Healing Media: The moderating role of presence in restoring from stress in a mediated environment

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Abstract

Restorative environments are environments that can help restore directed attention or reduce emotional and psychophysiological stress. The present study investigates the importance of presence in relation to restoration. We hypothesized that presence would moderate the stress-reducing effects of a mediated restorative environment. After performing a stress-inducing task, participants watched a restorative film on either a small or big screen. Physiological measurements (heart period and skin conductance level) were taken throughout the experiment. In addition we measured self-reported affect and presence using the ITC-Sense of Presence Questionnaire. Significant results appeared for skin conductance level (SCL) showing an interaction between screen size and time on restoration. No remaining effects of screen size were found on restoration.

1. Introduction

Hassles and troubles of everyday life make us feel stressed and mentally fatigued. In order to reduce the unhealthy consequences of stress, it is important to improve our mental, affective, and physical state. In the recent past there have been numerous studies indicating the beneficial effects of restorative – often natural - environments. These are said to help people reduce psychophysiological stress and renew attentional and other psychological resources [1].

Unfortunately, restorative environments are not always handy. An alternative solution would be to restore in a simulated (e.g. virtual) or mediated environment (e.g. slides and film). In fact, most of the studies performed in the research domain of restoration make use of simulations of environments instead of actual ones and have been effective in changing mood.

The present study investigates the importance of presence in relation to restorative environments. We hypothesize that presence – the sense of actually being there in the presented environment – may moderate the effect the restorative environment has. It might increase the psychological feeling of being away from work routine, demands, and obligations. This feeling of 'being away' is considered one of the central components of a restorative experience.

2. Theoretical background

2.1. Restoration

Restoration involves renewing diminished functional resources and capabilities [2]. It enhances the ability to focus attention [3], it reduces stress [4], and leads to positive affective states [5]. Although the field has not reached consensus regarding the basic mechanism behind these effects – two prominent theories coexist, one claiming recovery from psychophysiological stress as the central process [4], the other recovery from directed attention fatigue [6] – the number of publications reporting restorative effects of certain types of physical environments is growing.

In his psychoevolutionary theory, Ulrich [4] focuses mainly on the visual perception of certain environments, and the aesthetic and affective reactions associated with it. He emphasizes that most affective reactions are precognitive. The visual properties influencing aesthetic preference and interest Ulrich discusses are: complexity, structure, depth, ground surface texture, threat or tension, deflected vistas, and water. According to Ulrich's evolutionary approach, such surroundings optimally support approach and avoidance behaviors which are relevant for people's well-being and survival. The experience of visually pleasant physical surroundings is thought to reduce stress by eliciting positive emotions, sustaining non-vigilant attention, restricting negative thoughts, and returning physiological arousal to more moderate levels [1], see also [7].

Restoration Theory (ART, Kaplan & Kaplan [6]) postulates that to direct or focus attention requires a certain capacity that can become depleted, resulting in directed attention fatigue. This resource can slowly regenerate in the absence of an ongoing need for directed attention, but ART suggests that it will be restored faster by what Kaplan and Kaplan have called 'involuntary attention'. Involuntary attention is attention that is drawn by stimuli that are fascinating in themselves, not requiring the resources directed attention does. Fascination is drawn by stimuli that are reasonably complex, coherent, and legible and yet hold some mystery. Fascination however, is one necessary but not sufficient prerequisite for restoration. Ideally, the environment should also afford a feeling of 'being away', have 'extent' and be compatible with the viewer's wishes and capacities.

Although these two theories attribute the restorative effects to different processes, both support the idea that nature functions well as a restorative environment. These expectations have been supported by a number of empirical studies, reporting stronger reductions of negative feelings such as anger and aggression and stronger increase of overall positive affects such as happiness, friendliness, or elation after viewing natural vs. urban scenes [3,8,9,10]. In addition, similar empirical evidence exists of physiological restoration in terms of skin conductance, muscle tension, and pulse transit time and blood pressure e.g. [7,10,11,12].

Only a small number of studies on restorative effects have actually taken participants on a visit to natural places, e.g. [3]; most of these studies have been performed in psychological laboratories, employing photographs, slides, or videos, under the implicit assumption that this will result in similar effects as experiencing the real environment in its full sensorial richness – in other words assuming experiential isomorphism for mediated and unmediated stimuli. Strikingly, only little or attention is paid to optimizing the mediation or experience of actually being there.

2.2. Presence as a moderator

In using mediated or simulated environments for evaluative and therapeutic purposes, response similarity with regard to real environments is considered a prerequisite, e.g. [13,14,15]. The presence experience thus becomes an important means – even the key - to valid and effective use of mediated environments, following the response similarity approach [16] stating that 'it is reasonable to expect that as the fidelity of the displayed environment increases, responses to that environment will be increasingly similar to responses we exhibit to the same objects, agents and events in real environments' (pp 202).

This same assumption underlies the use of psychophysiological measures as potential objective indicators of presence, as for instance suggested by [17, 18], and studied by – among others – [13,19] (for a thorough review see [20]. If a real environment causes certain (psychophysiological) responses, then the similarity (or often strength) with which a mediated environment engenders the same effects can serve as an indicator of the amount of experienced presence in that environment. Here presence is the ultimate goal and psychophysiological measures are a means to measure presence.

The present study adheres more strongly to the rationale presented in the first paragraph than that of the second one (though both share common grounds and in fact represent two sides of the same medal): in parallel to the use of mediated or simulated environments in therapeutic settings – e.g. the treatment of phobias [21] in [13] – we expect that treatment in a restorative environment will be more successful as the person experiences more presence. Presence thus is a means to enhance restorative effects. An experiment was set up to test this assumption, in which we manipulated presence in a restorative environment. Both self-report measures of affect and psychophysiological measures were taken to investigate moderating effects of presence on restoration. We hypothesized that as presence in the mediated environment increased, restorative effects would be stronger.

3. Method

3.1. Design

The effect of presence on restoration was studied in an experiment in which after a stressful episode, participants watched a film of a restorative environment under low or high presence conditions. Presence was manipulated between-subjects by varying screen size. In the low presence condition the film of the restorative environment was shown on a small screen, whereas in the high presence condition it was shown on a large screen. To assess whether the restorative effect of the nature film depended on the level of presence, we measured changes in participants' skin conductance level (SCL), inter beat interval (IBI), and self-reported positive and negative affect.

3.2. Participants

A student sample of N = 80 participated in the experiment, of which 36% was female and 64% was male. Their mean age was 23. The participants were paid € 8 in exchange for their effort. Participants were randomly assigned to the two presence conditions.

3.3. Setting

The experiment was conducted at the Eindhoven University of Technology, in a laboratory. Participants were seated at a table in front of a large back projection screen. The back projection screen of 110 by 145 centimeters (72") was positioned with its center on eye level, at a 2.25 meters distance approximately. On the table was a computer on which participants received instructions, performed the stress task, and filled in the self-report measures.

3.4. Stressor task

In this experiment we made use of the Markus & Peters Arithmetic Test (MPATest, [22,23]) to increase participants' level of stress prior to exposing them to the film of the restorative environment. This stressor consists of a mental arithmetic task in combination with uncontrollable industrial noise. The effectiveness of the stressor has been confirmed by previous research, showing that the stressor brings about heightened heart rate [24], increased skin conductance and a negative mood [22,23]. The stressor task took between 18 and 32 minutes. The variation in duration was due to the time participants took to read the instructions, and the first exercises of the task, as the task only continued after three correct answers. The actual stressor took about 16 minutes, as it included 16 1-minute trials.

3.5. Restorative film

In the two presence conditions the same 10 minutes film without sound was presented. The film was a compilation of nature scenes from two DVD's created under the authority of "Vereniging Natuurmonumenten", a Dutch nature reserve association. The duration of the restorative film was exactly ten minutes.

3.6. Presence manipulation

We chose to manipulate presence by varying screen size, because this manipulation does not change the content of the sensory input. In the low presence condition the restorative film covered 47 x 60 centimetres (31") of a 110 x 145 centimetres (72") screen. In the high presence condition the film covered the entire screen.

3.7. Presence measure

The subjective state of presence was measured using the ITC-Sense Of Presence Inventory (ITC-SOPI, [25]). This inventory taps four different factors (spatial presence, engagement, ecological validity / naturalness, and negative effects) with 44 items in total. The items are statements and participants are asked to indicate their degree of agreement with these statements on scales ranging from 1 "Strongly disagree" to 5 "Strongly agree". The reliability of the subscales was acceptable to high (alpha's from .60 to .92).

The questionnaire was administered immediately after the film.

3.8. Psychophysiological measures

Skin conductance level (SCL) was recorded directly using the constant voltage technique. A BioPac Electrodermal Activity Amplifier Module (GRS100B) measured the absolute skin conductance for every 5 milliseconds (200 samples/second). The lowpass filter was set to 1 Hz, the gain was set to 20µmho/V. Conductance was measured from the non-dominant hand by placing BioPac Electrodermal Activity transducer (TSD103A) Ag-AgCl electrodes on the first phalange of the index and middle fingers. A non-irritating electrode gel (Parker Signa gel) was used as the electrolyte.

Heart period (inter beat interval, IBI) was derived from an electrocardiogram (EKG), which was recorded from two BioPac Ag-AgCl disposable shielded electrodes (10 mm contact area) placed on each wrist after preparing the skin with alcohol. Another unshielded electrode was placed on an ankle for the ground. To obtain heart rate, the EKG signal was amplified with a BioPac Electrocardiogram Amplifier module (ECG100B), which detected the occurance of the 'R' wave. The 'R' wave detector circuitry consisted of a high Q (Q = 5), 17Hz band pass filter followed by a full wave rectifier, followed by a 10.0Hz three pole, low pass filter. The gain was set to 500 (40mV), the high pass filter switched to 0.05Hz the sample rate was 200 samples per second.

The physiological measures were taken during a baseline period, during the stress episode, and during the restoration episode.

3.9. Affect measures

An affect questionnaire was developed to measure positive and negative affect. The entire questionnaire consisted of 16 affect words. These affect words appeared in random order one by one on the computer screen, embedded in the sentence: "I feel …", followed by a 7-point answering scale, ranging from 0 "Not" to 6 "Very much". Examples of positive affect words are "relaxed" and "cheerful". Examples of negative affect words are "tense" and "irritated". The mean score on the eight positive items was used as a measure of positive affect (alpha = .73) and the mean score on the eight negative items was used as a measure of negative affect (alpha = .71).

Participants completed the affect questionnaire three times during the experiment: prior to the stressor, after the stressor, and after the restorative film.

4. Results

4.1. Effectiveness of stress task

To test whether the stress task was effective in eliciting stress, we conducted a repeated measures analysis of variance with skin conductance level as the dependent variable and Screen size and Time of measurement (baseline and at the end of the stressor) as the independent variables. This analysis showed a significant effect of Time of measurement, F (1, 78) = 108.84, p = .00, while the interaction effect with Screen size was insignificant, $F < 1$. The stress task increased skin conductance level (baseline M = 10.57 mumho, SD = 6.06, stressor M = 14.92 mumho, SD = 8.25).

A similar analysis was performed with heart period measured during baseline and during the stressor. Again, the effect of Time of measurement was highly significant, F (1, 78) = 19.56, p = .00; the interaction-effect with Screen size was insignificant, $F < 1$. The stress task decreased heart period (baseline M = 0.85 s, SD = 0.13, stressor M = 0.81 s, SD = 0.10).

We also tested the effect of the stress task on negative affect. A repeated measures analysis of variance with negative affect as the dependent variable and Screen size and Time of measurement (before and directly after the stress task) as the independent variables showed a significant effect of Time, F (1, 78) = 244.34, p = .00; the interaction-effect with screen size was insignificant, F < 1. Negative affect increased due to the stress task (before stressor M = 2.00, SD = 0.62, after stressor M = 3.44, SD = 0.84).

A repeated measures analysis of variance with positive affect as the dependent variable and Screen size and Time of measurement (before and directly after the stress task) as the independent variables also showed a significant effect of Time, F (1, 78) = 196.73, p = .00; the interaction-effect with screen size was insignificant, F < 1. The stress task resulted in a decrease of positive affect (before stressor M = 4.05, SD = 0.61, after stressor M = 2.62, SD = 1.02).

Hence all stress indicators point in the same direction, namely that the stressor task was successful in eliciting stress.

4.2. Effects of screen size on experienced presence

To examine whether the screen size manipulation had an impact on experienced presence, a multivariate analysis of variance was conducted with the four experienced presence factors (spatial presence, engagement, ecological validity / naturalness, and negative effects) as the dependent variables and screen size as the independent variable. This analysis showed no significant result, F (4, 75) = 1.59, p = .19. Hence screen size seems to have failed to influence experienced presence. It should be noted that levels of experienced presence were very low in both conditions. Spatial presence was rated M = 0.81 (SD = 0.53) in the small screen condition and M = 0.95 (SD = 0.63) in the large screen condition. Results are reported in Table 1.

4.3. Effect of screen size on restorative impact

To find out whether presence moderated the restorative impact of the nature film, a repeated measures analysis of variance was performed with skin conductance level as the dependent variable and Screen size and Time of measurement (before the film, and three times during the film) as the independent variables. A significant effect of Time of measurement was found, F (1, 76) = 8.43, p = .00, as well as a significant interaction-effect with Screen size, F (1, 76) = 2.79, p = .05. As can be seen in Figure 1, skin conductance level decreased faster and more in the large screen condition as compared with the small screen condition.

A similar analysis was conducted with inter beat interval as the dependent variable. This analysis showed a significant main effect of Time of measurement, F (1, 76) = 63.99, p = .00, but the interaction-effect with Screen size failed to reach significance, F < 1. This indicates that inter beat interval did not develop differently for the two experimental conditions. Results are shown in Figure 2. Means are reported in Table 1.

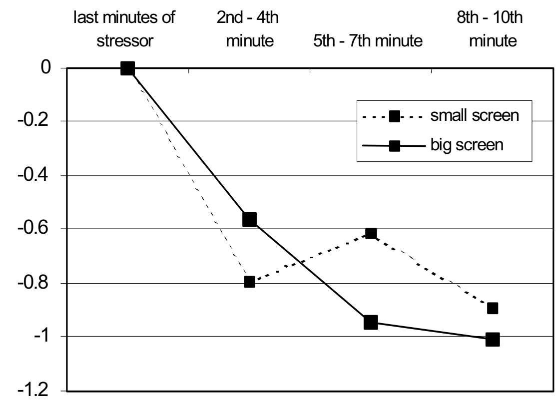

Figure 1 Skin conductance level (SCL) during restorative film, measured in mumho, corrected for last level during stressor (i.e. increase of SCL).

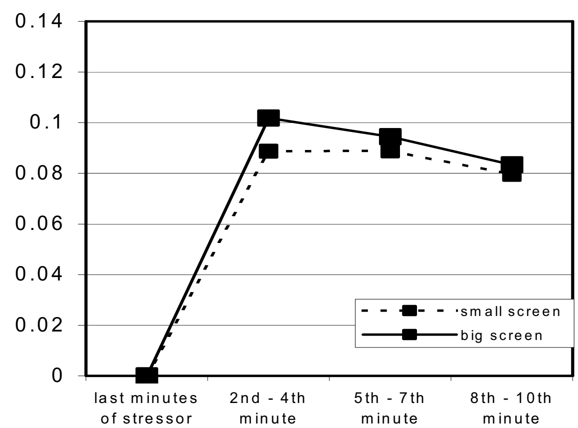

Figure 2 Inter beat interval (IBI) during restorative film, measured in seconds, corrected for last level during stressor (i.e. increase of IBI in s).

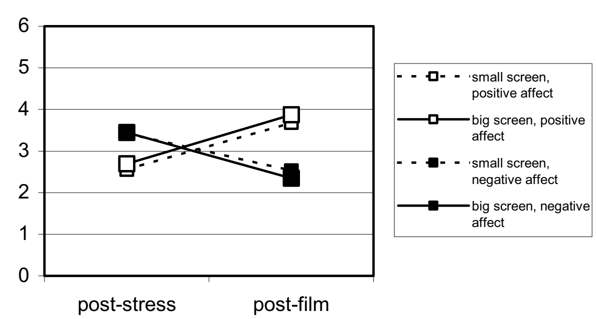

Figure 3 Positive and negative affect scores following the stressor and following the restorative film, for both experimental conditions.

Table 1: Means and SD of ITC-SOPI scales, SCL, IBI and positive and negative affect for both experimental conditions

	Small screen		Big screen	
	M	SD	M	SD
Spatial presence	1.81	.53	1.95	.63
Engagement	2.56	.60	2.77	.63
Naturalness	3.41	.78	3.57	.51
Negative effects	2.17	.59	1.88	.51
SCL scores corrected for last stressor level:				
SCL restoration 1	-.797	1.20	-0.565	1.22
SCL restoration 2	-.616	1.68	-0.944	1.59
SCL restoration 3	-.896	1.97	-1.009	1.83
IBI scores corrected for last stressor level:				
IBI restoration 1	0.089	.068	0.102	.06
IBI restoration 2	0.089	.061	0.094	.06
IBI restoration 3	0.080	.066	0.083	.06
Positive affect post stressor	2.55	1.12	2.69	0.92
Negative affect post stressor	3.43	1.02	3.49	0.94
Positive affect post restoration	3.68	0.65	3.87	0.74
Negative affect post restoration	4.78	0.80	5.04	0.81

Note: Skin conductance level (SCL) measured in mumho; Inter beat interval (IBI) measured in seconds; affect stores vary from 0 to 6.

To examine whether presence moderated changes in affect, a repeated measures analysis of variance was conducted with negative affect as the dependent variable, and Screen size and Time of measurement (before and after the film) as the independent variables. The main effect of Time was significant, F (1, 78) = 134.76, p = .00, but the interaction with Screen size was not, F (1, 78) = 1.29, p = .26, indicating that negative affect was lower after the restorative film than before, regardless of screen size.

The same analysis was conducted with positive affect as the dependent variable. Again a main effect of Time was found, F (1, 78) = 14.66, p = .00, but no interaction with Screen size, F< 1. This indicates that positive affect was higher after the restorative film than before, regardless of whether it was a small or a large projection. Results for positive and negative affect are shown in Figure 3.

5. Discussion

The present study showed some results in the expected directions but left us with some questions as well. In this discussion we will try to address some of the most important issues, but would like to inform the reader that data-analyses – especially of the physiological data – are still ongoing. We hope to present the finalized analysis at the conference.

Unfortunately, the manipulation of screen size was not successful in producing a significant difference on our manipulation check, although all components of presence showed trends in the expected direction. This was striking, since the manipulation was considerable and screen size manipulations have been shown to influence presence significantly in earlier studies [e.g. 26, 27].

However, the screen size manipulation did show a significant interaction with time on skin conductance level. Although no main effect emerged, results did indicate that arousal – as indicated by SCL – followed a clear downward slope for the big screen condition and did not do so in the small screen condition. Additional analyses on the electrodermal data still have to be performed. This particularly involves investigation of skin conductance responses, like the number and amplitude of fluctuations in skin conductance.

Similar results did not prove significant on the heart period (IBI) data. Looking at the trajectories we are tempted to conclude that reductions of heart rate to baseline level had already been realized in the first phase of the restorative film in both experimental conditions. Judging from the average increase in heart rate (or decrease in heart period) during the stressor we expect that the stressor task - although it did show effects on all measures in the expected direction – was not strong enough to require a lengthy restoration period for IBI data. We plan to look into the trajectories of IBI data in more detail, especially in the first four minutes during the restorative film.

Results of affect measures also show complete restoration and return to baseline level after ten minutes for both experimental conditions. Again we suspect that a more stressful task – requiring more and longer restoration might have shown differences between the two presence conditions. In line with this finding, other researchers in the domain of restoration also report great difficulties in engendering high levels of psychophysiological stress or attention fatigue in experimental settings. Some are now turning to naturally appearing stress e.g. as exists among students directly after exams. Higher levels of induced experimental stress would certainly increase the potential to study effects of restorative conditions.

Conclusions

In spite of the mixed results of the study, preliminary findings do point out the relevance of investigating moderating effects of presence in research on restorative environments. This and similar studies should prove useful for gaining a deeper understanding of all interrelationships between psychophysiology, restoration and presence and, in addition, may result in implications for the development of media technology that can help people restore from stress in settings as diverse as offices (work stressors), homes (restoring from daily hassles or negative life events), and even medical purposes as restoring from treatment-related and post-surgical stress.

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