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Treating Emotional Problems with Virtual and Augmented Reality

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Introduction

The term virtual reality (VR) was coined in 1989 by Jaron Lanier, although the literature usually cites Ivan Sutherland as the first author writing in the 1960s about this "computer-generated illusion." Some time and a lot of effort have been necessary for the computer science to develop useful virtual realities from a cost-benefit perspective. However, as it is true in computer science in general, as the technological advances develop and the costs become lower, VR systems are more and more available in the workplace, at home, and in most domains of our life. There is no doubt that VR is playing an important role in human–computer interaction and it is a valuable technological innovation. The advances achieved since the first works by Sutherland at the MIT and at the University of UTA are being fruitful now. Its impact in the field of health is remarkable.

VR allows generating three-dimensional (3D) computer-generated environments. The essential characteristic is being able to simulate reality; the user experiences the feeling of "being" in those virtual environments and interacts with the objects included in them. This feeling of "being immersed in the VR environment," of being there, of judging the experience as somewhat real, has been named as sense of "presence." From a psychological point of view, this feeling of being in a certain place and being able to have meaningful experiences there, becomes very important, given that it opens the possibility of using VR environments as powerful therapeutic tools helping the person to change. At the same time, this change is achieved in a safe place. In summary, it is possible to modify behaviors, thoughts, emotions, etc., by means of "special" virtual experiences, virtual experiences designed and adapted to the needs of the individual with the aim of promoting, facilitating, and enhancing the process of change (Botella, García-Palacios, Baños, & Quero, 2009). Because of

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this, in the last years, the use of VR has been widely extended to the field of psychological treatments.

In the last decade of the twentieth century, a research line dedicated to the design and testing of VR applications for the treatment of several mental disorders started. The goal was to explore if the use of VR could enhance the efficacy of the psychological treatments or overcome some of their limitations. The first work describing the application of a VR program for the treatment of a mental disorder was published by Rothbaum et al. (1995). Since then, the interest of the scientific community for VR has grown all over the world, as well as the publication of studies testing the utility and efficacy of this tool in the treatment of several mental disorders. A remarkable number of scientific works focused in the therapeutic application of VR in Clinical Psychology has been carried out. There are evidences of the efficacy of VR procedures for several mental disorders (Meyerbröker & Emmelkamp, 2010; Powers & Emmelkamp, 2008). However, the field of anxiety disorders is the area where the application of VR has been more extended.

Anxiety disorders have an elevated prevalence among the mental disorders. With regard to the treatment of anxiety disorder, exposure therapy is one of the most effective techniques, given that a key feature of these disorders is avoidance. Exposure therapy involves confronting the feared situation or object with the help of the therapist in a repeated, systematic, and progressive way until the individual learns how to confront anxiety in the feared situation, with the result that anxiety diminishes. Exposure therapy could be applied imagining the feared situation (imaginal exposure) or confronting the real situation (in vivo exposure). Considering the features of exposure therapy, some authors in the 1990s saw the possibility of using VR as new way of delivering exposure therapy. VR would allow simulating reality and it could help the patient to confront the feared situation in an efficacious, safe, and controlled way. The pioneer work by Rothbaum et al. (1995) showed the utility of VR exposure in a case of acrophobia. Other works were conducted since then showing, most of them, positive results about the efficacy of this new tool for the treatment of phobias. Although only few studies show good results like Kamphuis, Emmelkamp, and Krijn (2002), review and meta-analysis studies show that VR exposure is effective in the treatment of anxiety disorders (Meyerbröker & Emmelkamp, 2010; Powers & Emmelkamp, 2008). The meta-analysis carried out by Powers and Emmelkamp (2008) demonstrated that in vivo exposure was not significantly more effective than VR exposure in the treatment of several anxiety disorders. In some cases, VR was even more effective than in vivo exposure.

Some studies have indicated not only the efficacy but the advantages of using VR as a therapeutic tool (e.g., Anderson, Jacobs, & Rothbaum, 2004). First, VR allows graduating the situation in a way that the patient can progress from easier tasks to harder ones. Besides, VR enhances the generalization of the therapeutic outcomes given that it is possible to work in different environments related with the problem. VR is flexible enough to design different scenarios where the patient could virtually confront the feared situation, and this confrontation can be done at different levels, even achieving overlearning, that is, going beyond the feared situation. Little by little,

from the knowledge and master of the interactions with the virtual world, the individual is able to confront and master the real world. In this line, it is important to notice that VR allows structuring the treatment as a special and safe place, given that the individual is not confronting the "real" situation, so that it is easier to persuade him/her to take action and practice in the VR environment without feeling threatened. The virtual environment is a "secure base" that therapy makes available, because nothing bad can happen there given that it is virtual. This "as if" aspect of VR is very important given that it could be a key intermediate step between the therapist office (a totally safe environment) and the real world (a totally threatening environment for the patient). VR can be a fundamental step in order to overcome the problem, perhaps the step that prepares the patient to give more steps toward recovery. Besides, it is important to consider that VR allows even going beyond reality, making possible that the feared context changes at our convenience. VR does not have to recreate reality, but to create therapeutic contexts, that is, "create" aspects or features of the environment that are not available to the patient right now (probably because he/she has lost access due to his/her problem). In summary, VR becomes an important therapeutic tool that can be used for the patient to become familiar and interact with a situation that he/she considers threatening at his/her own pace.

Focusing in the specific use of VR as a means to deliver exposure therapy, it is important to notice that this tool can help to overcome some of the limitations of this therapeutic strategy.

- In vivo exposure has a high cost, given that many times it involves that the therapist goes with the patient to the feared situation. Related to this, the feared situation is not always easily available. VR technology allows generating different environments without traveling anywhere, even those that are not easily available.
- Some people are so afraid to confront the feared situation that refuse to get involved in in vivo exposure therapy or drop out from it. Even those people who accept the treatment can find it too aversive and feel not safe given that it is not possible to have control over the events in real life (e.g., stopping of an elevator or having technical problems in a plane, etc.). One of the advantages of VR is that it is safe. The individual and the therapist have control over the computer-generated environment without risks. Besides, VR allows graduating the feared situation with total accuracy, attending to individual differences. VR exposure can be "customized" for each patient or problem, for example, the particular hierarchy of each patient can be elaborated combining the different options offered by the virtual environment. The treatment can be applied in a progressive way attending to the specific feared stimuli by each patient. The treatment can progress in a controlled way, being focused on the particular target and the particular safety behaviors shown by each patient.
- When using imaginal exposure, there is an additional difficulty regarding individual differences in the ability to imagine. VR overcomes this limitation, given that it provides a sense of presence that is difficult to achieve with imagination.

- Although most patients improve significantly and overcome their fears, usually they are not totally free of symptoms after the treatment, presenting some "residual fears" in the feared situations. VR allows "mastering the feared environment" going beyond what a "real" situation would allow, generating high levels of self-efficacy. Being able to interact many times in a repeated way with a concrete key environment involves the possibility of re-experience and feeling many times the implications and consequences of that interaction. A good example is a well-known VR application, the flight simulator. It is possible to practice multiple situations, difficulties, unpredictable situations, mistakes, etc., although in the real world, nothing happens. The progress made in a feared virtual environment would help the patient to experience, feel, and live "reality" in a different way.

At this moment, there are many VR applications for the treatment of different mental disorders developed by several research teams all over the world. In this chapter, we will focus on the applications developed only by our research team for the treatment of anxiety disorders.

Open-Out: A Treatment for Claustrophobia

Claustrophobia is very common in the general population, it being one of the most prevalent specific phobias. The essential feature is a marked and persistent fear related to closed spaces. The exposure or anticipation of confrontation of these situations provokes an anxiety response, although the individual acknowledges that the fear is excessive or irrational. As a consequence of this marked fear, closed spaces are avoided or tolerated with a high level of discomfort, causing impairment in important life domains (family, work, social area, etc.). The treatment of choice for claustrophobia, as it is the case for other specific phobias, is exposure therapy. Our research team developed almost two decades ago a VR application named *Open-Out*, to facilitate the application of exposure therapy.

Open-Out includes two scenarios, the house and the elevator. The house has two rooms (the living room and the "magic room"). The living room has two windows and two doors, one of them takes to a balcony and the other one takes to the "magic room." In this environment, the individual can be exposed to different degrees of closure, open and closing windows, and doors. In the "magic room," there are no furniture and no windows. The ceiling and the floor have a texture designed to give a higher sense of closure. The door can be closed and locked. This room allows the overlearning feature that we mentioned in the former section because it allows going beyond reality. It is possible to make the space smaller and smaller, moving one of the walls (accompanied by a strong noise) toward the individual, which increases the sense of closure.

The elevator also offers different possibilities in order to simulate different degrees of threat, considering several parameters: size, position, possibility of sudden stop, and possibility of breakdown. Inside the elevator, there are two special buttons that

the patient can use. One makes one of the walls move (with a strong noise) toward him/her making the space smaller; the other button makes the wall go back to the original position.

We designed a clinical protocol for the use of *Open-Out* that has been tested with success in case studies (e.g., Botella et al., 1998); and also in studies with a higher degree of experimental control like single case studies (Botella, Baños, Villa, Perpiñá, & García-Palacios, 2000). These works demonstrated that *Open-Out* is effective to reduce claustrophobic fear and avoidance, obtaining a maintenance of the improvement at three-month follow-up.

Virtual-Flight: A Treatment for Flight Phobia

Flight phobia is a specific phobia, characterized by a marked fear related to flight situations. Anticipatory anxiety can be present in several situations such as buying flight ticket, waiting in the boarding area, or even at home, and packing. The fear can be so intense that the individual avoids confronting the flight or any situation related with flying; sometimes the individual does not avoid the situations but tolerates them with a high level of discomfort.

Again, the best treatment for this specific phobia is in vivo exposure. However, in this case, the treatment could entail a high cost both economic and related to time. Rothbaum team was again one of the pioneers in considering this phobia one of the best candidates for the application of VR exposure (Rothbaum, Hodges, Watson, Kessler, & Opdyke, 1996). Our research team developed more than fifteen years ago the program *Virtual-Flight*, that includes three virtual scenarios to deliver exposure therapy for this problem. In all of them, the therapist and patient can have control over several events: time of the day (day or night); good or bad weather, and also to control certain changes in the environment in order to adjust the degree of threat. The first scenario (*getting ready for the flight*) focuses on addressing anticipatory anxiety before the flight. It is a room where the action of packing is simulated. The second scenario (*at the airport*) also addresses anticipatory anxiety but being already at the airport. In this environment, the individual cannot interact with any person or object. He/she is at the boarding area waiting for his/her flight. The environment provides information about updates regarding the next flights, see through a big window planes taking off and landing, and listen to conversations among other passengers waiting for the flight. Finally, the third scenario (*aboard*) simulates being inside an aircraft. In this scenario, the patients can interact with some objects, look around, but it is not possible to get up or walk around. This scenario is used to simulate key events like taking off, landing, or turbulences.

Our team developed a clinical protocol for the use of *Virtual-Flight*. This VR program has been tested in different studies showing always positive results regarding clinical efficacy (e.g., Baños et al., 2002; Botella, Osma, García-Palacios, Quero, & Baños, 2004). Recently, Tortella-Feliu et al. (2011) compared the efficacy of *Virtual-Flight* with two computerized treatment programs for flight phobia in a controlled study. This study showed that *Virtual-Flight* was effective for the reduction of flight

fear and avoidance, achieving that the patients actually flew after the treatment. Besides, *Virtual-Flight* has demonstrated to be an efficient program, presenting advantages over traditional treatments related with saving time and money.

Going-Out: A Treatment for Panic Disorder with Agoraphobia

Panic disorder with agoraphobia (PDA) is one of the mental disorders with higher costs for health services. The main characteristic is the presence of panic attacks that consist of unexpected fear or intense discomfort attacks in which the person experiences intense bodily sensations (heart beatings, shakings, suffocation, dizziness, etc.). These attacks start abruptly and reach the maximum intensity in few minutes. They also go together with and immediate and imminent feeling of danger and a desire of escaping. Panic disorder, generally, goes together with agoraphobia, which consists of the experience of intense anxiety when the person comes across situations or places from where it is difficult to escape or obtain help in case of having a panic attack. This anxiety can make the person to avoid different situations: going out home alone, to be in crowded places such as football fields or concerts; traveling by train, bus, or car; and passing through bridges or tunnels.

After years of research, there is enough empirical evidence to affirm that cognitive–behavioral treatments are the most effective to treat this disorder. Many of these programs include the following therapeutic components: psychoeducation, cognitive restructuring in order to correct the catastrophic interpretations of the physical sensations, slow breathing training, relaxation, exposure to the feared physical sensations (interoceptive exposure), and exposure to the agoraphobic situations (in vivo exposure).

Following these guidelines, our group has designed an intervention protocol that includes those components applied along eight sessions. In order to apply both interoceptive and in vivo exposure using VR, the program *Going-out* is used. This program is made up of six virtual scenarios: a training scenario and five clinically significant scenarios for panic disordered patients (the house, the metro, the bus, the mall, and the tunnel). These scenarios include several modulators that allow to graduate and rank the difficulty of exposure for each patient: number of people, length of the trips, breakdown in the elevator, problems with the credit card payment, number of levels in the elevator, etc. In addition, all these scenarios, unlike other VR available programs currently, permit to simulate different bodily sensations (heart beatings, rapid breathing, tunnel vision, blurred vision, and double vision) through visual and auditory effects, allowing, therefore, to apply simultaneously both types of exposure. In sum, *Going-Out* is a flexible program that can be adapted to the patients' needs, offering the possibility of conducting the exposure technique in a gradual and controlled way.

The objective of "the house" is to diminish the anticipatory anxiety that patients with PDA have before facing an agoraphobic situation. The house includes a living room, an elevator, and the foyer. This scenario permits to work different typical

situations present in this problem such as being alone, going out of home alone, and using the elevator. The main objective of "the metro" and "the bus" is to confront the patient to situations in which he/she experiences fear and uncontrollability. In both scenarios, the number of stops and people who enter or go out is modulated. The "mall" scenario allows the patient to be exposed to agoraphobic situations such as shopping in a mall, being in a crowded place, being in a queue, being in narrow spaces (corridors), and using the escalators. Finally, "the tunnel" permits to expose the patient to a very threatening agoraphobic situation like being in a place where to find the exit or escape is difficult in case of having a panic attack.

Regarding efficacy data of *Going-Out* program, several studies have demonstrated its efficacy and utility. A controlled study (Botella et al., 2007) compared the efficacy of VR exposure with in vivo exposure. Results showed that both treatment conditions were equally effective with no significant differences between them. Furthermore, patients' acceptability of the exposure component in both conditions was very high, considering the component very logic, satisfactory, advisable to others, useful for their problem and for other problems. Finally, in a recent study (Pérez-Ara et al., 2010), the utility of VR to conduct interoceptive exposure was analyzed. The efficacy of two treatment conditions that used virtual exposure to the agoraphobic situations was compared, but in one condition, participants were exposed simultaneously to the program sounds and visual effects, whereas in the other condition participants received interoceptive exposure in the traditional way, that is, separately from the VR exposure to the agoraphobic situations. Results showed that both conditions were capable to reduce the symptoms significatively, and this reduction was maintained at 3-month follow-up. Therefore, evoking physical sensations through VR was as powerful as evoking them by doing traditional in vivo exercises (such as hyperventilation, to go up and down stairs, to draw in a chair, etc.). In addition, participants in VR condition considered the interoceptive exposure more logical and useful to treat other problems than participants belonging to in vivo exposure condition.

In sum, the studies conducted with *Going-Out* program show that RV allows to apply the interoceptive exposure component and the exposure to the agoraphobic situations simultaneously, which might facilitate treatment, conducting the exposure in the clinician's consulting room, protecting patients' confidentiality and reducing costs related to the therapist's traveling expenses.

The EMMA's World: An Adaptive VR System for Stress-Related Disorders

Stress-related disorders like posttraumatic stress disorder (PTSD), adjustment disorders, and complicated grief have in common the forthcoming of clinically significant behavioral, emotional, and cognitive symptoms after being exposed or having experienced an event that has a negative impact in people's life. A common element in many therapeutic approaches for these disorders is the exposure and processing of stimuli related to the negative event. However, exposure technique for these disorders seems to be underused in clinical practice. The studies carried out by Becker, Zayfert, and

Anderson (2004) indicate that only few psychologists use this strategy. Several reasons explain this low rate of use. Regarding patients, for some of them, the imaginal exposure to the stressful event is a challenge too difficult and some patients are reluctant to remember the traumatic event, as well as the situations, objects, or people related to them. In other occasions, the patients are able to talk about the trauma, but they do so "detached" of the experience, they do not involve emotionally in the experience. This lack of emotional involvement may interfere in the anxiety reduction resulting in poor treatment outcomes. Negative treatment results may also be found due to the difficulty in imagination capacity for some people. But the reluctance comes from the clinicians as well. Some of them find the exposure technique procedure too aversive and painful and consider that this technique can "re-traumatize" patients or that the stress caused by its use could decompensate them or make them to abandon the treatment. VR can be a promising alternative to overcome these difficulties.

In the specific case of PTSD, several studies have shown that the use of VR exposure produce a significant reduction of symptoms. For example, Rothbaum's group has reported improvements in the clinical situation of war veterans (e.g., Rothbaum, Hodges, Ready, Graap, & Alarcon, 2001). Difede's group has treated several survivor of the September 11 terrorist attack in New York, using a simulation of the twin towers, finding positive results even in patients who had not improved with the use of imaginal exposure technique (Difede et al., 2007).

However, regardless of the continuous improvement and innovation of technologies, the VR systems used in the aforementioned studies only include one or several scenarios related to a specific problem, given that their main objective is addressed to represent the reality with the higher fidelity as possible. This issue has an important limitation since these scenarios can hardly be used to treat other problems different to those they were designed for or be applied in a population different to that they were thought of (for instance, the twin towers scenario developed by Diffede and Hoffman cannot be used in someone who suffer PTSD but who was not a victim of the September 11 attack). This shortcoming is especially important in the case of stress-related disorders due to the big amount and the wide range of traumatic or stressful events that may result in the development of these problems.

With the aim of overcoming these difficulties, our group developed the "EMMA's World" (Engaging Media for Mental Health Applications). The main objective was to build a VR application able to adapt itself in a flexible manner to the particular needs present in different problems (overcoming the limitation of the traditional VR systems that use the same scenario for everyone) providing, at the same time, significant environments capable of activating and enhancing the emotional processing of the experienced event. In addition, we also pretended to reduce the reluctances showed from both therapists and patients when applying exposure technique, trying to make the exposure less aversive and painful. The application, instead of building "realistic" scenarios, combines virtual elements that are capable of representing and evoking a symbolic way the meanings and emotional reactions related to the experienced event and which, at the same time, can be modified according to the changes that patients are experiencing along treatment. The objective is to offer the users a "physical" representation (virtual) of the event and their emotions and, through the

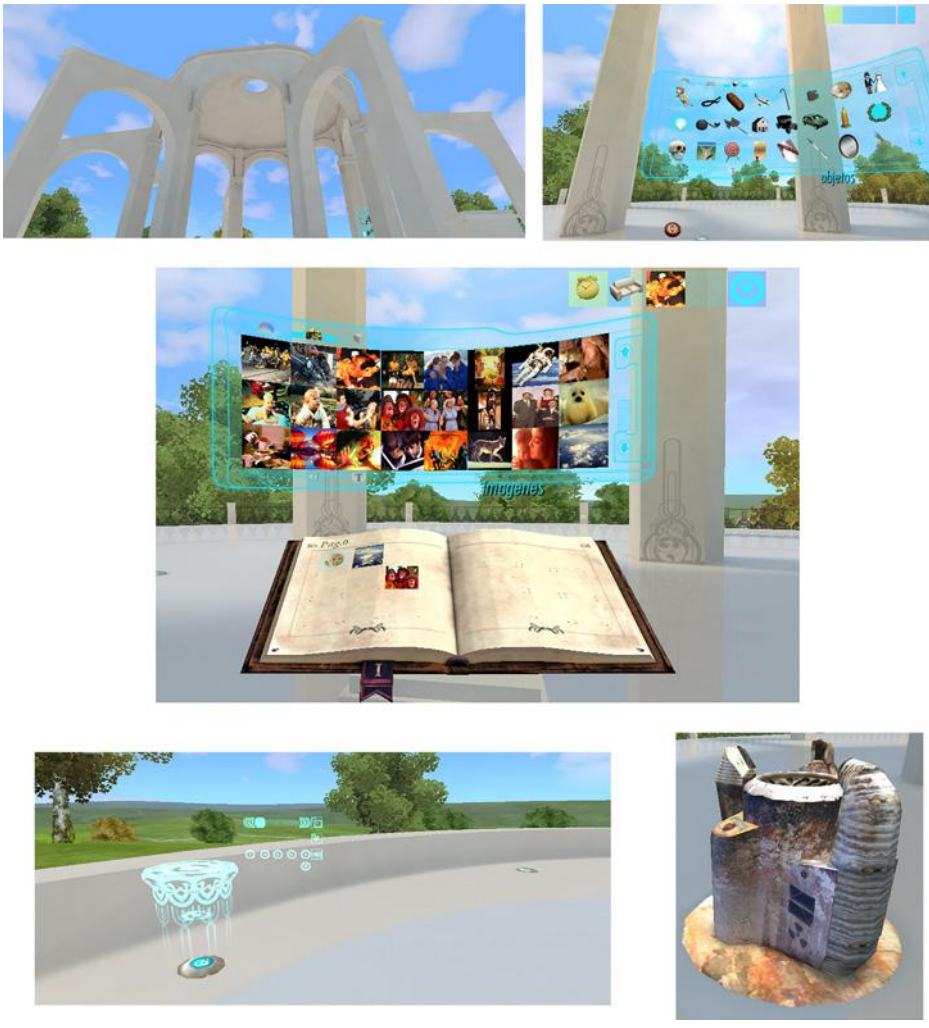

Figure 25.1 "EMMA's room" and its elements.

therapeutic work with such representation, to facilitate the emotional change, the improvement of the coping competences, and learning from the problems. In addition, the system maintains the advantages of the traditional VR systems, by permitting the control of the process at all time and by guarantying this occurs in a gradual and safe way. EMMA's World also allows creating and personalizing virtual environments that can be modified in real time and in which it is possible to introduce personalized multimedia elements (pictures, music, texts, videos or user's narratives). EMMA's World includes two virtual environments: "EMMA's room" and "EMMA's environments":

1. "EMMA's room" simulates an architectural structure where all therapeutic sessions start. It is an open space, with no walls, from where the surrounded landscape can be observed (see Figure 25.1). This room includes several

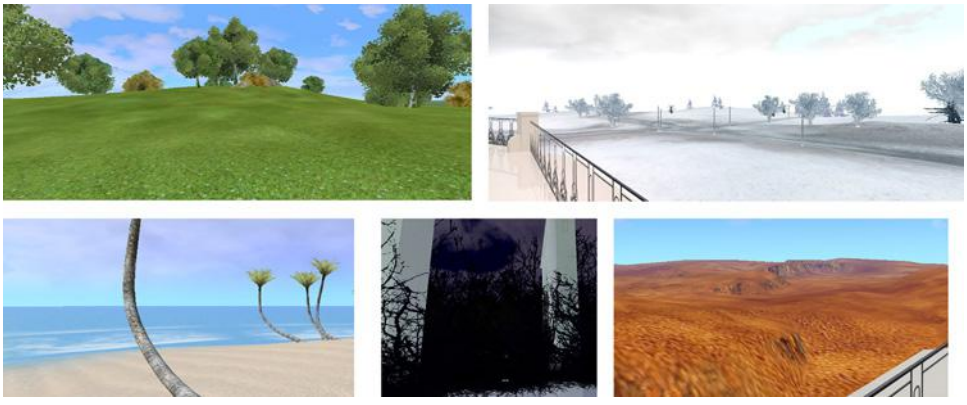

Figure 25.2 EMMA's environments.

therapeutic tools: (a) The database, which consists of a mobile screen with different elements that the user can manipulate (3D objects, pictures, music and sounds, colors and proverbs or sayings); the system also permits to introduce in the database elements from the particular patient, such as pictures or music. (b) The stands, a place where the elements chosen by the patient to work with are located, being possible different ways of mixing and combining them. (c) The inventory, a small viewer located in the right superior part of the screen with permits to carry the elements from the database to the stands. From there, can be stored in the book of life. (d) The book of life, which includes an index and a series of pages where the patient can write the chapters of his/her life related with the stressful event. In this book, the elements that are being processed and elaborated in therapy can also be stored; the book of life helps the patient to remember, analyze, and elaborate the events and allows him/her writing and rewriting (with words and with the database elements) the emotional experiences associated with the situation. (e) The Emotional Processor, which is a device that emerges from the floor when is activated. The elements related to the painful experience which have lost the power to emotionally disturb the patient can be located on this device so they can be transformed in a symbolic way.

2. "EMMA's environments" are five predefined landscapes that the patient can choose (see Figure 25.2): a meadow, a snow-covered town, an island, a threatening forest, and a desert. The landscapes can be selected and modified in real time with the aim of promoting the induction of emotions, reflecting the changes in the affect experienced by the patient during the session and helping him/her in his/her regulation and awareness work. The changes that can be done affect the environment conditions (e.g., to provoke wind, rain, snow, fog, a storm, an earthquake, or make the brambles grow) and the representation of time (e.g., to vary the time of the day or the speed with which time goes pass) and they can be made with different levels of intensity. All the elements and possibilities are designed with the purpose of reflecting the patient's mood state in the most accurate way as possible, aiming at helping the patient to experience, accept, and manage the suffered emotions and experiences that caused his/her discomfort.

Along with the development of the system, the design for the treatment protocols was developed. The treatment structure is similar for the three considered disorders, although the necessary modifications according to the specific characteristics of each disorder are included. In the case of PTSD, we made and adapted Foa and Rothbaum's (1998) treatment protocol and, for the adjustment disorders and complicated grief, we followed the guidelines stated by Neimeyer (2001). The common components in these protocols are (a) educational component; (b) exposure in EMMA's World, where the patient chooses the virtual environment and elements that represent the suffered event and his/her emotions that allows him/her to face them and to process and overcome progressively the experience; (c) the book of life, whose aim is to help the patient to recall, order, and save his/her memories, thoughts, feelings, and emotions related with the suffered experience; this book helps to the elaboration of the event, permits to extract learning from the event itself, and contributes to the process of incorporating the suffered experienced joint with the remaining life experiences; (d) in vivo exposure that states an exposure hierarchy or a graded list of situations, objects, or persons feared by the patient to which he/she has to confront progressively, starting with the easiest situation and moving forward to the most feared ones; (e) cognitive restructuring, focused on the identification, evaluation, and modification of negative thoughts and dysfunctional beliefs the patient has related to the stressful event; (f) acceptance strategies whose aim is that the patients become aware and "allow themselves" experiencing emotions, having thoughts, or producing behaviors, although these are aversive and they manage, finally, to accept the disturbing event; and (g) relapse prevention.

Patients are explained that, apart from the therapist, the system will accompany, support, and guide them along the whole process. They are told that EMMA's World is a place where they can express their problems, thoughts, and emotions freely and with no pressure, that the whole system is thought to help, support, and guide them and that the environment is a place where they can stop, rest, and think. Once the patient is immersed in the scenarios, the therapist ask him/her to narrate his/her memories about the disturbing experience in present time and with the highest level of detail as possible, reflecting at the same time the experience in the virtual environment. The selected elements that have been chosen and worked in session by the patient are saved in the book of life whose aim is to help the patient to order his/her life, to represent how he/she is solving the emotional and behavioral problems as he/she is confronting the disturbing elements of his/her experience, and to store those elements.

The utility and efficacy of this system has been tested in several works. Results obtained in case studies (Andreu-Mateu, Botella, Quero, Guillén, & Baños, 2012; Botella, Osma, García-Palacios, Guillén, & Baños, 2008) showed an improvement in the patients' clinical condition with different stress-related disorders. Other between-group studies were also conducted (e.g., Botella, Baños et al., 2006), finding that patients reported very high scores regarding treatment satisfaction, even higher than the expectations generated by the patients before treatment. It was also found that the condition that used EMMA's World evoked lower levels of aversiveness over the traditional condition. Finally, controlled studies have been conducted (e.g., Baños et al.,

2011) and the obtained results so far support the efficacy of the VR system developed by our group for the treatment of stress-related disorders, concretely for PTSD, adjustment disorders and complicated grief, and show that the system is well accepted and valued by both the patients and the therapists.

At this moment, an adaptation of EMMA's World for children and adolescent are being carried out and a study is being planned to test the efficacy of this adaptation in abused children and adolescent. We expect to apply this system for the treatment of other kind of problems in the future. We think that this is the first step in a line of research that will be very productive. We envision a time in the near future when each researchers and clinicians will have a versatile and complex virtual world available to them, to which they will be able to add elements, enriching it and exploring new utilities and possibilities. This will allow us to work with our patients in "virtual worlds" and "real worlds" that fit the specific needs of every patient in different situations.

Limitations of VR

In spite of the advantages we have highlighted so far, VR has shortcomings too. First of all, it is important to stand out the necessity of studying and specifying the possible harm of the wrong use of virtual worlds. One of the possible harmful effects are the collateral effects suffered by some users after the virtual exposure (Rizzo, Wierderhold, & Buckwalter, 1998). The symptoms include eye problems, disorientations, balance alteration, and sickness. These secondary effects are not frequent in users who do not suffer any physical nor neurological problems, affecting only to a short percentage of the population. In any case, and specifically the first times when people interact with the virtual world, some motion sickness and instability may appear. In these situations, the therapist has to calm the user down, explaining that these effects do not suppose a risk for his/her health. In addition, we should explain that the sensations are temporary and very similar to others experimented when people travel by boat or by car. The therapist has to make sure that the symptoms have disappeared before the user goes out of the therapist's office. Another limitation is related to individual differences in the sense of presence achieved by users. Some users do not feel immersed in the virtual world, and then the efficacy of this technology to overcome their problems may be limited. Further research is needed on how to improve virtual worlds to make achievements that are easily transferable to the real world.

Augmented Reality and the Treatment of Specific Phobias

An advance in VR technology, augmented reality (AR) has overcome some of the limitations of VR, contributing with mixed realities to increase realism and the patients' sense of presence, "filling" reality instead of substituting it. AR could also improve therapy duration and acceptance.

AR allows the user to see the real world, but in this real world, some objects and 3D elements are placed, as part of what the user can see. Then, it can be said that AR

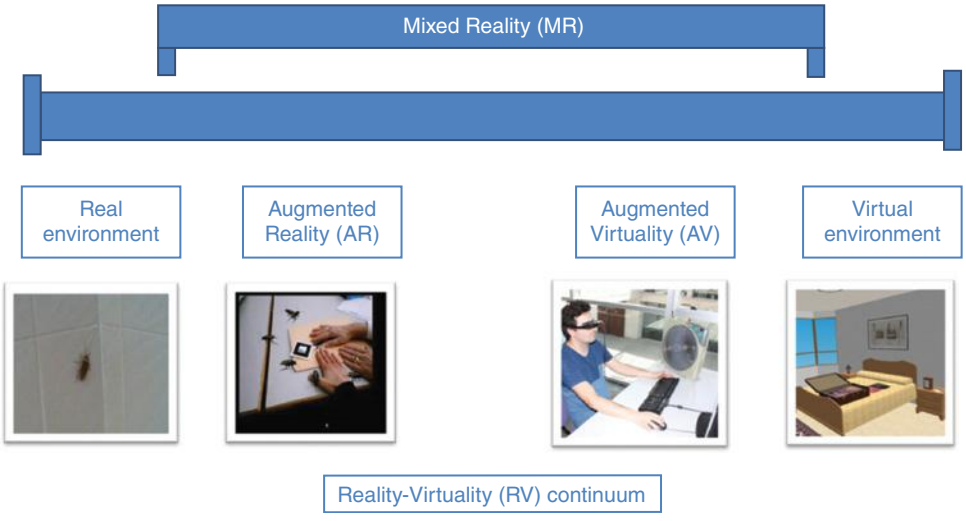

Figure 25.3 The reality-virtuality-continuum.
Source: Milgram, P., Takemura, H., Utsumi, A., & Kishino, F. (1994). Augmented reality: A class of displays on the reality-virtuality continuum. *Proceedings of Telemanipulator and Telepresence Technologies* (pp. 285–292). SPIE.

complement the reality instead of fully replacing it, as VR does. The central characteristic of AR is that virtual elements that are superimposed let additional and relevant information to the image of the system the user is visualizing, with the purpose of helping him/her.

The reality–virtuality continuum proposed by Milgram, Takemura, Utsumi, and Kishino (1994) can help us to better understand AR and the main differences with VR. As it can be observed in Figure 25.3, in an extreme of the continuum "the real environment" is located, which, obviously, is not modelled at all. In the other extreme, "the virtual environment" is positioned, which is totally modelled. AR would be located near from the real world, as the user can see an image composed by the visualization of the real world and some virtual elements superposed on it. "Augmented virtuality" consists of a virtual environment where real stimuli are included (e.g., the smell of the flowers in a virtual environment). Both AR and augmented virtuality have two main characteristics: they both mix realities and they are both worlds partially modelled but in a different degree, the AR being modelled in a lower degree.

AR is a technology that offers very promising possibilities in several fields, due to its characteristics, especially in the clinical psychology area. This technology offers additional advantages over VR. First, AR can provoke a greater feeling of presence and reality than VR because the environment and the tools the patient uses to interact with the application are real. Second, in AR the users can see their own bodies in context, interacting with the feared stimuli; the system allows patients to use real elements and their own hands and bodies to interact with the feared stimuli. Finally, AR is cheaper than VR, as it is only necessary to design and simulate the feared elements rather than an entire immersive environment.

Figure 25.4 AR system for the treatment of acrophobia.

AR is having several applications in engineering, medicine, entertainment, and in other disciplines and areas (Azuma et al., 2001). However, there are few AR applications in psychology. So far, the scarce available applications in the psychological treatment field have been carried out by our research group and have been focused on the treatment of specific phobias: acrophobia and small animal phobia (spiders and cockroaches).

The AR system for acrophobia uses immersive photography technique (Juan, Baños, Botella Pérez, Alcañiz, & Monserrat, 2006), consisting of photographed environments representing the real ones, where the user can move around. By using immersive photographs, a complete space is captured from a single point and it is worked in a digital way in order to create a photogram of 360°. The system includes different locations and levels that patients can visualize (see Figure 25.4): images taken from a window of a building (located on the first, second, third, fourth, fifth, and fifteenth floors), view of a stairwell from the second and third floors, view of a staircase from a terrace situated on the second floor, view of a dam (both sides), and images taken from a terrace located on the second and third floors. The therapist can modify each level with an option menu. The treatment includes AR exposure by using immersive photos, reinforcement practice, and cognitive challenge.

The AR system for small animal phobia uses a USB or FireWire camera incorporated in a Head-Mounted Display (see Figure 25.5). When the camera finds a marker (a white square with a black border containing symbols or letters) in the real world, the program recognizes it and activates the virtual elements (spiders and cockroaches in this case).

The therapist can monitor and control the virtual stimuli presented to participants during the exposure session. The system includes the following menu options: number of cockroaches (it is possible to increase or reduce the number of animals with 60 as the maximum number); movement of cockroaches (static or moving); state of the

Figure 25.5 AR system for the treatment of small animal phobia.

animal (alive or dead: the participant can "kill" the animal using an insecticide or crushing it with some object); and kind of animals (there are three different kinds of spiders and cockroaches). The AR treatment is applied following the guidelines developed by Öst, Salkovskis, and Hellström (1991), which involve intensive exposure, lasting up to 3 hr and incorporate treatment components like modeling, exposure (in this case using AR), reinforced practice and cognitive challenge.

Several studies have offered data about the efficacy and utility of AR for the treatment of small animal phobia (e.g., Botella, Bretón-López, Quero, Baños, & García-Palacios, 2010). These studies have shown that AR exposure can reach an important reduction of the fear, avoidance, and beliefs linked to situations that involve confronting these feared elements (spiders and cockroaches). In addition, virtual objects (small animal) are assessed by patients as very realistic and useful to activate the anxiety, mainly when the animals are in movement. These positive results suggest AR's potential in psychology. It is needed to apply this treatment to larger samples and in a group design that includes a control group. Furthermore, some aspects could be improved. Firstly, as usual, participants came to the "one-session treatment" with high levels of fear. We hypothesize that asking the patients to complete homework assignments involving familiarization with the feared object (cockroach) could help make the "one-session" exposure treatment less aversive. Secondly, following Öst's recommendation (Öst et al., 1991), participants are advised to continue confronting cockroach-related phobic situations after therapy in order to completely surmount the problem. This aspect can be difficult, since the feared object (cockroach) is sometimes not present for

the duration that the patient requires. Computer games could help make post-treatment self-exposure tasks more effective. We have developed a serious game for the treatment of cockroach phobia that uses a mobile phone as the application device. We have analyzed whether the use of this mobile game can facilitate treatment of this specific phobia preparing his or her for the AR exposure (Botella et al., 2011). Preliminary data show that the use of the game reduced fear and anxiety punctuations of participants before starting the AR session, and consolidated treatment gains reached by the therapy, reducing more the punctuations of fear, avoidance, and beliefs in irrational thoughts.

In the same way that VR began with the treatment of specific phobias and its use was extended in a quickly way to more complex disorders, AR can become a very useful tool in the treatment of several problems. Future research lines have to be focused on testing the utility of these systems, by controlled studies, large samples, and with follow-up data in order to confirm the efficacy and efficiency of AR as a therapeutic tool for the treatment not just of specific phobias but other anxiety disorders.

Conclusions

VR and AR are showing their versatility and utility in the psychological treatment application. Since the past years, we have witnessed an important development of applications for the treatment of different mental disorders, especially anxiety disorders. VR and AR are effective tools for delivering exposure technique as several controlled studies have stated, with short- and long-term results in specific phobias and panic disorders with agoraphobia. Regarding PTSD and the disorders related to stress, results are preliminary, but yet very promising. These technologies can be an effective alternative to patients who do not have a good response to the imaginal exposure, which could help increase the number of patients who benefit from a cognitive–behavioral treatment.

VR and AR can contribute to improve the clinical utility axis (*APA Task Force on Psychological Intervention Guidelines*, 1995), increasing the acceptation of the exposure technique or proving efficacy in a group of patient who do not respond to other ways of applications. The usefulness of VR and AR in clinical psychology lies on its ability to improve existing intervention techniques in order to better support to people with mental disorders.

Finally, we should remark that in addition to expanding the applications field, technological innovations include the use of other information and communication technologies (ICTs) such as the Internet, mobile devices, or a combination of different ICTs as pervasive computing, ubiquitous computing, or ambient intelligence. The possibilities of VR and other ICTs like AR are very enormous. Although currently most VR applications have been designed to be applied in one PC located in the therapist's office, however, it is important to be aware that the technology is changing very quickly. Recently we are witnessing a vertiginous development of the mobile communications, and an increase in the range, accessibility, and extent of communications, by the development of the multimedia

technologies. Linked to this process, it is expected the emergency of the called "Virtual Immersive Telepresence". This consists of VR systems that combine "wireless" multimedia devices, streaming videos, biosensors, and brain-computers interfaces.

Rigorous research will be necessary to test the utility of these tools in the treatment of psychological disorders and the promotion of health. The ICTs have become a reality that is changing codes and forms of communication in our society. Psychological therapy has to adapt to these changes in order to offer its worthy techniques and procedures to the present and future generations. However, in order to reach an optimum in the use of these technologies, it will be necessary to work in a multidisciplinary way, collaborating together engineers, computer programmers, graphic designers, and experts in ergonomics, and also with clinicians and experts in other fields of psychology. Only from this joint work of all these experts, we will be able to develop innovative applications that use appropriate technologies, and which are useful for improving well-being and quality of life of people.

Finally, the necessity of obtaining more data regarding the therapeutic efficacy of VR and AR has to be emphasized, especially regarding the differential efficacy in comparison to other techniques widely used in therapy. VR and AR are still new tools; a lot of work has to be done. A fundamental feature in this work, not existing yet, is the necessity of structuring the theoretical framework to guide predictions and to organize the results. VR and AR have a great future and the available applications so far are only the starting point.

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