Journal of Environmental Psychology 30 (2010) 464–472

Contents lists available at ScienceDirect

Journal of Environmental Psychology

journal homepage: www.elsevier.com/locate/jep

A comparison of the restorative effect of a natural environment with that of a simulated natural environment

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ARTICLE INFO

Article history:
Available online 4 February 2010

Keywords:
Restorative environments
Altered states of consciousness
Restoration
Stress
Energy

ABSTRACT

This study aimed to compare the restorative effects of 30 min relaxation in a natural environment with an indoor simulation of the same natural environment. A repeated-measure design was carried out and 18 participants suffering from stress and/or burnout syndrome were counterbalanced into the two conditions. Both physiological measures and psychological instruments were applied. Further, qualitative descriptions of experiences were obtained. A phenomenological analysis of the qualitative data resulted in six categories for the natural environment: *Intensified sensory perception; A feeling of harmony and union with nature; Well-being and quality of life; Renewed energy and awakening; "Here-and-now" thinking*; and *A sense of tranquillity*, while for the simulated natural environment, there were five categories: *Restlessness and anxiety; Lack of concentration; A sense of being cut off from nature's sensory input; A longing to be in 'real' nature;* and *Positive emotions.* The natural environment yielded a significantly higher rating of degree of altered states of consciousness (ASC) and energy than the simulated natural environment. The results suggest that both environments facilitated stress reduction, with the natural environment additionally bringing increased energy and ASC, thus possibly enhancing and promoting restoration.

1. Introduction

Stress-related illnesses such as burnout syndrome, fatigue, depression and stress-related illnesses have increased in number and frequency in recent decades in western societies (e.g., Ekman & Arnetz, 2005; Folkow, 2005). To improve health and well-being, research on different relaxation techniques such as yoga, meditation and flotation tank therapy has been performed (e.g., Bood, 2007; Kjellgren, Bood, Axelsson, Norlander, & Saatcioglu, 2007). Research on restorative environments and psychological restoration could complement present efforts towards preventing stress-related illnesses. The present study contributes to the literature on restorative environments by comparing restoration in a natural environment with restoration in a simulation of the same natural environment, and by considering alteration of states of consciousness as an outcome of environmental experience potentially relevant for restoration.

1.1. Restoration and restorative environments

A restorative environment is one which can help to restore depleted emotional and functional resources and capabilities. The assumption that recovery from stress takes place in the absence of stressors is a simplification of the recovery process. Some environments may facilitate restoration more completely than others (Hartig, 2005).

Two prominent frameworks coexist (Hartig, Böök, Garvill, Olsson, & Gärling, 1996). One framework focuses on diminished psycho-physiological stress in relation to restoration in the natural environment (Ulrich, 1983; Ulrich et al., 1991), and the other involves a cognitive framework concerned with recovery from directed attention fatigue (Kaplan & Kaplan, 1989; Kaplan, 1995).

Ulrich (1983) (Ulrich et al., 1991) focuses mainly on the visual perception of the environments in his psycho-evolutionary theory. Surroundings with depth, complexity, structure, and water, support behaviours relevant to an individual's well being. Humans have an evolutionary, aesthetic preference for the natural environment. Visiting visually pleasant surroundings contributes towards reducing stress by restricting negative thoughts and eliciting positive emotions, as well as enhancing parasympathetic nervous system activity.

Attention Restoration Theory (ART) (Kaplan & Kaplan, 1989; Kaplan, 1995) includes a cognitive framework concerned with recovery from directed attention fatigue. In urban settings and modern society, directed attention is an important resource for coping with various demands. However, directed attention is assumed to depend on an inhibitory mechanism that is subject to

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doi:10.1016/j.jenvp.2010.01.011

fatigue. Directed attention fatigue may result in negative corollaries somehow similar to certain deficits in the frontal lobe; diminished helping behaviour, inability to plan, and failure to recognize interpersonal cues. ART suggests that persons suffering from directed attention fatigue will be restored faster by fascination. This refers to an effortless type of attention, drawn by stimuli that are fascinating in themselves, that do not require any mental resources, and are reasonably complex and coherent.

The assumption of these frameworks is that natural environments appear to offer a restorative advantage in comparison to urban environments (e.g., Grahn & Stigsdotter, 2003; Hartig et al., 1996; Ulrich et al., 1991).

1.2. Natural vs. simulated vs. urban environments

Several studies have explored the difference in restoration between simulated natural and simulated urban environments and have found that the simulated natural environment engendered generally more positive emotional self-reports, faster recovery from stress, and better recovery from directed attention fatigue than did the simulated urban environment (e.g., Berto, 2005; Hartig et al., 1996; Laumann, Gärling, & Stormark, 2003; Ulrich et al., 1991).

Some studies on the restorative effect of natural environments have brought participants to visit a natural environment (e.g., Hartig, Mang, & Evans, 1991), others have investigated the effects of looking at natural environment through a window (e.g., Ulrich, 1984) and found positive therapeutic effects, and others have been performed in laboratories assuming 'experimental isomorphism', in other words, assuming that exposure to a simulated natural environment will result in similar restorative outcomes to exposure to an actual natural environment (de Kort, Meijnders, Sponselee, & Ijsselsteijn, 2006). Hence, the implicit assumption might have been that exposure to a simulated natural environment (slides, photographs or videos) is a satisfactory substitute for an actual natural environment. However, it might be speculated (according to Kaplan's ART) that a simulated natural environment might require more directed attention in order to focus on the simulation and exclude distracting sceneries than would an authentic natural environment; the former is less complete in natural scenery and might therefore be assumed to provide less effortless fascination.

1.3. Relaxation and altered states of consciousness

The Human Performance Group (HPG) at Karlstad University, Sweden has performed studies using relaxation in flotation tanks as an efficient method for treating chronic stress-related pain, burnout, depression and other stress-related disorders (e.g., Bood, 2007; Kjellgren, 2003; Kjellgren, Sundequist, Sundholm, Norlander, & Archer, 2004). In addition to the therapeutic effects of relaxation per se in the flotation tank observed during these studies, the altered states of consciousness (ASC) elicited during treatment in the flotation tank seem to contribute to an improved sense of well-being.

ASC, in general terms, are states of reality that are separate from an individual's normal day-to-day reality. They are characterised, among other things, by alterations in cognition and perception, changes in emotional expression, a sense of the ineffable, feelings of rejuvenation, and enhancements in quality of life (e.g., Kjellgren, 2003; Lawlis, 1996; Tart, 1972). An ASC is associated with a cognitive shift in favour of primary process oriented cognition; i.e., logical thinking and directed attention (secondary process) are pushed aside by more intuitive thinking, creativity, and non-directed fantasy (primary process) (Martindale, 1975, 1990; Norlander, Kjellgren, & Archer, 2003). Fischer (1971) describes a variety of mental states (i.e. tranquil, relaxed, aroused, hyperaroused, and ecstatic) that will elicit an altered state; in the present study, however, we focus on relaxation techniques that might induce a mildly altered state (more like day-dreaming or imagery).

Individuals most in need of relaxation techniques are often those who find it most difficult to initiate relaxation exercises; this complicates the use of various relaxation techniques (Maslach, 1998; Norlander, 1997). We wanted to investigate the extent to which the individuals most in need of relaxation (e.g., those suffering from stress and/or "burnout syndrome") would respond to and appreciate relaxing in a natural environment and in a simulated natural environment.

No explicit assumption has been found in terms of a natural environment's ability or a simulated natural environment's ability to elicit an ASC, despite an extensive search in the literature. However, attempts have been made to bring together a full range of human experiences, including self-transcendence and 'mystical' states of consciousness into the discourse of restorative environments (e.g., Davis, 1998). Since ASC during relaxation (based on our own earlier research) seems to be of importance contributing to beneficial effects of relaxation, we wanted to introduce this concept in connection with research with restorative environments.

We wanted to investigate the role of ASC in restorative environments. A qualitative measure was included in order to obtain a more complete understanding of thoughts and emotional experiences. Further, we wanted to shed light on whether or not exposure to a simulated natural environment will result in similar restorative outcomes and experiences as exposure to an actual natural environment. To the best of our knowledge, no one has yet carried out a similar comparison. We did not have any specified hypothesis or preconceptions regarding differences in the effects resulting from relaxation in the two different conditions.

1.4. Purpose

The aim of the present study was to compare the restorative effects of relaxation in a natural environment with those of relaxation in a simulated natural environment, in terms of some psychological and physiological measures, and to obtain qualitative descriptions of experiences gained while relaxing in each environment. We also wanted to evaluate the ability of natural and simulated natural environments to induce ASC.

2. Method

2.1. Participants

A sample of 65 people was randomly selected from the waiting list for flotation tank therapy at the stress clinic of the Human Performance Laboratories, Karlstad University (Sweden). The participants had been diagnosed, either according to their own statements or according to a physician's diagnosis, as suffering from stress and/or burnout syndrome. The participants received information about the study by mail and were given the opportunity to take part in the present study by responding to a letter of interest within a two-week deadline. A total of 11 letters were returned to sender due to unknown address. Of the remaining 54, a total of $n = 18$ agreed to participate in the experiment. The gender distribution amongst the participants was 14 female (78%) and 4 male (22%) with the mean age being 36.83 years (SD = 12.46). This distribution of 78% female corresponds to the gender distribution of the waiting list and to our previous studies on stress and burnout syndrome (Bood, 2007). The participants were counterbalanced into conditions to control for order effect; equal numbers of men

and women were randomly allocated into the two orders. To obtain background information, the Hospital Anxiety and Depression scale (HAD) (Herrmann, 1997) was applied (see Instruments below). Values below six are considered normal, those between six and ten are considered borderline, and all values over ten points indicate a probable depression-anxiety diagnosis. The mean HAD value for the depression scale was 6.28 points (SD = 3.95), while for the anxiety scale it was 7.83 points (SD = 3.49). This can be compared with the clinical boundary of 6 points for evidence of being borderline, in terms of both depression and anxiety, indicating that our participants could not be classified as 'healthy normal'.

2.2. Design

A repeated-measure design was implemented. The natural condition included inspecting the natural environment, and the simulated condition included viewing a slideshow of pictures of the same natural environment during a half hour.

2.3. Measures

2.3.1. HAD – hospital anxiety depression scale

The HAD instrument measures the individual's degree of anxiety and depression. This instrument consists of seven statements regarding depression and seven regarding anxiety, with four response alternatives. The validity and reliability of HAD has been examined by Herrmann (1997). This scale asked for symptoms in the last week.

2.3.2. Stress-VAS

This scale was used for measuring the individuals self-estimated level of current stress. This VAS-scale consists of a 100 mm horizontal line with the anchors "not at all stressed" (0 mm) on the left-hand side, and "maximally stressed" (100 mm) on the right-hand side. The question asked was: "How stressed do you feel right now?" Three VAS scales were applied during each condition and are subsequently labelled S-VAS1, S-VAS2, and S-VAS3, according to the order in which they were applied.

2.3.3. Syllogism I–II

The syllogism test requires logical and deductive thinking during a limited amount of time (Holmquist, 1974), and was utilized as a manipulative step towards inducing more stress and mental fatigue amongst the participants prior to exposure to each environment. It consists of twenty items and has a time limit of 5 min. The test was presented in two versions and the participants were counterbalanced to receive version I in the first condition and version II in the second condition, or receiving the tests in the opposite order. The syllogism test demands logical reasoning, here presented along with an illustrative example: "K is bigger than L, and M is bigger than K. Is L bigger than M?" Response alternatives were Yes, No, or Don't know.

2.3.4. Emotional state test

During exposure to each environment, the participants were asked to inspect and experience the simulated and the natural environment for half an hour, and reflect on "the influence of spring on human beings." In addition, the participants were asked to describe their emotional state in an open-ended question by writing up to ten sentences. The Emotional State Test contained written instructions about this.

2.3.5. SE – stress and energy

The SE instrument consists of two subscales and is a self-estimation instrument concerning individuals' stress and energy experiences. There are six items for the stress subscale and six items for the energy subscale. The response alternatives were arranged on a scale of 0–5 where 0 indicates "not at all" and 5 indicates "very much." The SE instrument has been validated by analyses taken from studies focusing on occupational burdens and pressures (Kjellberg & Iwanowski, 1989). Cronbach's alpha was 0.80 for the stress subscale, and 0.76 for the energy subscale.

2.3.6. EDN – experienced deviation from normal state

Utilizing the internationally applied psychometric instruments APZ-questionnaire and OAVAV (Dittrich, 1998) for obtaining judgments regarding altered states of consciousness, a shortened but similar instrument was modified for use with flotation tank therapy (Kjellgren, Sundequist, Norlander, & Archer, 2001). The original tests have been validated in several studies in different countries (Dittrich, 1998). The shortened version utilized in the present study consists of 29 questions, each followed by a Visual Analogue Scale (0–100 mm) (See Appendix 1). All points from the 29 items were averaged to form a "sum of experience" which reflects the total experience of deviation from normal states. The instrument acquired judgments regarding altered states of consciousness (ASC). Cronbach's alpha was 0.97 when the instrument was applied in the simulated natural environment and 0.96 when it was applied in the actual natural environment.

2.3.7. Physiological measures

The pulse and the systolic and diastolic blood pressure were measured immediately before and after the half hour of relaxation on each occasion using an automatic OMRON M4-I blood pressure monitor (arm cuff, BHS validation, British Hypertension Society, 2008). In addition, the automatic OMRON M4-I was calibrated every morning before the tests against a manual blood pressure cuff (Welch Allyn SK), as well as on a weekly basis against a Polygraph Biopac 100, by our registered nurse. The measure was applied equally to both environments; hence the participants were sitting in a relaxed position in both the natural and simulated natural environments during the entire intervention as well as when the measures were applied. The first measure was applied subsequent to the participants fulfilling the background variable, which means that they had been sitting down for approximately 30 min prior to the measure. They were therefore assumed to be physically comfortable and calm. The second measure was applied immediately after the 30 min of relaxation. The cuff was attached and removed directly before and after each time of measuring.

2.3.8. Environments

The natural environment consisted of the woods in Karlstad Nature Park (*Mariebergsskogen*) with 400 year-old pines and deciduous trees, as well as lakes, and rivers. The Nature Park is a unique ancient woodland that is easily accessible, providing both wide and smooth footpaths and trails. See Fig. 1 for a photo showing the view towards to the south from the bench where participants were seated in the park.

For the simulated natural environment a quiet, dimly lit room (12 m^2) without windows was utilized, located in the Human Performance Laboratory. The only equipment in this room was a table, chairs and the TV/video equipment. The participants were seated at the table at a distance of 2 m from the TV-screen to enhance their feeling of presence during the slideshow, in accordance with a concept presented by de Kort et al. (2006). The slideshow, consisting of 97 photographs, was made in Windows Movie Maker Version 5.1, and displayed at 10-second intervals. The slides were visually displayed using a DVD-player connected to a 28 inch TV. The photographs (used in the simulated natural

Fig. 1. The view towards to the south from the bench where participants were seated in the park.

environment) were taken in Karlstad Nature Park on one occasion in April under clear sky using a Canon IXUSi camera with a 6.4 mm lens. The scenery visible on the photographs displayed the scenery visible from the benches in the natural environment

2.4. Procedure

Each participant's initial contact with the present study was the information mailed to him or her about the study. After returning a letter of interest, the participants received a phone call regarding details of the study (location, time, etc.). The information given to the participants during the initial contact was strict (no mention of the hypothesis) and the additional oral instructions regarding the procedure were standardized. All instruments contained written instructions. In order to make the two environments comparable, we implemented the natural condition during weather conditions similar to those visible on the slides utilized in the simulated condition (a clear sky).

Data was gathered for each participant on 2 separate occasions in a simulated natural environment at the Psychology Department of Karlstad University (Karlstad, Sweden), and in a natural environment in the woods of Karlstad Nature Park (*Mariebergsskogen*). No more than two participants attended simultaneously. For each participant, a period of six to eight days elapsed between exposures to the two conditions.

Upon arrival at the natural environment setting (the walking distance was 500 m from the car park) and upon arrival at the simulated natural environment in the laboratory (approximately the same walking distance), all the participants signed a written consent regarding their guarantee of anonymity and their right to withdraw whenever they wanted. The participants then were requested to complete the HAD. This instrument was used as a background variable and was thus only applied on the first occasion. Subsequently, the questionnaires were identical on each occasion with regard to the sequence of the tests. The S-VAS1 scale regarding the individual's experienced stress level was applied. Then the syllogism test was applied as a manipulative step towards inducing a state of stress and mental fatigue in participants before exposing them to the natural and simulated natural environments. To reveal its stress-inducing effect, the S-VAS2 scale was applied after the syllogism test. A physiological measure of stress was applied immediately thereafter; each participant's blood pressure and pulse were measured using an automatic monitor (OMRON M4-I). The participants were then asked to relax for half an hour, inspect the simulated and natural environments and to reflect upon the influence of spring on human beings. This task was inspired by a meditation exercise (Brügge, Glantz, & Sandell, 2007). Whilst completing the relaxation exercise in the simulated natural environment, participants viewed a slideshow composed of photographs taken at the exact location of the natural environment setting. Participants were seated at a table a distance of 2 m from the screen. During the intervention in the natural environment, participants were seated on benches in the Nature Park. Participants were not allowed to move around in either condition after arrival. A second round of blood pressure and pulse measurements were taken immediately after the relaxation exercise, using an automatic monitor. Further, the participants were asked to describe their emotions and thoughts in an open-ended question. In addition, three instruments (S-VAS3, SE and EDN) were then applied. All questionnaires were coded to achieve anonymity.

2.5. Analysis and statistics

Quantitative data were analyzed using SPSS 15.0. These analyses are described in the results section. For all the various quantitative measures mixed ANOVAs with Order (natural first, simulated first) were performed, checking for order effects. No such order effects were found ($ps > 0.11$). These results are omitted from the presentation in the Results section.

The Empirical Phenomenological Psychological method (EPP) was used when processing the qualitative data from the Emotional State Test. The EPP method, devised by Karlsson (1995), entails an analysis in several stages including techniques for dividing the text into Meaning Units (MUs).

Step 1. In this first step, the written descriptions were read three times in order to gain a good understanding of the material and to separate relevant psychological phenomenon without testing validity or any hypothesis.
Step 2. In the second step of the analysis, material was divided into so-called Meaning Units. The division did not follow any grammatical rules, but was made when researchers experienced a shift in meaning. A total of 84 MUs were identified in the natural environment sample, and a total of 49 MUs were identified in the simulated natural environment sample.
Step 3. Each MU was then transformed from the language of the participant to the language of the researcher, or into a language relevant to the research question. An example: "The participant experienced a feeling of harmony".
Step 4. In this final step, the transformed MUs were synthesized into categories or situated structures. An attempt is made to

describe "how" (noesis) the phenomenon expresses itself, and "what" (noema) the phenomenon is. The categories or situated structures were developed during processing whereby repeated consultations of the raw data continued in a hermeneutic manner. The level of abstraction for presenting the results was decided upon, according to the principle that clarity should be attained without excessive detail. The purpose is to reflect on a more abstract level. Six categories appeared from the natural environment sample, while the simulated natural environment sample generated five categories.

Each environment was analysed separately. A control for ordering-effect (natural first, simulated first) regarding the participants' qualitative descriptions was carried out. No such patterns of differences could be found. The results will be presented separately for each environment.

A trustworthiness test, the Norlander Credibility Test (NCT), was used for the phenomenological analysis (e.g., Edebol, Bood, & Norlander, 2008; Norlander, Gård, Lindholm, & Archer, 2003; Pramling, Norlander, & Archer, 2001; Pramling, Norlander, & Archer, 2003) in order to ensure reliability. It was conducted randomly selecting five of the eleven categories. Thereafter, four of the MUs were randomly selected from each of the five categories. The material was then given to two independent assessors. Their assignment was to put the twenty MUs into the five different categories. One of the tests yielded an 85% agreement, and the other test yielded a 79% agreement. The overall agreement was thus 82%.

2.6. Manipulation checks

In order to check the "stress-inducing effect" of the Syllogism test, a repeated-measure ANOVA was performed. There was a significant increase ($ps < 0.003$) in Stress (as measured with VAS-scales) before and after the syllogism test in both environments, indicating that the Syllogism test did induce a state of heightened stress or arousal.

3. Results

3.1. Physiological measures

3.1.1. Pulse

The analysis yielded a significant difference for Time, where the pulse was lower after the relaxation period ($M = 65.56$, SD = 7.09) than before ($M = 69.17$, SD = 7.98). There were no other significant effects ($ps > 0.56$). (See Tables 1 and 2).

3.1.2. Systolic blood pressure

The analysis yielded a significant difference for Time, where the systolic blood pressure was lower after the relaxation period ($M = 124.9$, SD = 19.28) than before ($M = 128.1$, SD = 18.81). In addition, there was a significant Time × Environment interaction effect, indicating that the simulated natural environment lowered the systolic blood pressure while the natural environment did not lower the systolic pressure. There was no other significant effect ($p = 0.79$). (See Tables 1 and 2).

3.1.3. Diastolic blood pressure

The analysis yielded a significant difference for Time, where the diastolic blood pressure was lower after the relaxation period ($M = 78.39$, SD = 9.51) than before ($M = 82.17$, SD = 9.22). There were no other significant effects ($ps > 0.23$). (See Tables 1 and 2).

3.2. Psychological measures

3.2.1. Stress (as measured using the SE test)

No significant effects were found ($ps > 0.60$). (See Tables 1 and 2).

3.2.2. Energy (as measured using the SE test)

The analysis yielded a significant effect for Environment, where the energy after natural environment was higher than after the simulated natural environment. (See Tables 1 and 2).

3.2.3. Altered states of consciousness (EDN)

The analysis yielded a significant effect for Environment, where the EDN after natural environment was higher than after the simulated natural environment. (See Tables 1 and 2).

3.2.4. Stress (as measured using S-VAS)

A repeated-measure ANOVA was performed with Time (at arrival, pre- and post-test) and Environment (natural and simulated) as within-subject variables; the dependant variable was S-VAS. The analysis yielded a significant main effect for Time, where subsequent pairwise comparisons (Bonferroni correction) showed significant differences between all three S-VAS values ($ps < 0.003$). Mean value of S-VAS1 at arrival ($M = 18.03$, SD = 12.68) was significantly lower than S-VAS2 (pre-test, after the syllogism test), $M = 41.50$ (SD = 22.31), indicating the stressing effect of the syllogism test. Both S-VAS1 and S-VAS2 were significantly higher than S-VAS3 (post-test), $M = 9.94$ (SD = 8.10), indicating the stress-reducing effect of the relaxation, regardless of condition. Also, a main effect of Environment (averages across the three measures) was found, where the S-VAS in the simulated natural environment was a little higher ($M = 26.30$, SE = 14.17) than in the natural environment ($M = 20.02$, SD = 12.81). There was no significant Time × Environment interaction effect; indicating similar patterns of S-VAS values in both conditions (see Tables 2 and 3).

The Empirical Phenomenological Psychological method (EPP) (Karlsson, 1995) was used in analysing the qualitative data from the Emotional State Test. The results from each environment are presented below.

3.2.5. The natural environment sample

The analysis of the material yielded 85 MUs from which six categories emerged. Each category illustrated a special perspective on the phenomena studied. The categories were representative of all opinions described by the participants, except for one MU that could not be categorized due to the illegibility of the handwriting. Thus, it is not in any of the categories. The six categories are

Table 1
Means (M) and Standard deviations (SD) for the dependent variables as a function of environment and time.

Dependent variable	Environment	Pretest M (SD)	Posttest M (SD)
Pulse	Natural	69.89 (12.50) bpm	66.33 (9.11) bpm
	Simulated	68.44 (7.61)	64.78 (7.81)
Systolic bp	Natural	126.2 (18.64) mmHg	126.39 (20.81) mmHg
	Simulated	130.11 (21.40)	123.50 (18.75)
Diastolic bp	Natural	82.89 (9.92) mmHg	80.06(11.23) mmHg
	Simulated	81.44 (10.26)	76.72 (10.22)
SE-Stress[a]	Natural		5.33 (3.27)
	Simulated		5.89 (4.14)
SE-Energy[a]	Natural		13.89 (3.60)
	Simulated		11.44 (4.83)
EDN-ASC[a]	Natural		26.48 (20.53)
	Simulated		17.66 (19.21)

[a] Range of possible scores: SE-Stress 0–30; SE-Energy 0–30; EDN 0–100.

Table 2
Results of the statistical tests of the experimental effects on the physiological and psychological measures.

Dependant variable	F	p	Partial-eta^2
Pulse			
Time	19.16	0.001	0.53
Environment	0.35	0.56	0.02
Time × Environment	0.004	0.95	0.00
Systolic blood pressure			
Time	6.96	0.017	0.29
Environment	0.072	0.79	0.004
Time × Environment	7.57	0.014	0.31
Diastolic blood pressure			
Time	16.95	0.001	0.50
Environment	1.56	0.23	0.084
Time × Environment	0.91	0.35	0.051
Stress (SE-test)			
Environment	0.29	0.60	0.018
Energy (SE-test)			
Environment	9.31	0.008	0.37
Altered states of consciousness (EDN)			
Environment	6.25	0.024	0.28
Stress (S-VAS)			
Time	41.86#	0.001	0.71
Environment	5.36	0.033	0.24
Time × Environment	0.94#	0.40	0.052

For the two tests marked with #, degrees of freedom (df, df_{error}) was (2, 34). For all other tests degrees of freedoms were (1, 17).

presented below along with a few randomly selected citations. The categories are not presented in any particular order.

3.3. Intensified sensory perception (18 MUs)

The participants noticed nature surrounding them in an intense way. They enjoyed the natural environment and their sensory perceptions.

Examples "Delightful colours"/"After awhile I hear more and more sounds of nature"/"Beautiful surroundings"/"A nice smell of flowers"/"The singing of birds"/"My senses feel heightened now"/"Beautiful colours"/"I love the view".

3.4. A feeling of harmony and union with nature (12 MUs)

It seems to be the case that participants felt a union with nature that was experienced as positive. Their experiences of harmony with the natural environment seem to be of great significance.

Examples: "I feel at home here in the great outdoors"/"We are all one with nature and belong together"/"I feel a connection with nature"/"Nature makes me see and feel an all-embracing fellowship"/"The cycle of life"/"Connection"/"I got a feeling of harmony and union with nature. It was wonderful"/"The trees, the plants, and the animals are my friends. They do not judge me or make me sad"

3.5. Well-being and quality of life (17 MUs)

The participants found that the natural environment induced a positive state and enhanced their sense of well-being. They felt an improved quality of life during the half hour of relaxation in the natural environment.

Examples: "I felt happy, it was as if all my problems and worries disappeared while I was sitting there"/"I experienced a strong positive emotion that is not normally there"/"Right now I feel happy"/"This was the greatest feeling of quality of life"/"I feel so happy and fortunate to be experiencing this wonderful nature"/"Happiness"/"A good feeling"/"I feel that just sitting here amongst the trees is the strongest feeling of having quality of life"

3.6. Renewed energy and awakening (16 MUs)

The natural environment was experienced as a source of energy by the participants, and they felt that their energy levels increased after the half hour of relaxation in nature.

Examples: "The warm sun gives me a lot of energy"/"Nature is a great energy source"/"I feel myself and everything around me awakening"/"It feels like my mind has been restored"/"My thoughts are a lot clearer now"/"I feel more focused"/"Energy boost"/"Power"/"Exhilarated"

3.7. "Here-and-now" thinking (4 MUs)

Some of the participants felt like they were living in the present whilst they were relaxing in the natural environment. It seemed to be a positive experience.

Examples: "Just being, right here and now I am just watching a bumblebee flying around, that's all I'm doing"/"I don't think so much, I just am"/"For a change I am not thinking of anything else but just being here"

3.8. A sense of tranquillity (17 MUs)

The natural environment was experienced as a totally peaceful and calming place, which brought about an effortless relaxed state.

Examples: "All the sounds and smells and light makes me calm"/"The singing of the birds makes me feel relaxed"/"Permissive"/"Calming sounds"/"Internal quietness"/"Nature brings about a relaxed state"/"It is impossible to feel any stress when I am sitting here in the great outdoors"/"Just receiving"/"No effort is needed"

3.8.1. The simulated natural environment sample

The analysis of the material yielded 49 Meaning Units (MUs) from which five categories emerged. The categories include all but two MUs which could not be categorized due to the illegibility of the handwriting. The five categories are presented below along with a few randomly-selected citations. The categories are not presented in any particular order.

3.9. Restlessness and anxiety (5 MUs)

The relaxation in the simulated natural environment seemed to cause feelings of restlessness and anxiety in the participants.

Examples: "Restlessness"/"I feel tense"/"Frustration and anxiety"

3.10. Lack of concentration (4 MUs)

It was difficult for participants to maintain focus on the simulation displayed on the TV screen. Reports were made of negative experiences during exposure.

Table 3
Means (M) and Standard deviations (SD) of S-VAS scales in the natural and simulated environments on the three occasions: 1) at arrival, 2) after syllogism test = pre-test, and 3) post-test.

Dependent variable	Environment	Means	SD
S-VAS1 (at arrival)	Natural	14.33	10.88
	Simulated	21.72	15.83
S-VAS2 (pre-test)	Natural	37.78	23.44
	Simulated	45.22	23.63
S-VAS1 (post-test)	Natural	7.94	10.80
	Simulated	11.94	10.56

Possible range for S-VAS is 0–100.

Examples: "I am bored and annoyed."/"I feel apathetic and cannot concentrate"/"Lack of concentration"

3.11. A sense of being cut off from nature's sensory input (14 MUs)

The participants experienced a feeling of isolation from sensory input whilst exposed to the simulation of the natural environment. In this regard, the simulation was insignificant to the participants.

Examples: "Something is missing. I cannot experience nature with all of my senses"/"Empty and clichéd"/"The simulation is insignificant"/"I feel cut off from real nature"/"Missing the smells and sounds"/"Too quiet"

3.12. Longing to be in 'real' nature (12 MUs)

The participants described how they did not experience the simulation as a satisfactory substitute for a natural environment; that they longed to be in 'real' nature, and felt confined.

Examples: "I want to be outside in nice weather and the great outdoors; instead of sitting indoors in this room"/"I want to take an active part in nature, not just be a passive spectator"/"I wish to be outdoors"/"Longing to be outside"/"I feel a lonely quietness"/"I feel lonely and confined"

3.13. Positive emotions (12 MUs)

Feelings of freedom and happiness were described. The participants reported that being exposed to a simulation of the natural environment enhanced their feelings of well-being, and that they felt relaxed.

Examples: "I feel an inner peace."/"I feel happy."/"I feel free."/"I feel relaxed."/"No demands."/"Just being."/"Peace and quiet."

4. Discussion

The present study principally found that the actual natural environment resulted in a higher degree of ASC (Altered states of consciousness) and increased energy than did the simulated natural environment. Furthermore, it seemed as if both environments were equally efficient in reducing stress.

The phenomenological analysis (EPP-method) of the verbal descriptions obtained in the natural environment resulted in six categories describing positive experiences: *Intensified sensory perception*; *A feeling of harmony and union with nature; Well-being and quality of life; Renewed energy and awakening; "Here-and-now" thinking*; *A sense of tranquillity*. The experiences of relaxation in the simulated natural environment were partly characterized by positive experiences, but mainly by more negative descriptions; the EPP analysis yielding the following five categories: *Restlessness and anxiety; Lack of concentration; A sense of being cut off from nature's sensory input; Longing to be in 'real' nature;* and *Positive emotions*.

It is clear that the natural environment induced more ASC than the simulated natural environment. First, the participants' qualitative descriptions of the natural environment, i.e., intensified sensory perception; feeling of harmony and union with the surroundings, and "here-and-now" thinking, illustrate some of the hallmarks of an ASC. Second, this is supported by the quantitative analysis where the natural environment yielded a significantly higher degree of ASC (26 EDN-points) than did the simulated natural environment (17 EDN-points). Third, since ASC is associated with the primary process (Norlander, Kjellgren et al., 2003) which brings about increased originality and creativity, and subsequent effects on language content (Martindale, 1975, 1990; Neisser, 1967) this might offer an explanation of the more numerous MUs in the natural environment (85) than in the simulated natural environment (49). Finally, the descriptions obtained in the natural environment seemed to be more lengthy and detailed than the ones obtained in the simulated natural environment, also reflecting a more creative primary process oriented state. We propose that these differences indicate that the natural environment is superior to the simulated natural environment in eliciting an ASC.

An important aspect of restoration is the recovery of depleted energy resources, as is argued by the Attention Restoration Theory (ART) (Kaplan & Kaplan, 1989; Kaplan, 1995). Being in a mild ASC might be associated with some aspects of the recovery from directed attention fatigue. In addition to the higher degree of ASC, relaxation in the natural environment also yielded a significantly higher energy level (as measured with the SE-test) compared to that in the simulated natural environment. Qualitative descriptions also revealed the ability of nature to induce energy, i.e. to contribute towards restoration in the natural environment: "*Nature is a great energy source*"/"*It feels like my mind has been restored*".

Despite the fact the participants were not healthy persons (they were all suffering from stress and/or burnout syndrome) they all experienced many positive effects subsequent to a hard, stress-inducing task that required directed attention, during the relatively short period of relaxation (30 min) in the natural environment: this is a particularly noteworthy aspect of the study.

It is interesting to note the results of the qualitative reports in the simulated natural environment; positive experiences were achieved – but participants did not appreciate the time spent in that environment, as highlighted by the following citations: *"I am bored and annoyed"/"Something is missing"*. It seems as if the lack of complete natural scenery caused frustration. Perhaps the concept of presence (de Kort et al., 2006) plays a critical role in the participants more negative experiences, if it is hypothesized that the simulation lacked in presence. Contradictorily, the natural environment generated merely positive statements, perhaps mirroring more fascination and restoration: *"I feel a connection with nature"/" My senses feel heightened now"*. The positive emotions experienced in the simulated natural condition seem to correspond in part to some of the categories in the natural environment condition *(A sense of tranquillity* and *"Here-and-now thinking*) probably mirroring the stress reducing and relaxation effects. The remaining natural environment categories *(Intensified sensory perception, A feeling of harmony and union with nature, Well-being and quality of life*, and *Renewed energy and awakening)* do not appear to be represented in the simulated condition, probably indicating how the simulated natural environment fails to deliver the same experiential benefits as the natural environment, i.e., the photographic simulation allows people to relax and feel good, but fails to stimulate sensory perceptions, does not induce a feeling of connection with nature, and does not promote a sense of energy and awakening.

The physiological measures (pulse, blood pressure) as well as the S-VAS scales yielded significantly lower values after relaxation (than before), indicating a stress reducing effect. It must be remembered that the measures were collected in different locations; for the outdoor condition participants had significantly lower stress already at arrival and at the pre-test. The interpretations of the stress reducing effects of these tests therefore have to be considered as more precarious. There were no significant differences between the two environments in terms of lowering pulse and diastolic blood pressure, but systolic blood pressure was reduced in the simulated natural environment though not in the natural one. The latter might indicate a better potential for simulated natural environments reducing stress (if blood pressure is seen as indicative of stress reduction), or, on a speculative level, it might be hypothesized that the greater fascination offered in the natural environment brought about a pleasurable arousal in that environment. The quantitative analysis did not show any differences between perceived stress levels (SE-test) after the relaxation across the two conditions. In addition, the qualitative descriptions point to similar stress reducing potentials in both environments. The overall picture, as far as we can see, is that both the natural and the simulated natural environments seemed to be equally efficient in reducing stress for our participants.

Some limitations of this study need to be considered. Given that no similar comparisons of the restorative effects of natural and simulated natural environments have been carried out previously, the results of the present study are novel and would benefit from replication in similar settings. It is not clear whether a similar study would generate the same results if a larger sample were used, if gender distribution was more even, if individuals were not suffering from stress and/or burnout syndrome, if the intervention did not include a stress-inducing task, or if the level of stress on arrival in both conditions (as measured on the VAS scales) had been similar. Another limitation of the study is that results were not compared to a control condition (e.g., relaxation in a neutral condition). Finally, we recommend that future studies include a direct measure of "directed attention". Future studies are needed to evaluate suggested interpretations.

The findings of the present study suggest that both environments facilitate stress reduction in line with the positive effects of restorative environments, as described by Ulrich (1983) and that stress reduction alone might not be sufficient to completely explain beneficial effects and well-being. Some environments may facilitate restoration more completely than others (Hartig, 2005). The natural environment seemed to promote restoration and increased energy by offering 'fascination', in line with Kaplan and Kaplan (1989), and by inducing altered states of consciousness to a greater extent than those induced by the simulated natural environment. In this study, the simulated natural environment did not seem to be experienced as a completely satisfactory substitute for the natural environment and assuming 'experimental isomorphism' (de Kort et al., 2006), is simplifying the restorative effect of the natural environment. This should, however, be viewed as a hypothesis, not as a fact. Furthermore, the role of ASC seems to be involved in the more positive and restorative effects experienced by the participants in the natural environment and we wish to emphasize the importance of ASC in connection with the human experience of restoration and restorative environments.

Acknowledgements

This study was supported by grants from the County Council in Värmland, Sweden (LiV – Landstinget i Värmland), and from the Department of Psychology at Karlstad University, Sweden. The research conducted has complied with the ethical standards of the World Medical Association's Helsinki Declaration concerning Ethical Principles of Medical Research Involving Human Subjects.

Appendix. Supplementary data

Supplementary data associated with this article can be found in the online version, at doi:10.1016/j.jenvp.2010.01.011.

References

Berto, R. (2005). Exposure to restorative environments helps restore attentional capacity. *Journal of Environmental Psychology, 25*, 249–259.

Bood, S. Å. (2007). *Mending and bending the neurosignature: Frameworks of influence by flotation-REST (restricted environmental stimulation technique) upon well-being in patients with stress related ailments*, Doctorial dissertation, Karlstad University, Sweden.

British Hypertension Society. (2008). Validation of new blood pressure devices for the measurement of blood pressure. Retrieved March 28, 2008, from. http://www.bloodpressure-monitoring.org/blood-pressure-monitors-bhs-list.htm.

Brügge, B., Glantz, M., & Sandell, K. (2007). *Friluftslivetspedagogik: Förkunskap, känsla och livskvalitet*. [*The pedagogic of outdoor life: For knowledge, feelings, and quality of life*]. Stockholm: Liber.

Davis, J. (1998). The transpersonal dimensions of ecopsychology: nature, non-duality, and spiritual practice. *The Humanistic Psychologist, 26*, 60–100.

Dittrich, A. (1998). The standardized psychometric assessment of altered states of consciousness (ASCs) in humans. *Pharmacopsychiatry, 31*, 80–84.

Edebol, H., Bood, S.Å., & Norlander, T. (2008). Case studies on chronic whiplash associated disorders and their treatment using flotation-REST (restricted environmental stimulation technique). *Qualitative Health Research, 18*, 480–488.

Ekman, R., & Arnetz, B. (2005). *Stress: Individen, samhället, organisationen och molekylerna*. [*Stress: The individual, society, the organisation, and the molecules*]. Stockholm: Liber.

Fischer, R. (1971). A cartography of the ecstatic and meditative states. *Science, 174*, 897–904.

Folkow, B. (2005). Evolution och fysiologi. [Evolution and physiology]. In R. Ekman, & B. Arnetz (Eds.), *Stress: Individen, samhället, organisationen och molekylerna [Stress: The individual, society, the organisation and the molecules]* (pp. 29–45). Stockholm: Liber.

Grahn, P., & Stigsdotter, U. A. (2003). Landscape planning and stress. *Urban Forestry, Urban Greening, 2*, 001–018.

Hartig, T. (2005). Teorier om restorativa miljöer – förr, nu och i framtiden. [Theories of restorative environments – previous, current, and future]. In M. Johansson, & M. Küller (Eds.), *Svensk Miljöpsykologi* (pp. 263–279). Lund: Studentlitteratur.

Hartig, T., Böök, A., Garvill, J., Olsson, T., & Gärling, T. (1996). Environmental influences on psychological restoration. *Scandinavian Journal of Psychology, 37*, 378–393.

Hartig, T., Mang, M., & Evans, G. W. (1991). Restorative effects of natural environment experiences. *Environment and Behaviour, 23*, 3–26.

Herrmann, C. (1997). International experiences with hospital anxiety and depression scale: a review of validation data and clinical results. *Journal of Psychosomatic Research, 42*, 17–41.

Holmquist, R. (1974). *Testbeskrivningar för Syllogismer I och II*. [*Manual to the syllogisms I and II test*]. Stockholm: Psykologiförlaget.

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

Kaplan, S. (1995). The restorative benefits of nature: toward an integrative framework. *Journal of Environmental Psychology, 15*, 169–182.

Karlsson, G. (1995). *Psychological qualitative research from a phenomenological perspective*. Göteborg, Sweden: Almquist & Wiksell International.

Kjellgren, A. (2003). *The experience of flotation-REST (restricted environmental stimulation technique): Consciousness, creativity, subjective stress and pain*, Doctorial dissertation, Göteborg University, Sweden.

Kjellgren, A., Bood, S.Å., Axelsson, K., Norlander, T., & Saatcioglu, F. (2007). Wellness through a comprehensive Yogic Breathing Program – a controlled pilot trial. *BMC Complementary and Alternative Medicine, 7*, 43.

Kjellberg, A., & Iwanowski, S. (1989). *Stress/energiformuläret: Utvecklingav en metod förskattningavsinnesstämningiarbetet*. [*The stress/energy questionnaire: Development of a method for assessment of mood at work*]. Solna, Sweden: National Institute for Occupational Health.

Kjellgren, A., Sundequist, U., Norlander, T., & Archer, T. (2001). Effects of flotation-REST on muscle tension pain. *Pain Research and Management, 6*, 181–189.

Kjellgren, A., Sundequist, U., Sundholm, U., Norlander, T., & Archer, U. (2004). Altered consciousness in flotation-REST and chamber-REST: experience of experimental pain and subjective stress. *Social Behaviour and Personality, 32*, 103–116.

de Kort, Y. A. W., Meijnders, A. L., Sponselee, A. A. G., & Ijsselsteijn, W. A. (2006). What's wrong with virtual trees? Restoring from stress in a mediated environment. *Journal of Environmental Psychology, 26*, 309–320.

Laumann, K., Gärling, T., & Stormark, K. M. (2003). Selective attention and heart rate responses to natural and urban environments. *Journal of Environmental Psychology, 23*, 125–134.

Lawlis, G. F. (1996). *Transpersonal medicine*. Boston/London: Shambhala.

Martindale, C. (1975). *Romantic progression: The psychology of literary history*. Washington DC: Hemisphere.

Martindale, C. (1990). *The clockwork muse: The predictability of artistic change*. New York: Basic Books.
Maslach, C. A. (1998). Multidimensional theory of burnout. In C. L. Cooper (Ed.), *Theories of organizational stress* (pp. 68–85). Oxford: Oxford University Press.
Neisser, U. (1967). *Cognitive psychology*. New York: Appleton Century Crofts.
Norlander, T. (1997). *Alcohol and the creative process: Frameworks of influence by alcohol upon creative performance*. Örebro, Sweden: Tryckverkstan.
Norlander, T., Gård, L., Lindholm, L., & Archer, T. (2003). New age: exploration of outlook-on-life frameworks from a phenomenological perspective. *Mental Health, Religion and Culture, 5*, 1–20.
Norlander, T., Kjellgren, A., & Archer, T. (2003). Effects of floatation- versus chamber- restricted environmental stimulation technique (REST) on creativity and realism under stress and non-stress condition. *Imagination, Cognition and Personality, 22*, 343–359.
Pramling, N., Norlander, T., & Archer, T. (2001). Moral expression in 6–7-year-old children's stories in Sweden, Hungary and China: a phenomenological study. *Childhood, 8*, 361–382.
Pramling, N., Norlander, T., & Archer, T. (2003). Conceptualization of the unknown by 6-, 9- and 14-year-old children in a story telling context. In search of a 'heffalump'. *Childhood, 10*, 379–392.
Tart, C. T. (1972). *Altered states of consciousness*. New York: Harper Collins.
Ulrich, R. (1983). Aesthetic and affective response to natural environment. In I. Altman, & J. F. Wohlwill (Eds.), *Human behaviour and environment: Advances in theory and research* (pp. 85–125). New York: Plenum Press.
Ulrich, R. S., Simons, R. S., 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*, 201–230.
Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science, 22*, 420–421.