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The VEPSY Updated Project: Virtual Reality in Clinical Psychology

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ABSTRACT

Many of us grew up with the naive assumption that couches are the best used therapeutic tools in psychotherapy. But tools for psychotherapy are evolving in a much more complex environment than a designer's chaise lounge. In particular, virtual reality (VR) devices have the potential for appearing soon in many consulting rooms. The use of VR in medicine is not a novelty. Applications of virtual environments for health care have been developed in the following areas: surgical procedures (remote surgery or telepresence, augmented or enhanced surgery, and planning and simulation of procedures before surgery); preventive medicine and patient education; medical education and training; visualization of massive medical databases; and architectural design for health care facilities. However, there is a growing recognition that VR can play an important role in clinical psychology, too. To exploit and understand this potential is the main goal of the Telemedicine and Portable Virtual Environment in Clinical Psychology—VEPSY Updated—a European Community–funded research project (IST-2000-25323, http://www.vepsy.com). The project will provide innovative tools—telemedicine and portable—for the treatment of patients, clinical trials to verify their viability, and action plans for dissemination of its results to an extended audience—potential users and influential groups. The project will also develop different personal computer (PC)–based virtual reality modules to be used in clinical assessment and treatment. In particular, the developed modules will address the following pathologies: anxiety disorders; male impotence and premature ejaculation; and obesity, bulimia, and binge-eating disorders.

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INTRODUCTION

As noted by Székely and Satava,[1] "virtual reality technology aims at closing the gap between the capability of present technology to acquire images and properties and then to calculate the behavior of virtual objects, and the ability to observe and interact with them. The ultimate goal is to allow the presentation of virtual objects to all of the human senses in a way identical to their natural counterpart" (p. 1305). For this capability, virtual environments (VEs) have recently attracted much attention in medicine.[2] In fact, by offering a "manipulable" reality, they can play an important role in reducing the cognitive demands on health care practitioners by helping them to manage, filter, and analyze multiple sources of information.[3] As noted by different authors, there are at least four areas of medicine in which VEs can provide a number of advantages[4]:

- *Anatomical relations of various organs and systems*: The possibility of "walking" through the body can facilitate the acquisition of anatomical knowledge.
- *Development of manipulative skills involving precise motor control and hand-eye coordination*: Using VEs is possible for the surgeon to practice surgical techniques.
- *Image interpretation*: Augmented-reality systems allow the user to see virtual information superimposed over real structures. This makes it easier to identify the often small differences between normal and abnormal images.
- *Telemedicine through teleoperation*: Telemedicine offers the potential to place medical expertise in locations that might not otherwise have access to it.

We are now entering a second wave of virtual reality (VR) applications in medicine that is using VEs for the assessment and treatment in clinical psychology.[5–7] Why should we use VR in clinical psychology? Three important aspects of virtual reality systems offer new possibilities for assessment and treatment[8,9]:

- *How they are controlled*: VR systems open the input channel to the full range of human gestures; the potential is there to monitor movements or actions from any body part or many body parts at the same time. All properties of the movement can be captured, not just contact of a body part with an effector. It follows that, in the VE, these actions or signals can be processed in a number of ways. They can be translated into other actions that have more effect on the world being controlled; for example, virtual objects could be pushed by blowing, pulled by sipping, and grasped by jaw closure.
- *Feedback*: Since VR systems display feedback in multiple modes, feedback and prompts can be translated into alternate senses for users with sensory impairments. The environment can be reduced in size to get a larger or overall perspective (without the "looking through a straw effect" usually experienced when using screen readers or tactile displays). For the individual, multimodal feedback ensures that the visual channel is not overloaded. VR presents information in alternate ways and in more than one way. Sensory redundancy promotes learning and integration of concepts.
- *Control*: VEs provide the opportunity of locating clients in environments that would otherwise be dangerous or inaccessible, or would generate too much initial stress for effective therapy. A clear example has been the work on overcoming fear of flying. Exposure therapy in relation to social phobias, such as extreme shyness or fear of public speaking, is practically impossible with traditional means. It would require the engineering of social scenarios such as a party or a public audience solely for the purpose of the client therapy. VR can address this challenge through the creation of virtual social settings, which can be used for such therapy and experimentation by patients.

However, only a small number of real-world applications have been developed for clinical psychology; the largest number of subjects ever reported in any published study is 72 students.[10] This makes investigations into the feasibility of VR-based psychological applications of considerable importance.

Previous work has shown that even relatively unsophisticated VR tools can prove a valuable tool in psychoneurological assessment and rehabilitation.[11–19] To date, however, the use of VR technologies has been limited to single locations—typically, hospital or rehabilitation centers. In theory, new multiuser VR technologies, combined with rapid increases in Internet bandwidth and performance, and steep reductions in the cost of hardware and software, make it possible to bring distributed VR environments directly to clients' homes—thereby offering improved access for users who are inadequately served by current services.[3–8] In order to achieve this goal, it will first be necessary to overcome a number of clinical, ergonomic, technological, and organizational challenges. The main contribution of the European Community–funded Telemedicine and Portable Virtual Environment for Clinical Psychology—VEPSY Updated—research project to innovation in this area will be to design, test, and validate solutions to these challenges.

PROJECT GOALS

The main objective of the project is to prove the technical and clinical viability of using virtual reality therapy (VRT) in clinical psychology. Using VRT, it is possible both to offer exposure therapy, the most effective form of behavioral therapy for many conditions, and to integrate it with other behavioural and cognitive methods in order to improve their effectiveness. In particular, the project will provide innovative tools (telemedicine and portable) for the treatment of patients, clinical trials to verify their viability, and action plans for dissemination of its results to an extended audience (potential users and influential groups). In particular, the project aims at the following:

- Designing and developing four clinical modules to be used with the Virtual Reality Modular System (VRMS) defined by the Virtual Reality Environment for Psycho-Neurological Assessment and Rehabilitation—VREPAR[20]—European Community–funded research projects (HC-1053/HC-1055, http://www.psicologia. net). The selected disorders are (1) panic disorder and agoraphobia; (2) male impotence and premature ejaculation; (3) obesity, bulimia, and binge-eating disorders; and (4) social phobia.
- Defining new treatment protocols for the use of the clinical modules in assessment and therapy. In doing this, the project will follow a user-centered strategy—where feedback from individual users (and from groups representing users) will play a key role in driving the design and implementation process.
- Testing their efficacy at a scale of operation representing reality. In particular, the project plans a 9-month demonstration phase involving no less than 30 patients and a 15-months validation phase involving no less than 240 patients from at least three different European Community countries.
- Disseminating the obtained results to an extended audience. Both clinicians and end users will be reached.

The VEs developed by VEPSY will be based on the same standards-based technology used to create state-of-art distributed VR environments. In particular, VEPSY will adapt this technology to the needs of the health care community—moving beyond the current paradigm where the user–machine interface is rigidly defined by the system designer to a system of multiple control paradigms and multiple views in which each user interacts with the system using his or her specific abilities.

The VR applications developed will be of particular utility for the treatment of phobias. The typical clinical approach to the treatment of phobias is the graded exposure of the patient to anxiety-producing stimuli (systematic desensitization) generated either through the patient's imagination or *in vivo*. As mentioned, social phobias offer a particular challenge that VR is particularly suited to solve.

VR tools such as current imaginal and *in vivo* modalities are able to generate stimuli that could be used in desensitization therapy with patients who have difficulty in imagining scenes and/or are too phobic to experience real situations. Moreover, these tools have some unique advantages. The use of computer graphics techniques allows the creation of stimuli of much greater magnitude than standard *in vivo* techniques. Since the virtual environment may be under patient control, it appears safer than *in vivo* desensitization and at the same time more realistic than imaginal desensitization.[21]

Finally, the low cost of actual personal computer (PC)–based VR platforms adds the advantage of greater efficiency and economy in delivering the equivalent of *in vivo* systematic desensitization within the therapist's office.

Moreover, VR may enhance cognitive therapy in the treatment of obesity, bulimia, and binge-eating disorders by addressing two key topics that are somewhat neglected by current clinical guidelines: body experience disturbances and motivation for change.[14–22] The advantages of a VR-based treatment are clear. It minimizes distortion in self-report, since there is no script for conforming clients to parrot or oppositional clients to reject—a typical behavior of anorexic individuals. VR-based therapy is also able to circumvent power struggles because the therapist can be invisible to the patient and presents no direct arguments to oppose. Finally, evidence is more convincing and conclusions better remembered because they are one's own. As noted by many therapists, people are "more persuaded by what they hear themselves say than by what other people tell them."[20]

In the treatment of male impotence and premature ejaculation, the use of VR enables the patient to quickly develop memories and emotions that are worked through with the psychotherapist at the end of the session. In particular, the patient follows pathways in the virtual experience that accelerate a psychodynamic process that eludes cognitive defenses and directly stimulates the subconscious, hence also everything related to his experience in the sexual sphere. The obstacles that lead to sexual dysfunction are thus brought to light, and the patient becomes aware that the causes of his sexual dysfunction can be modified.

Finally, the ability to control VEs and then to introduce a predetermined set of stimuli can also enhance the standard approach used in psychological assessment. Moreover, the additional capabilities that are inherent in VEs can lead to greater flexibility in the adaptation to the patient's individual problems, improving the efficacy of the rehabilitation process. VEs are highly flexible and programmable. They enable the therapist to present a wide variety of controlled stimuli, and to measure and monitor a wide variety of responses made by the user. Both the synthetic environment itself and the manner in which this environment is modified by the user's responses can be tailored to the needs of each client and/or therapeutic application. It is also possible for the therapist to follow the user into the synthesized world.[23]

THE USE OF LOW-COST PCs IN VIRTUAL REALITY

To ensure the broadest user base, the developed modules will be available both as shared telemedicine tools available through Internet by using a plug-in for the most common browsers (Explorer and Navigator) and as portable tools based on Speed-Step notebook PCs (Pentium III/IV, 128/256 Mb RAM). This choice ensures wide availability, an open architecture, and the possibility of benefiting from the improvements planned for these machine by Intel, mainly faster processors and enhanced multimedia support. Both solutions will allow the support of end-users in their living environment.

Even if the history of VR is based on expensive graphic workstations, the significant advances in PC hardware that have been made over the past 3 years are allowing the appearance of low-cost VR systems. While the cost of a basic desktop VR system has not changed much, the functionality has improved dramatically, both in terms of graphics-processing power and VR hardware such as head-mounted displays (HMDs). The availability of powerful PC engines based on Intel's Pentium III/IV, AMD's Athlon, and Motorola's Power PC G4, and the emergence of reasonably priced 3D accelerator cards allow high-end PCs to process and display 3D simulations in real time.

A standard Pentium Celeron 833 Mhz with

as little as 64 Mb of RAM can offer sufficient processing power for a bare-bones VR simulation, a 1.1 Ghz Pentium III//Athlon with 128 Mb of RAM can provide a convincing virtual environment, while a dual 1.5 Ghz Pentium IV XEON configuration with OpenGL acceleration, 256 Mb of RAM and 64 Mb of VRAM running on Windows 2000 can match the horsepower of a graphics workstation.

Immersion is also becoming more affordable. For example, Virtual I-O (USA) now has an HMD that costs less than $800 and has built in head tracking. Sony distributes its basic Glasstron headset for about $600 without head-tracking. Two years ago, HMDs of the same quality were about 10 times more costly. A HMD with VGA quality produced by Sony is now about $2,000. However, this price will probably decrease during the next 5 years.

Presently, input devices for desktop VR are largely mouse- and joystick-based. Although these devices are not suitable for all applications, they can keep costs down and avoid the ergonomic issues of some of the up-to-date I/O devices such as 3D mouses and gloves. Also, software has been greatly improved over the past 3 years. It now allows users to create or import 3D objects, to apply behavioral attributes such as weight and gravity to the objects, and to program the objects to respond to the user via visual and/or audio events. Ranging in price from free (ALICE 99—http://www.alice.org; BLENDER—http://www.blender.nl; CYBERWORLD Personal Edition—http://ww3.cyberworldcorp.com/corpsite/products/products_personal.html) to $6,000, the too-kits are the most functional among the available VR software choices. While some toolkits rely exclusively on C or C++ programming to build a virtual world, others offer simpler point-and-click operations for simulation.

A further attempt to spread the diffusion of low-cost VR comes from the development and increasing diffusion of the virtual reality modelling language (VRML). The VRML is a file format and run-time description of 3D graphics for use on the World Wide Web. It includes interaction and animation elements as well as interfaces to scripting languages, thereby providing more general simulation behaviors and interfaces in network services.[24] Today, VRML worlds can be scripted with JAVA and JavaScript, both of which are familiar to most web programmers.

The first version of VRML (1.0) allowed the creation of virtual worlds with limited interactive behavior. These worlds can contain objects that have hyper links to other worlds, HTML documents, or other valid multimedia Internet mail extensions (MIME). The second version of VRML (2.0), available now, allows the user richer behaviors, including animations, motion physics, and real-time multi-user interaction.

The general experience of VRML worlds on the Internet will be vastly improved over the next few years as basic technologies such as second-generation graphics accelerators and network technologies such as asymmetric digital subscriber line (ADSL) become available. Up to now, applications of VRML for telemedicine VR are available in visualization and training.[3]

CONCLUSION

The main task of the VEPSY project is the development of PC-based virtual reality modules to be used in clinical assessment and treatment. In particular, the modules will address the following pathologies that have a strong impact on the actual health care policies:

- Anxiety disorders: panic disorders, agoraphobia, and social phobia
- Male impotence and premature ejaculation
- Eating disorders: obesity, bulimia, and binge-eating disorders

Anxiety disorders, the most common mental illnesses, are a significant and costly problem. In Europe, 21 million subjects will suffer from an anxiety disorder at some time in their life, with anxiety disorders being the fifth most common diagnosis in primary care and the most common psychiatric diagnosis made by primary care physicians.

Specific phobias, which are one type of anxiety disorder, are the most prevalent mental health disorder, more common than alcohol abuse, alcohol dependence, or major depression. Moreover, 33% of patients presenting with chest pain, abdominal pain, or insomnia actually have an anxiety disorder, as do 25% of those with fatigue, headache, or joint pain. The average person with an anxiety disorder has 10 encounters with the health care system before being correctly diagnosed, increasing health care costs, and causing frustration on the part of both the patient and physician.

Social phobia is thought to be one of the largest mental health care problems, with about 7% of the population experiencing significant social anxiety and about 2% social phobia. The Royal College of Psychiatrists estimates that about 1–2% of men and 2–3% of women develop full social phobia, with the danger of subsequent development of a depressive illness. Nevertheless, social phobia is one of the least researched and neglected of all mental health problems, and yet has extremely debilitating effects for sufferers. It significantly limits people from forming relationships by generating severe phobic responses at the prospect of human social contact, causing suffers significant impairment of their professional and private lives.

Impotence, or erectile dysfunction, defined as the inability to reach or maintain an erection sufficient for sexual performance, is undoubtedly a more widespread phenomenon than has been estimated up to today. Since approximately 100 million men in the world suffer just from erectile dysfunction (3 million in Italy, 3–5 million in Germany, 14–18 million in Europe, 18 million in the United States), and we know that a psychogenous component is always present even when the primary cause is organic, contributing to maintaining a vicious circle. The natural sense of shame that afflicts individuals affected by this pathology is probably the reason that only a fraction of the cases is brought under medical observation. Impotence causes a loss of self-esteem and may lead the patient, beyond a depressed condition, to be so skeptical about the chances of treatment (preferably simple, and above all, immediate) so as to keep him from willingly asking a therapist for help, making him ready to stop treatment not giving quick results.

The eating disorders module is aimed at the assessment and treatment of obesity and eating disorders, pathologies with an increasing diffusion in Europe. Obesity, in addition to having a high priority in nutritional health policies of several industrialized countries, has been recognized as a growing problem that must be corrected and prevented, not only as a nutritional disease, but also as a risk factor for diet-related chronic diseases such as coronary heart disease, hypertension, and type II diabetes. The latter includes overweight (BMI > 25) and not only severe obesity (with BMI > 35). Body image disturbances and eating disorders are increasing in female adolescents, making these the most prevalent psychological disorders in this community, with a penetration ranging from 5% to 15% according to the European Community.

The number of potential users for the tools developed by the project is very high: as a rough estimate, within Europe there are more than 10,000 hospitals and health care centers with concrete needs for using the developed tools. However, we feel that there are now serious barriers to the possibility for health care centers to gain advantages from the use of virtual reality. Due to the uniqueness of the solution (the system will use standard components) and its relative low cost when compared with usual investments in this area, the final VR system will be available to a side spectrum of potential users—hospitals, universities, and research centers—who will benefit to a large extent from the advantages of this new technology. A penetration of 3% within 2 years from product availability (Spring 2005) seems quite realistic.

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