Clinically Significant Virtual Environments for the Treatment of Panic Disorder and Agoraphobia

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ABSTRACT

The aim of this work is the description of virtual environments designed to apply exposure therapy in the treatment of panic disorder and agoraphobia. The program allows the simultaneous exposure to two different kinds of stimuli usually avoided by panic disorder and agoraphobia sufferers (external and interoceptive). The characteristics of the virtual environments are described, as well as the target behaviors that can be simulated with these virtual environments.

INTRODUCTION

In the last few years, virtual reality (VR) has become a tool that is demonstrating a great potentiality in different fields of health disciplines. Concretely, VR offers new alternatives for assessment, treatment and research in clinical psychology. The studies which demonstrate the utility of this tool for the treatment of psychological disorders are increasing, mainly in the field of anxiety disorders.1-15

With regard to the treatment of panic disorder and agoraphobia (PDA), although we have at our disposal empirically validated treatments for this disorder,16-19 VR offers some advantages over the traditional programs. VR can help to overcome some of the limitations of one of the main therapeutic components to treat this problem, exposure. For example, the high number of patients who refuse or drop out the in vivo exposure component—because this therapeutic technique could be too aversive20,21—or the difficulties of some patients to practice an alternative to in vivo exposure, imaginal exposure.22,23

In comparison with imaginal exposure, VR allows a higher immersion in the situations, given that several sensorial modalities can be triggered at the same time (e.g., audio, visual, interoceptive). This can be very helpful to people who have difficulties imagining the target scenes. Also, a virtual environment allows a high control over the elements of the exposure hierarchy, and the exposure tasks, given that the therapist can introduce in the virtual world the elements required, and only them, with a high degree of accuracy. Besides, the therapist can see on a screen exactly what the patient sees in the virtual world. This allows to know what elements are provoking the anxiety response.

As compared to in vivo exposure, in the virtual environments the patients can feel safer because the privacy of the consultation room (VR involves exposure to different situations generated by a computer without leaving the consultation room) could help the patient to reduce the fear to lose control in public during the exposure tasks, or also, to avoid that other people know about his/her problem. Besides, virtual exposure can be a useful intermediate step for those patients who find too aversive the idea of confronting agoraphobic situations and refuse in vivo exposure. We think that the receiving a virtual exposure treatment can increase the possibilities of accepting an in vivo exposure program in

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the future. Finally, considering the wide number of situations and activities that agoraphobic sufferers avoids, the use of VR can entail an important saving of time and money in comparison with in vivo exposure.

Another important advantage for the treatment of PDA is the possibility that our virtual program offer conduct situational and interoceptive exposure at the same time. Interoceptive exposure consists of exposing the patients to the feared bodily sensations, similar to the ones experienced in panic attacks. Traditionally, this kind of exposure is conducted in the consultation room by means of several exercises (e.g., hyperventilation, blowing through a straw, running, jumping). This technique is not usually conducted at the same time as situational exposure (which should be practiced outside the consultation room). We think that conducting interoceptive and situational exposure at the same time could entail more therapeutic benefits, given that it could simulate in a more ecological way how the bodily sensations occur in the agoraphobic situations. We can introduce in the virtual world several bodily sensations with sound and optical effects (breathing difficulties, increasing heart rate, tunnel vision, blurred vision) in order to achieve a higher activation of the anxiety response during the virtual exposure to agoraphobic situations.

Before describing the characteristics of our virtual program, we would like to comment briefly some VR environments for PDA designed by other research teams. We highlight some of the advantages and limitations of these programs, as well as the therapeutic results obtained.

The first study about the use of VR for the treatment of PDA used a virtual environment composed by several scenarios: A building with four balconies at different heights; a 6 x 4 m room with a door; an old and dark house (with black walls and dark colored objects) placed in the countryside; the same house with a black cat inside; the elevator of a hotel, open and without walls in order to see outside; a geographical canyon, with different bridges with different length; and three balloons placed at different heights. One of the limitations of these scenarios is that they seem more targeted to acrophobia than to agoraphobia, and some important agoraphobic situations are missing (e.g., crowds, public transportation, shopping center). Also, the possibilities of introducing anxiety modulators are very reduced. As for the clinical utility of these scenarios, the authors only offer efficacy results with a subclinical sample.

Later, Jang et al. used a virtual environment (a traffic jam in a tunnel) in a group of patients with PDA. However, they do not obtain good results due to the difficulties of immersion that some patients presented. The VR environment used is limited considering the number of situations that agoraphobic avoidance entails, also it was not able to induce the anxiety response in some participants.

Finally, Vincelli et al. described a virtual environment for the treatment of PDA with four scenarios: an elevator; a supermarket where the patients can buy some products and pay for them at the cashier; an underground train where the user can travel from one station to another; and a big square with a church, some buildings and a pub. The program allows the therapist to manipulate the time of the virtual experience and the number of people present (from none to a crowd). These scenarios have a more clinical significance for PDA patients, although the possibility of introducing modulators is limited (only time and number of people), and the program lacks flexibility (the manipulations have to be performed before entering the scenario and it is not possible to introduce changes during the exposure tasks). These authors do not offer efficacy data either.

The scenarios developed by our research team allow solving some of the limitations mentioned. In the design of the software we have considered the main characteristics of PDA (situational and interoceptive avoidance), as well as some important anxiety modulators (e.g., number of people, conversations and instructions with threatening contents, length and duration of the trips). The program offers the possibility of introducing bodily sensation effects, elements and modulators during the exposure tasks at the therapist’s will with only the action of pushing a key on the computer keyboard.

One of the important issues in the development of VR exposure programs is the knowledge about the disorder to be treated and the therapeutic technique to be used. It is important to design VR meaningful environments from an emotional perspective to achieve a high degree of sense of presence and reality judgment. The patient has to feel that he/she is there and that the situation seems real. As for the exposure technique, an important parameter to be considered is time. VR scenarios have to allow the patient to stay in the situation as long as is needed for the anxiety to go down, and this time varies from one patient to another. VR environments have to be flexible about the time that trips, or other sequences take. Another important issue to be considered is the flexibility of the VR situations in order to build hierarchies adapted to each patient. To achieve this goal it is important to simulate enough situations where the use of several
modulators could be done. All these issues have guided the development of our VR program for the treatment of PDA.

**MATERIALS AND METHODS**

Our virtual exposure treatment program is called Panic-Agoraphobia and have six virtual scenarios. The first one is an emotionally neutral scenario designed for the patient to get familiar with the virtual environment. The other five scenarios are clinically significant scenarios for PDA patients.

The devices used are a Pentium III (1000 HZ, 256 MB of RAM and CD-ROM drive) and a AGP graphics card, 64 MB, with support for OpenGL and with support for a 60-Hz rest frequency at 640 x 480 resolution. The patient’s visual device is a V6 (Virtual Research) head-mounted display (HMD), and the psychologist’s visual device is a 17” monitor. The patient tracker device is an InterTrax 2. The patient navigation and interaction device is a mouse of three buttons and the psychologist interaction device is the keyboard. Finally, the patient audio device is a V6 Headphones and the psychologist audio device is a regular Headphones. The software used to develop the Virtual Environments is 3DIVE, and it runs in Microsoft Windows (95, 98, ME, 2000, or NT 4.0, with Service Pack 6).

In each scenario, exposure to external and interoceptive stimuli can be conducted simultaneously. The bodily sensations that can be simulated in each one of the scenarios are (1) palpitations and breathing difficulties with three levels of intensity (mild, moderate, and accelerated); and (2) visual effects—tunnel vision, blurred vision, and double vision. On the other hand, the difficulty of each scenario can be graded using some modulators, which allows to establish flexible virtual exposure hierarchies. This possibility increases the likelihood to obtain significant hierarchies for each patient, and allows the progressive exposure to the feared situations; important issues to be consider in exposure therapy. Also, each action in the VR world can be repeated as many times as needed and the time needed for each patient.

*The training room*

In this scenario we find a table with some objects on it. The user can interact in different ways with each object. The aim of this scenario is to introduce patients to the virtual world in order to practice and learn to move around it. The patients can move around the room, identify objects, and interact with them (Fig. 1).

*The room*

One of the objectives of this scenario is the treatment of anticipatory anxiety that PDA patients usually experience before confronting agoraphobic situations. This scenario is a living room (with a couch, book shelves, pictures on the walls, a TV, a radio, a phone and answering machine, magazines). The patients can interact with the virtual objects, read magazines and listen to the radio where some announcements of big sales in a shopping center are displayed. The patients can also listen to some messages in the answering machine from a friend where he apologizes for not being able to go with him/her to the shopping center and asking him/her to do some errands (each one of the messages involves an increase in the difficulty of the errand) (Fig. 2).

Once the patient has made the decision of going shopping, he/she can leave the room and take an elevator to leave the building. The therapist can modulate the number of people in the elevator (from none to four people). If there are people in the elevator...
there is an option where two people have a conversation with agoraphobic content. The patient can go up and down. The elevator offers other options: push the alarm button in case of an emergency, stop the elevator simulating a breakdown, and make people in the elevator talk about the elevator breakdown. (Fig. 3).

In summary, this scenario is designed to work on anticipatory anxiety and expose the patients to different agoraphobic situations: being alone at home, going out alone from home, and the elevator.

The subway

The main objective of this scenario is the treatment of one of the agoraphobic situations that patients experience as being uncontrollable: the use of public transportation. The starting situation is being in the underground station waiting for the train. The train arrives and the patient can enter the coach. The number of passengers can be changed from a minimum level (only people seated), medium (people seated and some standing), and maximum (people seated and many people standing). If the number of passengers is high, it can be difficult for the patient to get in the coach. The duration of the trip between two stations is controlled by the therapist who can make the train arrives to the following station and stops pushing a key when it is convenient. When the train stops, some people can get in or get out the coach (a maximum of four people). The patient also has the possibility of getting out of the train at each station, and getting in again. There are nine different stations (Fig. 4).

The bus

The aim of this scenario, as well as the subway, is to expose the patient to public transportation. Here the starting situation is the patient waiting for the bus at the street. The bus arrives and the patient
gets in. As in the subway, there are different levels regarding the number of people in the bus. As for the trip, two routes can be chosen, one with three stops, and a longer one with eight stops. The therapist decides when the bus stops. Also the number of people getting in and out of the bus can be controlled by the therapist (Fig. 5).

The target behaviors that can be practiced in these two scenarios are: taking the subway and the bus, being in crowded places and going far from home.

*The shopping mall*

The objective of this scenario is to expose the patients to agoraphobic behaviors that can take place in a shopping mall. The shopping mall has two levels: the books and music section; and the supermarket section.

*Ground level.* The patient can move around the mall and interact with different objects: take a look at a book or a CD, take them, wait in line and pay the cashier for them. The number of people can be increased too. In this scenario, several difficult situations can be simulated: (1) the aisles can be blocked with people, preventing the patient to move easily around the environment; (2) once the patient is placed in the cashier line, a problem with a credit card can happen, making the patient wait longer. The patient arrives to the first level using an escalator (Fig. 6).

*First level.* This is the supermarket section where the patient can purchase different products, e.g., milk, cookies, and beverages. The patient can go to the cashier to pay. The same difficult situations as in the ground level can be simulated. The patient can go to the ground level using the escalator (Fig. 7).

The agoraphobic situations that the patient can practice in this scenario are: go shopping, being in a crowded place, being in line, being in narrow spaces (aisles), and using escalators.

*The tunnel*

This scenario is a dark tunnel which aims to expose the patient to agoraphobic behaviors that can take place in situations where finding the exit or escaping in the case of experiencing a panic attack is

![The shopping mall, escalator to first level.](image1)

![The tunnel.](image2)
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difficult. This scenario also allows to work specifically with interoceptive exposure, given that the absence of external stimuli (the tunnel is dark) promotes that the patient focuses his/her attention in the bodily sensations effects (the same as in the other virtual scenarios) (Fig. 8).

**RESULTS AND DISCUSSION**

In Table 1, we summarize the characteristics of each scenario, the anxiety modulators we can introduce, and some of the target agoraphobic behaviors that can be practiced. Although the virtual environments described can be used independently to work in different agoraphobic behaviors, considering the patients needs, there is a continuity among them, as well as link elements (messages in the answering machine, announcements about sales, etc.) that make it possible to build exposure sequences where each one of the scenarios can be considered as an item of a more global exposure hierarchy.

Our VR scenarios meet the requirements needed for exposure treatment of PDA. They allow simulate situations and bodily sensations which characterize PDA, and to build meaningful and flexible hierarchies adapted to each patient. They also allow the practice of exposure as many times and as long as needed in different situations without leaving the consultation room; saving time and money and keeping exposure tasks more confidential. In addition, the computer-generated situations and elements in the virtual scenarios can be controlled with high accuracy. These characteristics could make VR exposure a more attractive and perhaps accepted therapy strategy for PDA patients.

With regard to the clinical utility of these virtual environments, our research team has already presented some preliminary data that support the efficacy of this virtual program in the treatment of PDA. At the present time, we are also working on improving our VR environment in order to increase the efficacy of situational and interoceptive exposure, including new virtual agoraphobic situations, augmented reality, and more bodily sensations (i.e., haptic sensations).

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