

Ubiquitous Health for the Treatment of Generalized Anxiety Disorders

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ABSTRACT

Virtual Exposure is used to enhance emotional processing of anxious events by helping patients face memories and situations associated with them. Patients learn to distinguish memories and associated situations from the event itself. A critical issue related to the use of virtual exposure in the treatment of anxiety related disorders is the lack of availability of a virtual reality system in the real life context of the patient. In this paper we present a clinical protocol for the treatment of Generalized Anxiety Disorders (GAD) based on the ubiquitous use of a biofeedback enhanced virtual reality (VR) system: the protocol also includes the use of a mobile exposure system allowing patients to perform the virtual experience in an outpatient setting. To verify the efficacy of the proposed approach, a between subjects study (including 24 GAD patients) was carried out. The clinical data support the efficacy of the ubiquitous approach.

Author Keywords

Virtual reality, mobile phones, generalized anxiety disorders, clinical trial, ubiquitous computing

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Artificial, augmented and virtual realities. C.4 Performance of System: design studies.

General Terms

Design, Experimentation, Human Factors, Verification.

INTRODUCTION

Different VR applications for the understanding, assessment and treatment of mental health problems have been developed in the last 15 years [1].

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Typically, in VR exposure therapy (VRE) the patient learns to manipulate problematic situations related to his/her problem by working both on its experiential/emotional and cognitive/behavioral aspects. For this reason, the most common application of VR in this area is the treatment of anxiety disorders [2, 3]: from simple phobias [4, 5], to panic disorders [6, 7], and post-traumatic stress disorder [8, 9]. A critical issue related to the use of virtual exposure in the treatment of anxiety related disorders is the lack of availability of a Virtual Reality system in the real life context of the patient: both the cost and the setting of the system limit its use to the health care centre/hospital/therapist's office. In this paper we present a clinical protocol for the treatment of Generalized Anxiety Disorders (GAD) based on the ubiquitous use of a biofeedback enhanced virtual reality (VR) system. The paper also describes the results of a controlled trial (NCT00602212) involving 24 GAD patients.

THE TREATMENT OF GENERALIZED ANXIETY DISORDERS: AN UBIQUITOUS APPROACH

Generalized Anxiety Disorder (GAD) is a psychiatric disease characterized by long-lasting anxiety that is not focused on a specific object or situation. Within the treatment of GAD, physical (relaxation and controlled breathing), behavioural (visualization and controlled exposure) and cognitive control strategies (challenging negative thoughts) represent a key part of the treatment, even if they are hard to be learned. We suggested to improve the treatment of GAD through the use of a biofeedback enhanced virtual reality (VR) system used both for relaxation and controlled exposure [10, 11]. The treatment involves two virtual reality components (see Figure 1): I) an immersive virtual reality system experienced in the therapist's office; II) a mobile exposure system allowing patients to perform the virtual experience in an outpatient setting. The role of the mobile exposure system is the following:

- To present and structure emotionally relevant contents in an ubiquitous context.

- To verify the compliance of the patient and eventually alert patient/therapist;
- To track in real-time the emotional level of the patient and record it for later assessment by the therapist;
- To provide a feedback to the patient able to help him in coping with the contents;
- To automatically contact the therapist if the emotional level is higher than a preset cut-off value defined by the therapist.

Given its use in a real clinical context critical features of the mobile system are:

- *Cost effectiveness*: even with the emergence of PC based VR, the cost of a VR system is still out of range for the typical patient (2000/3000 € for a non-immersive system). Our goal was to develop a system in the >1000 € price range.
- *Usability*: the mobile system has to be simple enough to be used by an unsupervised patient after some training sessions.
- *Use of IT standards*: the mobile system has to be based as much as possible on off-the-shelf components and protocols.
- *Emotional response*: the mobile system has to be emotionally connected with the contents of the VR sessions experienced in the health care centre/hospital/therapist's office. This can be achieved by presenting on the mobile system a non-navigable version of the same virtual reality environment experienced during the therapy. Some features of the experience – speed, contents, etc. – were driven by the emotional status of the patient.

TESTING THE APPROACH: A CONTROLLED TRIAL

The sample

Twenty-six consecutive patients with a diagnosis of GAD (DSM-IV-TR criteria) were included in the trial. Criteria for participation in the study included age between 18 and 50 years, no psychotherapy treatment received for their GA, in case of taking pharmacotherapy, the type and amount of medication had to remain consistent during the experimental period, no history of neurological diseases, mental retardation, psychosis, alcohol or drug dependence, and no migraine, headache, or vestibular abnormalities.

Assessment tools

A semi-structured interview was used to identify relevant DSM-IV-TR diagnostic criteria for GAD in the sample.

The following psychometric questionnaires were also administered to each patient at pre-treatment and upon completion of the clinical trial:

- Penn State Worry Questionnaire (PSWQ [12]);



Figure 1. The ubiquitous VR system used in the experiment.

- Beck Anxiety Inventory (BAI [13]),
- State-Trait Anxiety Inventory Form Y-2 (STAI-Y [14]),
- Hamilton Anxiety Rating Scale (HAM-A[15]).

Protocol

The patients were randomly assigned to the following groups: (1) the VR and Mobile group (VRMB) including biofeedback – 7 subjects; (2) the VR and Mobile group (VRM) without biofeedback – 9 subjects; (3) the waiting list (WL) group – 8 subjects:

1. *Virtual Reality + Mobile Phone without Biofeedback Condition (VRM)*. In this experimental condition patients received an eight-session VR-based treatment including both relaxation and exposure and techniques supported by HR biofeedback. In sessions 1 to 6, the patient explored a beautiful tropical island (experienced with a head-mounted display and head-tracking) following a predefined path leading to different relaxing areas: Campfire, Beach and Waterfall. In these areas the patients started to relax by observing the flickering campfire, watching waves lapping gently on a shore, or looking to the waterfall and fish pond. Each experience was supported by an audio narrative based on progressive muscle relaxation and/or autogenic techniques. To improve the efficacy of the training and to increase the effects of relaxation, patients experienced at home, using a mobile phone, on a non-navigable version of the same virtual reality environment experienced during the therapy. The patient was asked to train relaxation abilities at least once a day for the entire duration of the treatment following the treatment plan provided by the therapist. In session 7 and 8 the patients explored again the island reaching a Gazebo in which they are exposed to pre-selected words or images related to their personal stressful events. The patients were then asked to use the learned relaxation techniques to cope with them.

2. *Virtual Reality + Mobile Phone with Biofeedback Condition (VRMB)*. The patients experienced the same protocol described above, but with the biofeedback support (see Figure 2). Specifically, in the sessions with the therapist, HR variations were used to modify specific features of the virtual environment:
 - a. *Campfire (sessions 1-2)*. HR controls the fire intensity: a reduction of the patient's physiological activation reduces fire intensity until it disappears;
 - b. *Beach (sessions 3-4)*. HR controls the movement of the waves: a reduction of the patient's physiological activation reduces the movement of the waves until the ocean becomes completely calm;
 - c. *Waterfall (sessions 5-6)*: HR controls the movement of the water: a reduction of the patient's physiological activation reduces the movement of the water until the water flow becomes completely still;
 - d. *Gazebo (sessions 7-8)*: HR controls the size of a stressful image or video: a reduction of the patient's physiological activation reduces the size of the stimulus until it disappears;
3. *Waiting List Condition (WL)*. This was a control condition, in which patients were included in a waiting list and not received any kind of relaxation training.

RESULTS

Given the limited size of the sample, we used non-parametric analyses to analyze the treatment effects (pre vs post treatment) on the psychometric variables within the 3 groups. Results show:

- *VRMB group*: a significant decrease in the BAI ($Z=-1.826$; $p<.05$) and STAI-Y2 ($Z=-1.826$; $p<.05$);
- *VRM group*: a significant decrease in the BAI scores ($Z=-2.383$; $p<.05$) and PSWQ scores ($Z=-2.103$; $p<.05$);
- *WL group*: a significant decrease in the PSWQ scores ($Z=-2.103$; $p<.05$).

Non-parametric K-Independent Tests were used to analyze the between subjects differences in the pre and post treatment anxiety questionnaires. No significant differences were found for $p<.05$. The GSR, the HR, as well as the STAI-Y1 and the VAS-A were recorded at the beginning and at the end of each training session in the VRMB and in the VRM groups. Regarding the physiological responses, we observed that the mean of the differences of HR and GSR before and after each session tended to be higher in the VRMB group than in the VRM group. Nevertheless, the difference between the two experimental groups was not statistically significant. Regarding the psychometric variables, we observed that the mean of the differences of STAI-Y1 and VAS-A before and after each session tended to be higher in the VRMB group than in the VRM group.



PC Virtual Reality



Biofeedback system



Mobile Virtual Reality

Figure 2. The VR Experiences

DISCUSSION

The study offered two interesting results. On one side, it confirmed the possibility of using VR in the treatment of GAD. Both experimental groups improved their clinical outcome after the end of the treatment. On the other side, it supports the clinical use of a mobile phone to re-experience and anchor the contents of the VR sessions at home. The study also suggested a possible added value offered by the use of biofeedback: only in the VRMB group we found a significant reduction in the anxiety scores (STAI) after the treatment. Regarding the patients' physiological responses, we found a tendency indicating a decrease in HR and GSR between the pre and post sessions measurements in the VRMB group, higher than in the VRM.

In conclusion, this study showed that (1) VR can be used also in the treatment of GAD; (2) in a VR treatment, patients take advantage of a mobile device that delivers in an outpatient setting guided experiences, similar to the one experienced in VR. It also suggested – but further analysis are needed – that with these patients the effectiveness of an immersive virtual relaxing environment may be improved by using physiological data to modify in real time specific features of the virtual environment.

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