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ORIGINAL ARTICLE

Does Interactive Media Enhance the Management of Stress? Suggestions from a Controlled Study

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Abstract

The relationship between interactive media and stress has gained wide interest in the mental health area. In our research, we found that interactive experiences helped people manage their stress. By combining different techniques, which may produce more significant outcomes than single-strategy programs, we developed a stress management protocol to increase self-awareness, to control and relax oneself, induce positive emotions, and substitute negative emotions. Our stress management protocol was tested in a controlled study comparing three interactive experiences (virtual reality [VR], video, and audio). Results showed the efficacy of all three interactive experiences in inducing positive emotions and integrating different approaches to manage stress. In particular, VR showed better improvements related to the psycho-physiological changes. Implications of the results for worldwide healthcare services will be discussed.

Introduction

During the last decade the relationship between interactive media and stress has gained wide interest in the mental health area. At least two different approaches of interactive media use can be identified. One approach induces emotional responses in users through mediated experiences, including films,[1] images, and sounds[2]; expressive behavior[3]; and music.[4] Another uses these technologies to improve mental health.[5–8] Virtual reality (VR), in particular, emerges as a potentially effective way to provide general and specialty healthcare services.[9–14] Traditionally, within the anxiety and stress area, the theoretical benefits of VR are based on the principle of exposure.[15,16] VR may offer a safe and cost-effective alternative for some *in vivo* impractical and potentially dangerous conditions, such as driving phobia,[17] or in the case of prohibitive costs, such as flight phobia. VR exposure takes place in a controlled environment that allows the maintenance of confidentiality and the increase of patients' feelings of self-efficacy.[18]

A new VR perspective is related to the interest toward the effects of positive mediated experiences. Based on previous results showing that aerobic exercise and relaxation training were associated with reduction of general and test-taking anxiety,[19] Plante and colleagues[20,21] reported that individuals who interacted in a mediated environment enriched with a variety of positive visual and auditory stimulation reported greater improvement in self-efficacy and mood. Recently, Valtchanov et al.[22] demonstrated that the computer-generated nature of VR can promote restorative effects.

These studies demonstrate that positive emotions can play a critical role for mental and physical health[23] because according to Fredrickson,[24] even though a positive emotional state is only momentary, benefits can last in the form of traits, social bonds, and abilities that endure well into the future.

Within this perspective, we propose an innovative research to help people manage stress through a positive mediated interactive experience. In a pilot study, Villani et al.[25] found that after a brief protocol of two sessions where the virtual experience was accompanied by a relaxing narrative, people could learn relaxation strategies. These resulted in the development of our extended stress management protocol (six sessions) that integrates other nonrelaxation stress management strategies.

To develop the extended protocol, we considered stress as having multiple components that typically involves cognitive, experiential, physiological, and behavioral response systems[26] that required multiple levels of analysis.[27] In accordance with Murphy,[28] we decided to combine different strategies to yield better stress management than single-strategy programs. We planned a positive mediated experience including important strategies used in cognitive-behavioral therapy (CBT) aimed to increase emotional awareness,[29] to learn to control emotions and to relax,[30] to induce positive emotions,[31–33] and to substitute negative emotions through the imagination process.[34,35]

As in the pilot study[25] and in accordance with Freeman and colleagues,[36] the "media content" included the theme, the narrative (i.e., the integration of different relaxation techniques),

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and the "media form" dimension (i.e., the physical, objective properties of the three mediated experience). To better understand the role played by the interaction, immersion, and imagination processes, in our experiment, we used media with appropriately different interaction, immersion, and imagination characteristics: VR (immersion and interaction), VIDEO (immersion without interaction), and the AUDIO conditions (only imagination). We aimed to test these hypotheses:

H1: Is the stress management protocol effective in each mediated condition?

H2: Is there a significant difference in effectiveness of the mediated experiences?

Methods

Participants and design

One hundred flyers were posted at several Universities and Public Offices in Milan to attract participants. Sixty-five people applied to participate. The informed consent letter and a questionnaire measuring levels of stress were sent to these participants by e-mail.

In agreement with Scherer's theory,[37] we maintained the coherence between the content of the experience and the goal of the participant, to increase their motivation and engagement during the experiment. As shown by a recent study, maintaining coherence is important with mediated experiences.[38] For this reason, compared to our pilot study, we selected participants who exceeded the higher quartile (Italian normative data) of stress, measured through the *Mesure du Stress Psychologyque* (MSP) Questionnaire.[39,40] Thirty-six participants met the cut-off. Participants were both students and nonstudents, and ranged in age from 18 to 35 (Men $M = 25.21$; standard deviation [SD] = 1.44; Women $M = 25.47$; $SD = 0.87$).

We randomly assigned 12 participants to each of the three conditions by a true random number service (www.random.org). A between-subjects design was used with the three experimental conditions (VR, Video, and Audio). We used technology to support only the relaxation phase of the protocol (see Protocol section), whereas the other strategies were managed without technology.

Measures

To identify the affective dimension of the participants, we proposed an integrated multimodal assessment—combining self-report and objective measures. Two self-report measures were used:

- The *MSP*[39,40] is a self-report questionnaire that evaluates one's perceived stress level within the last 3 months. The Chronbach's alpha of the Italian validated version is 0.95. It includes 49 items and considers six dimensions: (1) loss of control and irritability, (2) psychophysiological feelings, (3) sense of effort and confusion, (4) depressive anxiety, (5) pain and physical problems, and (6) hyperactivity and accelerated behaviors.
- The *State Trait Anxiety Inventory*[41] is a self-report questionnaire that assesses both state and trait anxiety levels. The "transitory emotional states" (State Anxiety Subscale, including 20 items) was used as a manipulation check to measure anxiety levels at the end of each session. The Chronbach's alpha of the subscales Italian validated version ranges between 0.83 and 0.92.

A psycho-physiological objective measure to identify the affective state of the participants was also used. Many studies[42–46] use heart rate (HR), skin conductance, and respiration, as important measures of physiological arousal related to the exposure to an emotional event. This research demonstrates that when emotions are elicited, changes occur in the activation of the autonomic nervous system. According to Healey[47] an increase in HR indicates a higher physiological arousal and valence, such as in stressful or very exciting situations. In particular, Schwartz and colleagues[48] found that HR was higher during the four emotion conditions (i.e., happiness, sadness, anger, and fear) than during relaxation and the control imagery condition.

HR (via the BioGraph Infiniti Procomp) was used to measure the affective state of the participants. HR was measured at the beginning and at the end of each session, but not during the experimental sessions because of a potential confound, that is, increased arousal due to the interaction with technological devices.

Protocol

The Stress Management protocol included important strategies used in CBT, such as a self-monitoring record card, different relaxation techniques, and a guided imagery experience. Each strategy refers to a specific CBT approach, as shown in Table 1.

The protocol is presented in Table 2. The experiment consisted of 6 sessions of about 1 hour each. The first four sessions were carried out within 2 weeks. The last two sessions were held after 1 month (first follow-up) and after 3 months (second follow-up).

Tools and strategies

"ESCAPE," the virtual environment (VE), developed with the software 3D Game Studio of Conitech, reproduced a wilderness park. Exploration in the immersive VR condition involved different natural zones related to different relaxation locations: lake, river, waterfall, garden, and forest.

We used two photographs [a lake—stimulus number 5780 of the International Affective Picture System (IAPS; Fig. 1); a garden close to the lake—stimulus number 5760 of the IAPS (Fig. 2)] selected from theIAPS,[49] an international database of photographs used as validated emotional stimuli. A wide variety of verbal judgments related to the database indicated that both stimuli, which represent just one scenario, were similar for affective valence mean and arousal mean. Photos from this database were used to develop different areas (with similar characteristics) of the VEs. Figures 3 and 4 represent two images of the developed Escape VE, which was derived from these two photos.

Multiple strategies were used to measure/induce reduced stress. These included

- A self-monitoring record card to help participants be aware of their own emotions, thoughts, and behaviors.
- A relaxation training that included Autogenic training,[50] Progressive Muscular Relaxation,[51] and breathing techniques.
- A guided imagery experience.

Treatment was similar but the medium differed between the three experimental conditions. The materials consisted of a portable computer (Fujitsu Siemens AMILO Processor,

Table 1. Approaches and Strategies Used

Cognitive-behavioral therapy approaches	*Strategies used*
The rational emotive therapy, developed by Ellis,[58] is an educational process that teaches the client how to identify irrational and self-defeating beliefs and how to replace them with more rational and self-helping ones.	We used a self-monitoring record card, referred to the ABC (Activating Event, Belief, Consequent Emotion) model developed by Ellis and Harper,[59] to help participants be aware of their own emotions, thoughts, and behaviors and to discover if distortions or "irrational beliefs" are present.
Behavioral therapy uses learning principles and relaxation to eliminate or to reduce maladaptive behaviors.	We used different techniques to induce relaxation, including Autogenic training Schultz and Luthe,[50], Progressive Muscular Relaxation,[51] and breathing techniques. In particular, according to results from our pilot study, this approach was supported by the use of different technologies.
According to the phase of "transforming emotion" of the emotion-focused therapy (EFT), developed by Greenberg,[29] positive imagery represents a good strategy of affecting an emotional response. Through practice, people can learn how to generate opposite emotions through imagery and use them as an antidote to negative emotions.	With this aim we proposed a guided imagery experience Lehrer et al.,[60] and Bender et al.,[61] related to a personal positive experience, to induce positive emotions. Patients are more and more relying on the use of guided imagery to provide a significant source of strength, support, and courage to manage daily stresses. Further, our idea was that through a virtual relaxing experience people primarily learned how to relax themselves. Then, they could use this experience to cope with difficult situations and remind images from virtual experience to visualize new and personal relaxing situations.

Pentium Core 2 Duo with an ATI Radeon HD3450, 512 Mb, graphic card); a wireless joystick (Logitech Wingman Cordless Rumblepad Gamepad); a Head-Mounted Display; a Sony Glasstron PLM S-700; and an Audiotape with headphones (Sony MDR-EX51LP Fontopia in-the-ear headphones).

Procedure

Participants were tested one at a time per session. Baseline was indicated with HR measurement and the completion of the State Trait Anxiety Inventory (STAI) Questionnaire. In the VR Condition, participants navigated freely within the VR environment. When participants felt ready to start the relaxation training (normally within a couple of minutes), they went to specific zones of the natural park, such as the river, waterfall, or garden, and they did the relaxation exercises supported by a relaxing narrative (an example of the narrative is presented in Table 3). In the VIDEO Condition, participants watched a video of the registered sessions of the Escape VR in immersion (experienced with a head-mounted display), following the same narrative but without interaction. The Video took them to specific zones of a natural park, such as the river, the waterfall, or the garden, and they did the relaxation exercises supported by a relaxing narrative. In AUDIO Condition, participants listened to the same relaxing narrative that guided them in the pictured scenario by the use of the headphones. In this condition, imagination skills were required to contextualize the relaxing experience.

Results

Data analyses

Treatment differences (between-groups effects) for the three conditions (VR, Video, and Audio) and changes within sessions (within-groups effects) were analyzed through repeated measures analysis of variance (ANOVA) tests with

Table 2. Protocol Schema

1st week	*2nd week*	*1st follow-up (after 1 month)*	*2nd follow-up (after 3 months)*
1st session Baseline assessment Self-monitoring record card ABC	*3rd session (by using media)* Assessment before Session 3 Use of self-monitoring record card ABC Relaxation phase (with media) Assessment after Session 3	*5th session* Assessment before Session 5 Questions about strategies used Self-relaxation phase Assessment after Session 5	*6th session* Assessment before Session 6 Questions about strategies used Self-relaxation phase Assessment after Session 6
2nd session (by using media) Assessment before Session 2 Imagination phase Relaxation phase (with media) Assessment after Session 2	*4th session (by using media)* Assessment before Session 4 Relaxation phase (with media) Assessment after Session 4 Delivery of Audio CD		

FIG. 1. The lake from International Affective Picture System (IAPS; stimulus number 5780), black-and-white version.

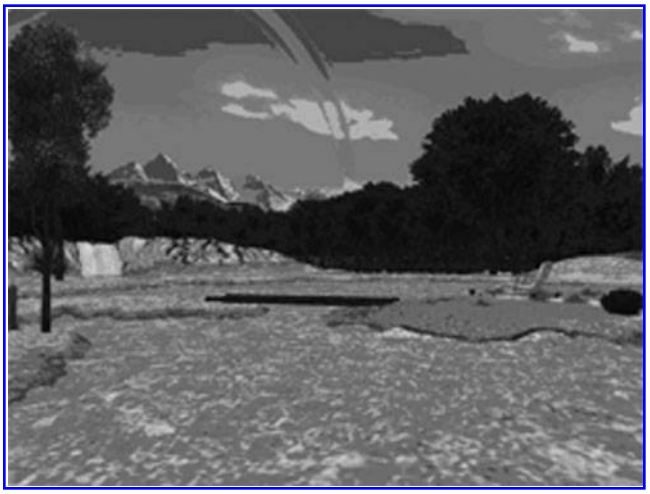

FIG. 3. Escape: view of lake and waterfall, black-and-white version.

time × condition. Then, we evaluated whether the interaction effect existed between the degree of change achieved and the experimental condition. Finally, we performed multiple comparison *post hoc* tests.

Physiological and psychological outcomes

HR measurements for all of the conditions were analyzed through Repeated Measures ANOVA and we found significant effects related to time (i.e., pre- and postexperimental exposure) and time × condition, as shown in Table 4. This was found for both the guided and the follow-up sessions.

In both cases we did not find significant effects related to condition due to a low statistical observed power (0.232 and 0.247, respectively). To solve this issue Dimitrov and Rumrill[52] suggest the use of the ANOVA on gain scores (HR mean reduction). The use of gain scores in measurement of change has been criticized because of the assertion that the difference between scores is much less reliable than the scores themselves. However, this is true only if the pretest scores and the post-test scores have equal or proportional variances and equal reliability.[52] When this is not the case, as in our sample, the reliability of the gain score is high.[53] So, we decided to perform a one-way ANOVA test comparing HR mean reduction during guided sessions. The data indicated a significant difference between groups ($p = 0.021$). In particular, VR reached a better HR reduction ($M = -6.76$; $SD = 7.63$) compared to Audio ($M = -3.62$; $SD = 6.51$) and Video ($M = -2.23$; $SD = 6.53$) groups. We found a similar result also in the follow-up sessions. One-way ANOVA test showed a significant difference between groups ($p = 0.009$), and also in these sessions, VR reached a better HR reduction ($M = -10.42$; $SD = 8.20$) compared to Video ($M = -6.06$; $SD = 6.51$) and Audio ($M = -3.34$; $SD = 7.96$) groups. Figure 5 summarizes the HR mean reduction in the three conditions in the guided and in the follow-up sessions, highlighting the better results achieved by VR.

Anxiety state outcomes

Since the time separating the four sessions involved in each condition was 3–4 days, some participants started each

FIG. 2. The lake from IAPS (stimulus number 5760), black-and-white version.

FIG. 4. Escape: view of garden and lake, black-and-white version.

Table 3. Narrative Description of the First Session

Welcome to this park,
try to pay attention to everything around you,
a lake, the green lawn, a wooden bridge, a little island,
the sun is shining in the sky and spreading out its warmth.
Feel your skin kindly becoming warmer,
a gentle breeze is caressing your skin,
freely lapse into the pleasantness of these sensations.
Start walking toward the little island.
Go ahead, come up on the wooden bridge
and walk to the lawn chair where you'll live the first relaxing experience.
Now focus your attention on the water of the lake.
Try to listen to your breath,
Breathe in deeply through your nose and breathe out from your mouth,
Continue to breathe deeply.
When you breathe, the air proceeds slowly, first in the abdomen and then in the thorax.
Listen to your abdomen expanding, your ribs broadening and your sternum raising up.
Continue to breathe.
Keep your concentration on the breathing: your breath is calm, rhythmic, harmonic.
Your body breathes with you.

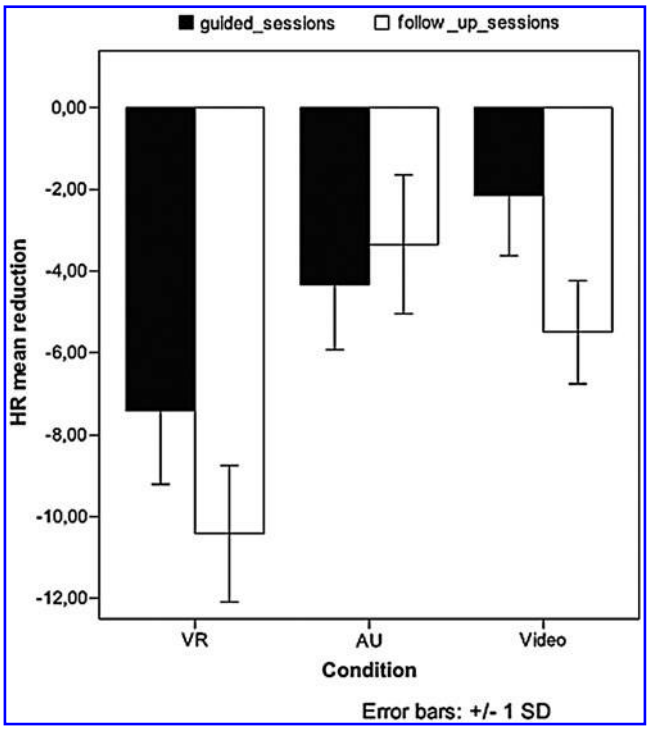

FIG. 5. Heart rate mean reduction.

session with different emotional state levels in comparison to the ones achieved at the end of the previous session. For this reason we focused on the outcomes related to the anxiety state (STAI) obtained in the three-guided sessions (session 2, 3, and 4) as shown in Table 5.

We found significant effects related to time (i.e., pre- and postexperimental exposure) and condition (VR, Video and Audio condition), but we did not find an interaction effect between the degree of change achieved and the experimental condition. Also, in this case the statistical observed power for identifying the interaction effect was too low (0.121). So, following the suggestion of Dimitrov and Rumrill[52] we decided to perform an ANOVA test on gain scores. In particular, we found significant changes in State Anxiety reduction (STAI), between Video ($M=-5.57$; $SD=1.01$) and VR ($M=-3.80$; $SD=1.41$) groups ($p=0.000$) and between Video ($M=-5.57$; $SD=1.01$) and Audio ($M=-4.83$; $SD=1.49$) groups ($p=0.006$). Video condition reached better results related to the anxiety state reduction in the guided sessions.

Discussion

Much research has shown a growing interest in using technologies to improve mental health, and VR has emerged as a potentially effective way to provide general and specialty healthcare services.[9] Our goal for this research was to examine the role that interactive media has in helping people manage their stress. Considering the results from our pilot study,[25] we decided to develop a six-session stress management protocol. In agreement with Murphy,[28] the protocol not only focused on relaxation, but also integrated other techniques, such as emotional awareness and transforming emotions. Compared to our pilot study, for this research presented herein we selected participants with a cut-off level of stress, measured through the MSP Questionnaire.[39,40]

According to several studies, within mediated experiences an important role is played by the content proposed to allow people to achieve affective changes.[8,38,54,55] In accordance

Table 4. Results of Repeated Measures Analysis of Variance with Heart Rate Scores as the Dependent Variable

Sessions	*Source of variance*	*Sum of squares*	*Df*	*Mean squares*	F	*Probability*	*Observed power*
Guided sessions (2, 3, 4)	Time	946.425	1.104	946.425	39.575	$p=0.000$*	1.000
	Time × condition	192.110	2.104	96.055	4.017	$p=0.021$*	0.706
	Condition (between groups)	592.070	2.104	296.035	1.062	$p=0.349$	0.232
Follow-up sessions (5, 6)	Time	1526.904	1.67	1526.904	53.061	$p=0.000$*	1.000
	Time × condition	294.033	2.67	147.016	5.109	$p=0.009$*	0.806
	Condition (between groups)	640.129	2.67	320.064	1.165	$p=0.349$	0.247

*Significant results.
Df, degrees of freedom.

Table 5. Results of Repeated Measures Analysis of Variance with Anxiety State (State Trait Anxiety Inventory) Scores as the Dependent Variable

Sessions	*Source of variance*	*Sum of squares*	*Df*	*Mean squares*	F	*Probability*	*Observed power*
Guided sessions (2, 3, 4)	Time	1008.200	1.87	1008.200	38.434	$p=0.000$*	1.000
	Time × condition	23.633	2.87	11.817	0.450	$p=0.639$	0.121
	Condition (between groups)	2265.433	2.87	1132.717	10.158	$p=0.000$*	0.984

*Significant results.

with Scherer et al.'s theory,[37] we maintained coherence between the content of the multimedia experience and the goal of the participants that helped increase motivation and engagement during the experience. Confirming previous results[38,55] we found that all media types induced significant changes in participant emotional states (HR mean and anxiety state level) both in the guided sessions and at the end of the follow-up phase.

We found a significant difference between the three conditions and an interaction effect between time and condition for participant's ability to reduce their HR. Specifically, participants in the VR condition were better at reducing their HR and significantly improved their emotional state during experimental sessions as well as the follow-up sessions.

About the anxiety subjective self-report scores, we found a significant difference between groups and in particular Video condition achieved better results, compared to VR and Audio groups.

Even though our research has demonstrated that interactive media can be usefully used to reduce stress, further studies (with larger samples) are needed to confirm our results. Worldwide healthcare services need to find new ways of providing accessible, engaging, cost-effective services and technology.[56,57] With tools, such as those used in this research, researchers/practicioners will develop effective methods/environments for answering these needs.

Disclosure Statement

No competing financial interests exist.

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