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VIRTUAL ENVIRONMENTS IN CLINICAL PSYCHOLOGY

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Virtual reality is a technology, a communication interface, and an artificial experience. These facets are the foundations of a new clinical environment that can be used for integrating and enhancing actual therapeutic approaches. For this reason, virtual reality is starting to play an important role in clinical psychology—as shown by its use in the treatment of phobias, eating disorders and obesity, male erectile dysfunctions, and posttraumatic stress disorders—that is expected to increase in the next years. This article presents the possible role of virtual environments in clinical psychology, discussing their clinical rationale. Finally, it describes the technological tools and safety requirements associated with the use of this approach.

People perceive external reality through the five senses of sight, hearing, touch, taste, and smell. If any one of these sensory inputs is replaced by an artificial source, then one will, to some degree, enter an artificial reality. Watching a film or a TV program or using an airplane training simulator has some degree of artificial reality, even though most of the sensory inputs come from "normal" reality. When one experiences most of the inputs from artificial sources, one enters a particular form of altered reality—a virtual reality (VR). The key feature of VR is the illusion of being a participant in a synthetic environment rather the observer of an external environment.

VR is starting to play an important role in clinical psychology. Virtual environments (VEs) are being used in the treatment of phobias, eating disorders and obesity, male erectile dysfunctions, and posttraumatic stress disorders. These applications will increase in the future. VR is simultaneously a technology, a communication interface, and an artificial experience. These facets are the foundations of new clinical environments that can be used for integrating and enhancing existing therapeutic approaches.

This paper presents the possible role of VEs in clinical psychology, discussing actual applications and their clinical rationale. Finally, it describes the technological tools and safety requirements associated with the use of this approach.

Applications of VR in Clinical Psychology

More than 10 years ago, Tart (1990) described VR as a technological model of consciousness offering "intriguing possibilities for developing diagnostic, inductive, psychotherapeutic, and training techniques that can extend and supplement current ones" (p. 222). Since then, different therapists have started to use VR in their clinical practice.

In the early '90s, Hodges and colleagues (Hodges, Bolter, Mynatt, Ribarsky, & Van Teylingen, 1993; Hodges et al., 1995) used different VEs—elevators inside or outside a skyscraper—to provide patients suffering from acrophobia

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with fear-producing experiences of heights in a safe situation. A similar approach has been used by Choi and colleagues (Choi, Jang, Ku, Shin, & Kim, 2001). More recently, Emmelkamp and colleagues (Emmelkamp, Bruynzeel, Drost, & van der Mast, 2001; Emmelkamp et al., 2002) compared the efficacy of VR exposure and in vivo exposure, where VEs used in treatment were copied directly from the real environments used in the in vivo exposure program in a controlled trial with 33 patients (16 in the vivo condition and 17 in the VR condition) suffering from acrophobia. The VR exposure was found to be as effective as exposure in vivo on anxiety and avoidance as measured by the Acrophobia Questionnaire and the Attitude Towards Heights Questionnaire (Abelson & Curtis, 1989). The improvements were maintained at the 6-month follow-up.

Rothbaum and colleagues (Rothbaum, Hodges, Watson, Kessler, & Opdyke, 1996) and North and colleagues (North, North, & Coble, 1997) evaluated the use of a VR airplane for exposure therapy in the treatment of fear of flying for a 42-year-old woman with a debilitating fear and avoidance of flying. VR exposure involved six sessions of graded exposure to flying in a virtual airplane. The planned posttreatment flight measures indicated a comfortable flight. In a more recent controlled study, Rothbaum's team (Rothbaum, Hodges, Smith, Lee, & Price, 2000) randomly assigned a sample of 49 patients with phobias to VR exposure therapy, standard exposure therapy, and wait-list conditions. The treatment consisted of eight sessions during a 6-week period: four sessions of anxiety management training followed by exposure either to a virtual airplane or to an actual airplane at the airport (Rothbaum, Hodges, & Smith, 1999). The results indicated that both VR treatment and standard exposure therapy were superior to the wait-list control, with no differences between them. The treatment gains were maintained at the 12-month follow-up (Rothbaum, Hodges, Anderson, Price, & Smith, 2002).

Muhlberger and colleagues (Muhlberger, Herrmann, Wiedemann, Ellgring, & Pauli, 2001) examined the effects of repeated exposure of individuals suffering from flight phobia to VR flights. Thirty participants with flight phobia were randomly assigned to either complete one VR test flight followed by four VR exposure flights in one lengthy session or complete one VR test flight followed by a lengthy relaxation training session. Fear of flying improved in both groups, but the VR group showed greater treatment gains than the relaxation group.

A similar result was also obtained by Maltby and colleagues with a group of 45 participants with phobias (Maltby, Kirsch, Mayers, & Allen, 2002) and by Wiederhold and colleagues with a group of 36 participants who suffered from fear of flying (Wiederhold, Jang, Kim, & Wiederhold, 2002). In the latter study, the physiological responses of participants with phobias, who were able to fly without medicine after VR treatment, showed a gradual trend in similarity with the physiological responses of those participants who did not suffer from phobias as therapy sessions progressed (Jang et al., 2002; Wiederhold et al., 2002).

North and colleagues (North, North, & Coble, 1996) verified the possibility of using VEs in the treatment of agoraphobia. In a controlled study on a sample of 60 patients with phobias, the experimental group exposed to VR therapy reported significant improvement (North et al., 1996). A similar approach was used by Botella, et al. (1998) in the treatment of a 43-year-old woman with claustrophobia. Expanding these approaches, Vincelli and colleagues (Vincelli, Choi, Molinari, Wiederhold, & Riva, 2000, 2001) outlined a multicomponent protocol utilizing virtual technology for the treatment of panic disorder with agoraphobia (Vincelli et al., 2003). VEs for the panic disorder VR system were developed for this therapy and included an immersive VR system, motion input system, and four-zone VE (elevator, supermarket, underground, and city square). The clinical protocol is based on eight sessions of treatment, an assessment phase, and six monthly booster sessions (Moore, Wiederhold, Wiederhold, & Riva, 2002; Vincelli & Riva, 2002).

Recently, Garcia-Palacios and colleagues (Garcia-Palacios, Hoffman, Carlin, Furness, & Botella, 2002) used VR therapy for the treatment of spider phobia. This study compared a treatment condition versus a wait-list condition in a between-groups design with 23 participants. Participants in the VR treatment group received an average of four 1-hr exposure therapy sessions. Eighty-three percent of patients in the VR treatment group showed clinically significant improvement compared with 0% in the wait-list group; no patients dropped out.

Wald and his group (Wald & Liu, 2001; Wald

& Taylor, 2000) designed a VE to be used as an assessment and clinical tool with individuals suffering from driving phobia. In a case study, they evaluated the efficacy of three treatment sessions during a 10-day period. Treatment included practice of four VR driving scenarios. Ratings of anxiety and avoidance declined from pre- and posttreatment, with gains maintained at 7-month follow-up.

Different groups developed clinical protocols and VR tools for the treatment of public speaking disorder (Lee et al., 2002; North, North, & Coble, 1998; Pertaub, Slater, & Barker, 2001). However, no clinical data supporting this approach have been published yet.

VR has also been used in the treatment of Vietnam combat veterans with posttraumatic stress disorder (PTSD; Rothbaum, Hodges, Alarcon, et al., 1999). After reporting a successful case report (Rothbaum, Hodges, Alarcon, et al., 1999), Rothbaum and colleagues (Rothbaum, Hodges, Ready, Graap, & Alarcon, 2001) exposed a sample of 10 combat veterans with PTSD to two virtual environments: a virtual Huey helicopter flying over a virtual Vietnam and a clearing surrounded by jungle (Hodges et al., 1999). All of the patients interviewed at the 6-month follow-up reported reductions in PTSD symptoms ranging from 15% to 67%.

Riva and colleagues (Riva, Bacchetta, Baruffi, Rinaldi, & Molinari, 1998; Riva, Bacchetta, Cesa, Conti, & Molinari, 2001) have proposed the Experiential Cognitive Therapy, an integrated approach ranging from cognitive–behavioral therapy to virtual reality sessions in the treatment of eating disorders and obesity (Riva, Bacchetta, Cesa, et al., 2001). With this approach, VR is mainly used to modify body image perceptions (Riva, Bacchetta, Cesa, Conti, & Molinari, 2003).

In a case study, a 22-year-old female university student diagnosed with anorexia nervosa was treated with Experiential Cognitive Therapy (Riva, Bacchetta, Baruffi, Rinaldi, & Molinari, 1999). At the end of the inpatient treatment, the participant increased her bodily awareness and indicated a reduction in her level of body dissatisfaction. Moreover, she presented a high degree of motivation to change. Expanding these results, Riva et al. carried out two different clinical trials with female patients (Riva, Bacchetta, Baruffi, Cirillo, & Molinari, 2000; Riva, Bacchetta, Baruffi, & Molinari, 2001; Riva, Bacchetta, Baruffi, Rinaldi, et al., 2000): Twenty-five patients suffering from binge-eating disorders were included in the first study and 18 patients who were obese were included in the second study. At the end of the inpatient treatments, patients in both samples modified significantly their body awareness. This modification was associated to a reduction in problematic eating and social behaviors (Riva, Bacchetta, Baruffi, & Molinari, 2002).

Optale and his team (Optale et al., 1999; Optale et al., 1997) used VR to improve the efficacy of a psychodynamic approach in treating male erectile disorders. In the proposed VE, different pathways open up through a forest, bringing the patients back to their childhood, adolescence, and teens. Different situations are presented with obstacles that the patient has to overcome in order to proceed. The obtained results—30 out of 36 patients with psychological erectile dysfunction and 28 out of 37 patients with premature ejaculation maintained partial or complete positive response after 6-month follow-up—show that VR seems to hasten the healing process and reduce the dropout rate. Moreover, Optale used positron emission tomography scans to analyze regional brain metabolism changes from baseline to follow-up in patients treated with VR (Optale et al., 1998). The analysis of the scans showed different metabolic changes in specific areas of the brain connected with the erection mechanism.

VR in Clinical Psychology: The Clinical Rationale

The analysis of the previous applications articulates the role of VR in psychotherapy: a communication interface based on interactive three-dimensional (3-D) visualization that is able to collect and integrate different inputs and data sets into a single real-life experience.

Clinical psychologists are using VEs within a new human–computer interaction paradigm in which users are not passive, external observers of images on a computer screen but are active participants within a computer-generated, 3-D virtual world. In VE, the patient learns to manipulate problematic situations related to his or her problem. The key characteristics of VEs for most clinical applications are the high level of control of the interaction with the tool and the enriched experience provided to the patient (Schultheis & Rizzo, 2001).

The most common application of VR in clinical psychology is the treatment of phobias. Indeed, VR exposure therapy (VRE) has been proposed as a new medium for exposure therapy (Riva, Wiederhold, & Molinari, 1998; Rothbaum, Hodges, & Kooper, 1997) that is safer, less embarrassing, and less costly than reproducing real-world situations. The rationale is simple: In VR, the patient is intentionally confronted with the feared stimuli while allowing the patient's anxiety to attenuate. Avoiding a dreaded situation reinforces a phobia, and each successive exposure to it reduces the anxiety through the processes of habituation and extinction. VRE offers a number of advantages over in vivo or imaginal exposure. First, VRE can be administered in traditional therapeutic settings. This makes VRE more convenient, controlled, and cost effective than in vivo exposure. Second, it can also isolate fear components more efficiently than in vivo exposure. For instance, in treating fear of flying, if landing is the most fearful part of the experience, landing can be repeated as often as necessary without having to wait for the airplane to take off. Finally, the immersive nature of VRE provides a real-life experience that may be more emotionally engaging than imaginal exposure. This facilitates a more efficient extinction of the fear response, as shown by successful clinical trials.

Optale (Optale et al., 1997) used a psychodynamic-oriented approach in his treatment of male sexual disorders. With his approach, the patient experiences a time-limited, 36-session treatment consisting of three different listening experiences alternated with three different virtual experiences. During the listening sessions, the patient hears, through headphones, three stories, recorded with background music and narrated by two different voices: one male voice and one female voice. During the VR sessions, the patient, who wears a head-mounted display, is free to move in different VEs reproducing the context described during the listening sessions. In particular, the proposed VE presents different pathways opening up through a forest, bringing patients back to their childhood and adolescence. The proposed approach is a modified form of psychodynamic psychotherapy that maintains the central psychodynamic principles of the importance of unconscious mental dynamisms and fantasies. VR environments are used in this situation as a form of controlled dreams that allow the patient to express in a nonverbal way fantasies related to his sexual experience. General principles of psychological dynamics such as the difficulty with separations and ambivalent attachments are used to inform interpretive efforts.

Riva and colleagues used an entirely different approach in their Experiential Cognitive Therapy (Riva, Bacchetta, Cesa, et al., 2001) for the treatment of eating disorders and obesity. They focused on a key feature of these disorders: body image disturbances. Although the mainstream media may claim that the best way to improve one's body image is to lose weight, empirical studies suggest that body image dissatisfaction—and any possible solution—is related to the mind rather than to the body (Thompson, 1996; Thompson, Heinberg, Altabe, & Tantleff-Dunn, 1999). Some authors suggest that body image dissatisfaction is a form of cognitive bias (Thompson, 1990; Williamson, 1996). As noted by Williamson (1996):

> If information related to body is selectively processed and recalled more easily, it is apparent how the self-schema becomes so highly associated with body-related information. If the memories related to body are also associated with negative emotion, activation of negative emotion should sensitize the person to body-related stimuli causing even greater body size overestimation. (pp. 49–50)

It is very difficult to counter a cognitive bias. Biased information processing occurs automatically, and participants are unaware of it. So, for them, the biased information is real. They are not able to distinguish between perception and biased cognition. Moreover, attempts at persuasion are usually useless and may even elicit strong emotional defense. Indeed, denial of the disorder and resistance to its treatment are two of the most vexing clinical problems with eating disorders. Through the use of immersive VR, it is possible to induce a controlled sensory rearrangement that unconsciously modifies a person's body awareness or body schema. Reason and Brand (1975) noted,

> All situations which provoke motion sickness are characterized by a condition of sensory rearrangement in which the motion signals transmitted by the eyes, the vestibular system and the non-vestibular proprioceptors are at variance either with one another or with what is expected from previous experience. (pp. 78–79)

When a particular event or stimulus violates the information present in the body schema (as occurs during a virtual experience), the information itself becomes accessible at a conscious level (Baars, 1988) and can be modified more easily.

This facilitates the modification of the body image through the differentiation and integration of new information, leading to a new sense of cohesiveness and consistency in how the self represents the body. This effect is strengthened by the integration of all the different methods (cognitive, behavioral, and visuomotor) commonly used in the treatment of body experience disturbances within a VE.

Although these approaches have very different theoretical rationales, they are linked. VR is primarily a sophisticated communication medium able to collect and integrate different inputs and data sets into a single real-life experience (Riva, Davide, & IJsselsteijn, 2003). As such, it is possible to target specific cognitive or affective systems without any significant change in the therapeutic approach. A behavior therapist may use a VE for activating the fear structure in a patient with a phobia through confrontation with the feared stimuli. A psychodynamic therapist may use VEs as complex symbolic systems for evoking and releasing affect. A cognitive therapist may use VR situations to assess situational memories or disrupt habitual patterns of selective attention; experiential therapists may use VR to isolate the patient from the external world and help him or her in practicing alternative actions.

VR is also an *advanced imaginal system*, an experiential form of imagery located between imagination and reality (North et al., 1997; Vincelli, 1999; Vincelli, Molinari, & Riva, 2001) that can be used to help the patient differentiate between perception and cognition. As noted by Glantz and colleagues (Glantz, Durlach, Barnett, & Aviles, 1997):

> One reason it is so difficult to get people to update their assumptions is that change often requires a prior step—recognizing the distinction between an assumption and a perception. Until revealed to be fallacious, assumptions constitute the world; they seem like perceptions, and as long as they do, they are resistant to change. (p. 96)

Using the immediacy of VR, the therapist can demonstrate to the patient that what appears real to them—their perception—is illusory. Once understood, individual maladaptive cognitions can then be challenged more easily (Riva, Molinari, & Vincelli, 2002).

Patients are very receptive to the use of VR. In a recent study, Garcia-Palacios and colleagues compared the acceptance of one-session and multiple session in vivo exposure to multisession VR exposure therapy (Garcia-Palacios, Hoffman, See, Tsai, & Botella, 2001). More than 80% of the sample preferred VR to in vivo exposure.

A final key advantage offered by VR is the possibility for the patient to successfully manage a problematic situation related to his or her disturbance. Using VR in this way, the patient is more likely not only to gain an awareness of his or her need to do something to create change but also to experience a greater sense of personal efficacy.

VR in Clinical Psychology: Technology and Safety Requirements

The significant advances in PC hardware that have been made over the past 5 years have transformed PC-based VR into a reality. The cost of a basic desktop VR system has been reduced by many thousand dollars, and its functionality has improved dramatically in terms of graphics processing power. A simple immersive VR system without dedicated software may now cost less than $6,000. A standard Celeron/Duron processor with only 128 Mbytes of RAM can provide sufficient processing power for simple VR simulations; a fast Pentium IV/Athlon XP-based PC (2.8 Ghz or faster) with 512 Mbytes of RAM can transport users to a convincing virtual environment; and a dual Xeon configuration (2.8 Ghz or faster) with 1 Gbyte of RAM, OpenGL acceleration and 128 Mbytes of VRAM running Windows XP Pro rivals the horsepower of a midlevel graphics workstation. To exploit this potential, a fast graphics card loaded with RAM is required. Happily, the new chip sets (GeForce NV30/35 and Radeon 9700) included in consumer graphics cards have eight times more video RAM and three and one-half times more 3-D acceleration than the first generation of chips (GeForce and Radeon VE) for less than $500.

In terms of software, there are only two distributors of ready-to-use clinical VR solutions in the United States: Virtually Better (http://www.virtuallybetter.com) and VRHealth (http://www.vrhealth.com). Virtually Better distributes five virtual environments—virtual airplane, virtual audiences, virtual heights, virtual storm, and virtual Vietnam—that are sold for about $10,000 each. Virtually Better also offers two different programs—clinical partners program and research partners program—that provide hardware and software for a starting fee plus a monthly fee. VRHealth distributes its five virtual environments—VR for body image modification, virtual open out, virtual flight, panic and agoraphobia, and acrophobia—only under a "medical service organization" scheme. The clinician pays the therapist who then pays an access fee plus a variable monthly fee related to the number of patients. The fee includes a 1-week training course, the use of the Virtual Reality Medical Center brand, and the license for all of the available virtual environments.

For any therapist interested in experimenting with VR, an interesting low-cost solution is the use of 3-D engines included in commercial 3-D games for developing simple VEs. Many 3-D games ($50 each), such as Quake 3 or Unreal, include level editors that allow the user to customize the environments and the avatars. Obviously, level editing does not allow full control of the environment. In particular, user interaction with the 3-D objects is usually very limited. To overcome this limitation, there are different VR development toolkits available for PCs, ranging from high-end authoring toolkits that require significant programming experience to simple "hobbyist" packages. Despite the differences in the types of virtual worlds that these products can deliver, the various tools are based on the same VR-development model: They allow users to create or import 3-D objects, apply behavioral attributes such as weight and gravity to the objects, and program the objects to respond to the user via visual or audio events.

Even if the significant advances in computer and graphic technology drastically improved the characteristics of a typical VE, VR is still limited by the maturity of the systems available. Even today, apart from the ones provided by Virtually Better and VRHealth, no off-the-shelf solutions are available. So, the set up of a VR system usually requires a great deal of patience for dealing with conflicting hardware or missing drivers. Nearly every VR system requires a dedicated staff or at least computer technician to keep the system running smoothly.

The introduction of patients and clinicians to VEs raises particular safety and ethical issues (Durlach & Mavor, 1995). The improved quality of the VR systems drastically reduces the occurrence of simulation sickness (i.e., sickness symptoms—nausea, headaches, sleepiness, sweating, apathy, dizziness, general fatigue, eye strain, and loss of skin color) that results from the experience of a virtual simulation. For instance, a recent review of clinical applications of VR reported that the instances of simulation sickness were few and nearly all were transient and minor (Riva, Wiederhold, et al., 1998). In general, for a large proportion of VR users, these effects are mild and subside quickly (Nichols & Patel, 2002). Nonetheless, patients exposed to VR environments may have disabilities that increase their susceptibility to side effects. Precautions should be taken to ensure the safety and well-being of patients, including established protocols for monitoring and controlling exposure to VR environments.

According to Lewis and Griffin (1997), exposure management protocols for patients in VEs should include the following: screening procedures to detect individuals who may present particular risks, procedures for managing patient exposure to VR applications to ensure rapid adaptation with minimum symptoms, and procedures for monitoring unexpected side effects and for ensuring that the system meets its design objectives.

Conclusions

Recently, a panel of 62 psychotherapy experts using Delphi methodology tried to outline how future changes will impact psychotherapy, psychologists, and patients (Norcross, Hedges, & Prochaska, 2002). According to these experts, the use of VR and computerized therapies will emerge as leading therapeutic approaches: They are ranked 3rd and 5th, preceded only by homework assignments (1st), relapse prevention (2nd), and problem-solving techniques (4th). On the other hand, traditional psychotherapy interventions such as hypnosis (32nd), paradoxical interventions (33rd), or dream interpretation (35th) were predicted to drastically diminish.

Although these results may be provocative to some researchers, there is no doubt that the possible use of VR in clinical psychology seems very promising. Controlled studies support the efficacy of VR in the treatment of different psychological disorders: acrophobia, body image disturbances, binge eating disorders, and fear of flying. In all of these treatments, VR is used as a sophisticated communication medium that is able to collect and integrate different inputs and data sets into a single real-life experience. Adjusting VR accordingly, it is possible to target specific cognitive or affective systems in a controlled and safe way. Moreover, the price of technology, which in the past was one of the main obstacles to the broad use of this approach in clinical practice, is falling quickly. In the early'90s, a typical VR system required a budget of about $15, 000. Today, a simple immersive VR system without dedicated software may cost less than $6,000. However, there are still some problems that continue to slow the diffusion of VR. Probably the most relevant is the lack of standardized tools and protocols that can be shared by the clinical community. If researchers check the PsycLIT database, they can find only five published clinical protocols for the treatment of the fear of flying (Klein, 1999; Rothbaum et al., 1999), fear of public speaking (Botella, Baños, Villa, Perpiña, & Garcia-Palacios, 2000), panic disorders (Vincelli, Choi, et al., 2001), and treatment of eating disorders (Riva, Bacchetta, Cesa, et al., 2001).

The lack of both clinical protocols and off-the-shelf VR tools forces most researchers to spend significant amounts of time and money in designing and developing their own VR application. Many of them can be considered "one-of-a-kind" creations tied to proprietary hardware and software, which have been tuned by a process of trial and error. According to the European funded project VEPSY Updated (Riva, Alcañiz, et al., 2001), the cost required for designing a clinical VR application from scratch and testing it with clinical patients in controlled trials may range between $150,000 and $200,000.

It is clear that building new VEs and developing standardized protocols are crucial if therapists are going to be able to adapt these tools to their day-to-day clinical practice (Riva, Wiederhold, et al., 1998). In fact, as usually happens in clinical practice, the clinical skills of the therapist remain the most important factor for the successful use of VR systems.

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