise. *International Journal of Environmental Research and Public Health, 7*(3), 1036-1046. doi:10.3390/ijerph7031036

Anderson, K. O., & Masur, F. T. (1983). Psychological preparation for invasive medical and dental procedures. *Journal of Behavioral Medicine, 6*(1), 1-40. doi:0160-7715/83/0300 -0001503.00/0

Andreassi, J. L. (2007). *Psychophysiology: Human behavior and physiological response* (5th ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Annerstedt, M., Jönsson, P., Wallergård, M., Johansson, G., Karlson, B., Hansen, A. S., & Währborg, P. (2013). Inducing physiological stress recovery with sounds of nature in a virtual reality forest – Results from a pilot study. *Physiology & Behavior, 118*, 240-250. https://doi.org/10.1016/j.physbeh.2013.05.023

Antonelli, M., Conti, G., Rocco, M., Arcangeli, A., Cavaliere, F., Proietti, R., & Meduri, G. U. (2002). Noninvasive positive-pressure ventilation vs conventional oxygen supplementation in hypoxemic patients undergoing diagnostic bronchoscopy. *CHEST Journal, 121*(4), 1149-1154. https://doi.org/10.1378/chest.121.4.1149

Appleton, J. (1975). *The experience of landscape*. London, England: Wiley.

Arneill, A. B., & Devlin, A. S. (2002). Perceived quality of care: The influence of the waiting room environment. *Journal of Environmental Psychology, 22*(4), 345-360. https://doi .org/10.1006 /jevp.2002.0274

Arntz, A., & Claassens, L. (2004). The meaning of pain influences its experienced intensity. *Pain, 109*(1-2), 20-25. doi:10.1016/j.pain.2003.12.030

Baker, F., Denniston, M., Zabora, J., Polland, A., & Dudley, W. N. (2002). A poms short form for cancer patients: Psychometric and structural evaluation. *Psycho-Oncology, 11*(4), 273-281. doi:10.1002/pon.564

Barton, J., & Pretty, J. (2010). What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. *Environmental Science & Technology, 44*(10), 3947-3955. doi:10.1021/es903183r

Baum, A., Fleming, R., & Singer, J. E. (1985). Understanding environmental stress: Strategies for conceptual and methodological integration. In A. Baum & J. E. Singer (Eds.), *Advances in Environmental Psychology*. Hillsdale, NJ: Lawrence Erlbaum Associates, vol. 5, *Methods and Environmental Psychology*, 185-205.

Berto, R. The role of nature in coping with psychophysiological stress: A literature review on restorativeness. *Behavioral Sciences, 4*(4), 394-409. doi:10.3390/bs4040394

Beter door Beeld. (2018). *Specificaties RelaxMaker*. Retrieved from https://relaxmaker.com /specificaties/

Beukeboom, C. J., Langeveld, D., & Tanja-Dijkstra, K. (2012). Stress reducing effects of real and artificial nature in a hospital waiting room. *Journal of Alternative and Complementary Medicine, 18*(4), 329-333. doi:10.1089/acm.2011.0488

Boomsma, C., Pahl, S., & Andrade, J. (2016). Imagining change: An integrative approach toward explaining the motivational role of mental imagery in pro-environmental behavior. *Frontiers in Psychology, 7*. doi:10.3389/fpsyg.2016.01780

Brennum, J., Kjeldsen, M., Jensen, K., & Jensen, T. S. (1989). Measurements of human pressure-pain thresholds on fingers and toes. *Pain, 38*(2), 211-217. doi:10.1016/0304 -3959(89)90240-6

Breuer, H. W. M., Charchut, S., & Worth, H. (1989). Effects of diagnostic procedures during fiberoptic bronchoscopy on heart rate, blood pressure, and blood gases. *Klinische Wochenschrift, 67*(10), 524-529. https://doi.org/10.1007/BF01719777

Brush, R. O. (1978). Forests can be managed for esthetics: A study of forest land owners in Massachusetts. In *Proceedings of the National Urban Forestry Conference* (pp. 349-360). Syracuse, NY: SUNY College of Environmental Science and Forestry and USDA Forest Service.

Button, K., Ioannidis, J. P. A., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. S. J., Munafò, B. A. (2013). Power failure: Why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience, 14*(6), 365-376. http://dx.doi.org/10 .1038/nrn3502

Chadha, M., Kulshrestha, M., & Biyani, A. (2015). Anaesthesia for bronchoscopy. *Indian Journal of Anaesthesia*, *59*(9), 565-573. doi:10.4103/0019-5049.165851

Craik, K. H. (1970). *A system of landscape dimensions: Appraisal of its objectivity and illustration of its scientific application* (Report to Resources of the Future, Inc.). Berkeley: University of California Institute of Personality Assessment and Research.

Cullen, G. (1961). *Townscape*. New York, NY: Reinhold.

Daykin, N., Byrne, E., Soteriou, T., O'Connor, S. (2008). The impact of art, design and environment in mental healthcare: A systematic review of the literature. *Journal of the Royal Society for the Promotion of Health*, *128*(2), 85-94. doi: 10.1177 /1466424007087806

Diette, G. B., Lechtzin, N., Haponik, E., Devrotes, A., & Rubin, H. R. (2003). Distraction therapy with nature sights and sounds reduces pain during flexible bronchoscopy: A complementary approach to routine analegesia. *CHEST Journal, 123*(3), 941-948. https://doi.org/10.1378/chest.123.3.941

Empatica Inc. (2018). *E4 wristband from Empatica*. Retrieved from https://www.empatica .com/research/e4/

Felsten, G. (2009). Where to take a study break on the college campus: An attention restoration theory perspective. *Journal of Environmental Psychology, 29*(1), 160-167. doi:10.1016/j.jenvp.2008.11 .006

Fernandez, E. (1986). A classification system of cognitive coping strategies for pain. *Pain, 26*(2), 141-151. doi:10.1016/0304-3959(86)90070-9

Fisher, J. D., Bell, P. A. & Baum, A. (1984). *Environmental Psychology* (2nd ed.). New York, NY: Holt, Rinehart & Winston.

Gatchel, R. J., Baum, A., & Krantz, D. S. (1989). *An introduction to Health Psychology* (2nd ed.). New York, NY: McGraw-Hill.

Gidlow, C. J., Jones, M. V., Hurst, G., Masterson, D., Clark-Carter, D., Tarvainen, M. P., . . . Nieuwenhuijsen, M. (2016). Where to put your best foot forward: Psycho-physiological responses to walking in natural and urban environments. *Journal of Environmental Psychology, 45,* 22-29. https://doi.org/10.1016/j.jenvp.2015.11.003

Gregory, R. (1970). *The Intelligent Eye*. London, England: Weidenfeld and Nicolson.

Guyton, A. C., & Hall, J. E. (2006). *Textbook of Medical Physiology*. Philadelphia, PA: Elsevier Saunders.

Hansson, M., & Jönsson, P. (2006). Estimation of HRV spectrogram using multiple window methods focusing on the high frequency power. *Medical Engineering & Physics, 28*(8), 749-761. doi:10.1016/j.medengphy.2005.11.004

Hardy, C. H., & Rejeski, W. J. (1989). Not what, but how one feels: The measurement of affect during exercise. *Journal of Sport and Exercise Psychology, 11*(3), 304-317. doi:10 .1123/jsep.11.3.304

Hartig, T., Nyberg, L., Nilsson, L. G., & Gärling, T. (1999). Testing for mood congruent recall with environmentally induced mood. *Journal of Environmental Psychology, 19*(4), 353-367. https://doi.org/10.1006/jevp.1999.0142

Heerwagen, J. H. (1990). Psychological aspects of windows and window design. In R. I. Selby, K. H. Anthony, J. Choi, & B. Orland (Eds.), *Proceedings of the 21st Annual Conference of the Environmental Design Research Association* (pp. 269-280). Oklahoma City, OK: Environmental Design Research Association.

Herzog, T. R., Black, A. M., Fountaine, K. A., & Knotts, D. J. (1997). Reflection and attentional recovery as distinctive benefits of restorative environments. *Journal of Environmental Psychology, 17*(2), 165–170. http://dx.doi.org/10.1006/jevp.1997.0051

Hubbard, H. V., & Kimball, T. (1967). *An introduction to the study of landscape design*. Boston, MA: Hubbard Educational Trust.

James, W. (1892). *Psychology: The briefer course*. New York, NY: Holt.

Johnson, J. E., Morrissey, J. F., & Leventhal, H. (1973). Psychological preparation for an endoscopic examination. *Gastrointestinal Endoscopy, 19*(4), 180–182. doi:10.1016 /S0016-5107(73)73995-X

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology, 15*(3), 169-182. https://doi.org/10.1016/0272-4944(95)90001-2

Kaplan, S. (2001). Meditation, restoration, and the management of mental fatigue. *Environment & Behavior, 33*(4), 480-506. https://doi.org/10.1177/00139160121973106

Kaplan, S., & Berman, M. G. (2010). Directed attention as a common resource for executive functioning and self-regulation. *Perspectives on Psychological Science, 5*(1), 43-57. https://doi.org/10.1177/1745691609356784

Kaplan, S., & Kaplan, R. (1981). *Cognition and Environment: Functioning in an Uncertain World*. Ann Arbor, MI: Ulrich's.

Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective*. Cambridge: Cambridge University Press.

Kates, S. G., McGinley, K. J., Larson, E. L., & Leyden, J. J. (1991) Indigenous multiresistant bacteria from flowers in hospital and nonhospital environments. *American Journal of Infection Control, 19*(3), 156-161. https://doi.org/10.1016/0196-6553(91)90022-5

Kavanagh, D. J., Andrade, J., & May, J. (2005). Imaginary relish and exquisite torture: The elaborated intrusion theory of desire. *Psychological Review, 112*, 446-467. doi:10.1037/0033-295X.112.2.446

Kent, G. Cognitive processes in dental anxiety. British Journal of Clinical Psychology, 24(4), 259-264. https://doi.org/10.1111/j.2044-8260.1985.tb00658.x

Kleinknecht R. A., & Bernstein, D. A. (1978). The assessment of dental fear. *Behavior Therapy, 9*(4), 626–634. https://doi.org/10.1016/S0005-7894(78)80138-5

Kreibig, S. D. (2010). Autonomic nervous system activity in emotion: A review. *Biological Psychology, 84*(3), 394-421. https://doi.org/10.1016/j.biopsycho.2010.03.010

Lang, E. V., Benotsch, E.G., Fick, L. J., Lutgendorf, S., Berbaum, M. L., Berbaum, K. S., Logan, H., & Spiegel, D. (2000). Adjunctive nonpharmacological analgesia for invasive medical procedures: A randomized trial. *Lancet, 355*(9214), 1486–1490. doi: 10.1016/S0140-6736(00)02162-0

Laumann, K., Gärling, T., & Stormark, K. M. (2003). Selective attention and heart rate responses to natural and urban environments. *Journal of Environmental Psychology, 23*(2), 125-134. https://doi.org/10.1016/S0272-4944(02)00110-X

Lechtzin, N., Rubin, H. R., Jenckes, M., White, P., Zhou, L., Thompson, D. A., & Diette, G. B. (2000). Predictors of pain control in patients undergoing flexible bronchoscopy. *American Journal of Respiratory and Critical Care Medicine, 162*(2), 440-445. doi:10 .1164/ajrccm.162.2.9910022

Malkin, J. (2008). *A Visual Reference for Evidence-based Design*. Concord, CA: Center for Health Design.

Mendes de Leon, C., Bezel, R., Karrer, W., & Brandli, O. (1986). Premedication in fibreoptic bronchoscopy from the patient's and the physician's viewpoint: A randomized study for the comparison of midazolam and hydrocodone. *Schweizerische Medizinische Wochenschrift, 116*(37), 1267–1272.

Mori, K., Saito, Y., Suga, Y., Takahashi, T., Yokoi, K., Miyazawa, N., & Tanaka, A. (1993). A study of pharyngeal symptoms caused by bronchofiberscopy. *Japanese Journal of Clinical Oncology, 23*(3), 162-165. https://doi.org/10.1093/oxfordjournals.jjco.a039627

Park, S-H., Mattson, R.H. (2009). Ornamental indoor plants in hospital rooms enhanced health outcomes of patients recovering from surgery. *Journal of Alternative and Complementary Medicine, 15*(9), 975-980. https://doi.org/10.1089/acm.2009.0075

Pickles, J., Jeffrey, M., Datta, A., & Jeffrey, A. A. (2003). Is preparation for bronchoscopy optimal? *European Respiratory Journal, 22*, 203-206. doi:10.1183/09031936.03 .00118302

Poi, P. J. H., Chuan, S. Y., Srinivas, P., & Liam, C. K. (1998). Common fears of patients undergoing bronchoscopy. *European Respiratory Journal, 11*(5), 1147-1149. doi:10.1183 /09031936.98 .11051147

Prakash, U. B., Offord, K.P., & Stubbs, S. E. (1991). Bronchoscopy in North America: The ACCP survey. *CHEST Journal, 100*(6), 1668–1675. https://doi.org/10.1378/chest.100.6 .1668

Redelmeier, D. A., Katz, J., & Kahneman, D. (2003). Memories of colonoscopy: A randomized trial. *Pain, 104*(1), 187-194. doi:10.1016/S0304-3959(03)00003-4

Rolo, R., Mota, P. C., Coelho, F., Alves, D., Fernandes, G., Cunha, J., Hespanhol, V., & Magalhães, A. (2012). Sedation with midazolam in flexible bronchoscopy – A prospective study. *Revista Portuguesa de Pneumologia, 18*(5), 226-232. https://doi.org /10.1016/j.rppnen.2012.04.002

Shacham, S. (1983). A Shortened Version of the Profile of Mood States. *Journal of Personality Assessment*, *47*(3), 305-306. https://doi.org/10.1207/s15327752jpa4703_14

Shafer, E. L., Hamilton, J. F., & Schmidt, E. A. (1969). Natural landscape preferences: A predictive model. *Journal of Leisure Research*, *1*(1), 1-19. https://doi.org/10.1080 /00222216.1969.11969706

Sternberg, E. M. (2009). *Healing Spaces: the science of place and well-being*. London, England: The Belknap Press of Harvard University Press.

Svebak, S., & Murgatroyd, S. (1985). Metamotivational dominance: A multimethod validation of reversal theory constructs. *Journal of Personality and Social Psychology, 48*(1), 107-116. doi:10.1037/0022-3514.48.1.107

Tanja-Dijkstra, K., Pahl, S., White, M. P., Auvray, M., Stone, R., Andrade, J., May, J., Mills., I., & Moles, D. R. The soothing sea: A virtual coastal walk can reduce experienced and recollected pain. Environment and Behavior, 50(6), 599-625. https://doi.org/10.1177 /0013916517710077

Tarvainen, L., Ojala, A., Korpela, K., Lanki, T., Tsunetsugu, Y., & Kagawa, T. (2014). The influence of urban green environments on stress relief measures: A field experiment. *Journal of Environmental Psychology, 38*, 1-9. https://doi.org/10.1016/j.jenvp.2013.12 .005

Tenholder, M. F., Ewald, F. W., Smith, J. K., & Brown, E. G. (1995). Blood pressure measurements during flexible bronchoscopy. *Journal of Bronchology & Interventional Pulmonology*, *2*, 206-210.

Terkelsen, A. J., Andersen, O. K., Mølgaard, H., Hansen, J., & Jensen, T. S. (2004). Mental stress inhibits pain perception and heart rate variability but not a nociceptive withdrawal reflex. *Acta Physiologica Scandinavica, 180*(4), 405-414. https://doi.org/10.1111/j.1365 -201X.2004.01263.x

Tsunetsugu, Y., Park, B. J., & Miyazaki, Y. (2010). Trends in research related to "Shinrin-yoku" (taking in the forest atmosphere or forest bathing) in Japan. *Environmental Health and Preventive Medicine, 15*(1), 27-37. doi:10.1007/s12199-009-0091-z

Ulrich, R. S. (1983). Aesthetic and affective response to natural environment. In I. Altman & J. F. Wohlwill (Eds.), *Human Behavior and Environment* (Vol.6). *Behavior and Natural Environment* (pp. 85-125). New York, NY: Plenum.

Ulrich, R.S. (1984). View through a window may influence recovery from surgery. *Science, 224*(4647), 420-421. doi:10.1126/science.6143402

Ulrich, R. S. (1991). Effects of interior design on wellness: theory and recent scientific research. *Journal of Health Care Interior Design, 3*(1), 97-109.

Ulrich, R.S (1995). Effects of healthcare interior design on wellness: Theory and recent scientific research. In Marberry, S.O. (Ed.). *Innovations in healthcare design* (pp. 88-104). New York, NY: Van Nostrand Reinhold.

Ulrich, R. S. (1999). Effects of gardens on health outcomes: theory and research. In *Healing Gardens*, C. Cooper Marcus and M. Barnes (Eds.), pp. 27-86. New York, NY: John Wiley & Sons.

Ulrich, R. S., & Lundén, O. (1990). *Effects of Nature and Abstract Pictures on patients recovering from open heart surgery*. Paper presented at the International Congress of Behavioral Medicine, Uppsala, Sweden, June 27-30, 1990.

Ulrich, R. S., Simons, R. F., Losito, B., D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology, 11*(3), 201-230. https://doi.org/10.1016/S02724944 (05)80184 -7

Ulrich, R. S., Zimring, C., Quan, X., & Joseph, A. (2006). The environment's impact on stress. Chapter 3 in Marberry, S. O. (Ed.), *Improving Healthcare with Better Building Design*, pp. 37-61. Chicago, IL: ACHE Management Series/Health Administration Press.

Ulrich, R., Zimring, C., Quan, X., Joseph, A., & Choudhary, R. (2004). *The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity*. Martinez, CA: The Center for Health Design.

Walch, J. M., Rabin, B. S., Day, R., Williams, J. N., Choi, K., & Kang, J. D. (2005). The effects of sunlight on postoperative analgesic medication use: A prospective study of patients undergoing spinal surgery. *Psychosomatic Medicine, 67*(1), 156-163. doi:10 .1097/01.psy.0000149258.42508.70

Watts, G., Khan, A., & Pheasant, R. (2016). Influence of soundscape and interior design on anxiety and perceived tranquility of patients in a healthcare setting. *Applied Acoustics, 104*, 135-141. http://dx.doi.org/10.1016/j.apacoust.2015.11.007

Appendix A. Pretest questionnaire

Vragenlijst

Deelnemer code: ☐

Voorafgaand aan de bronchoscopie

Algemene vragen

1. **Wat is uw geslacht?**
   - ❑ Man
   - ❑ Vrouw

2. **Wat is uw geboortedatum?**

   Dag ☐☐ - Maand ☐☐ - Jaar ☐☐☐☐

Wat is uw stemming op dit moment?
Omcirkel het cijfer dat het best weergeeft hoe uw stemming op dit moment is.

Heel slecht	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Heel goed**

De volgende stelling meet hoe ontspannen/kalm ofwel gespannen/onrustig u zich voe
cijfer dat het best weergeeft hoe u zich voelt op dit moment.

Ik voel me op dit moment:

Gespannen, onrustig	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Ontspannen, kalm**

Appendix B. Posttest questionnaire

<u>Na de bronchoscopie</u>

Wat is uw stemming op dit moment?

Omcirkel het cijfer dat het best weergeeft hoe uw stemming op dit moment is.

Heel slecht	1	2	3	4	5	6	7	Heel goed

De volgende stelling meet hoe ontspannen/kalm ofwel gespannen/onrustig u zich voelt. Omcirkel het cijfer dat het best weergeeft hoe u zich voelt op dit moment.
Ik voel me op dit moment:

Gespannen, onrustig	1	2	3	4	5	6	7	Ontspannen, kalm

Hoe prettig of onprettig vond u het inbrengen van de bronchoscoop?
Omcirkel het cijfer dat het beste bij uw ervaring past.

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?
Omcirkel het cijfer dat het beste bij uw ervaring past.

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 bronchoscopie?
Omcirkel 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 niet pijnlijk

Hieronder staat 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]

Hieronder staat een aantal stellingen. Omcirkel bij elke stelling het cijfer dat voor u het meest van toepassing is.

Ik vind dit een fascinerend filmpje.

Helemaal mee oneens	1	2	3	4	5	Helemaal mee eens

Dit filmpje bleef me boeien tijdens de bronchoscopie.

Helemaal mee oneens	1	2	3	4	5	Helemaal mee eens

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

Helemaal mee oneens	1	2	3	4	5	Helemaal mee eens

Ik had het idee door het filmpje afgeleid te zijn van de bronchoscopie.

Helemaal mee oneens	1	2	3	4	5	Helemaal mee eens

Appendix C. Follow-up questionnaire

Vragenlijst: week na bronchoscopie

Deelnemerscode:

Als u nu terugdenkt aan de bronchoscopie, kunt u dan aangeven hoe uw stemming was op dat moment? Omcirkel het cijfer dat het best weergeeft hoe uw stemming tijdens de bronchoscopie was.

Mijn stemming tijdens de bronchoscopie was:

Heel slecht	1	2	3	4	5	6	7	Heel goed

De volgende stelling meet hoe ontspannen/kalm ofwel gespannen/onrustig u zich voelde. Omcirkel het cijfer dat het best weergeeft hoe u zich tijdens de bronchoscopie voelde.

Ik voelde me tijdens de bronchoscopie:

Gespannen, onrustig	1	2	3	4	5	6	7	Ontspannen, kalm

Stel dat u nogmaals een bronchoscopie zou moeten ondergaan, hoe erg ziet u daar dan tegenop?
Omcirkel het cijfer dat het beste bij uw gevoel past.

Ik zie er heel erg tegenop	1	2	3	4	5	6	7	Ik zie er helemaal niet tegenop

Hoe prettig of onprettig vond u het inbrengen van de bronchoscoop?
Omcirkel het cijfer dat het beste bij uw ervaring past.

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? Omcirkel het cijfer dat het beste bij uw ervaring past.

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 bronchoscopie?
Omcirkel 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 niet pijnlijk.

Als u weer een bronchoscopie zou moeten ondergaan, zou u dan kiezen om de bril op te zetten?

- ❑ Zeker wel
- ❑ Waarschijnlijk wel
- ❑ Misschien wel, misschien niet
- ❑ Waarschijnlijk niet
- ❑ Zeker niet