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Interreality in Practice: Bridging Virtual and Real Worlds in the Treatment of Posttraumatic Stress Disorders

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Abstract

The use of new technologies, particularly virtual reality, is not new in the treatment of posttraumatic stress disorders (PTSD): VR is used to facilitate the activation of the traumatic event during exposure therapy. However, during the therapy, VR is a new and distinct realm, separate from the emotions and behaviors experienced by the patient in the real world: the behavior of the patient in VR has no direct effects on the real-life experience; the emotions and problems experienced by the patient in the real world are not directly addressed in the VR exposure. In this article, we suggest that the use of a new technological paradigm, Interreality, may improve the clinical outcome of PTSD. The main feature of Interreality is a twofold link between the virtual and real worlds: (a) behavior in the physical world influences the experience in the virtual one; (b) behavior in the virtual world influences the experience in the real one. This is achieved through 3D shared virtual worlds; biosensors and activity sensors (from the real to the virtual world); and personal digital assistants and/or mobile phones (from the virtual world to the real one). We describe different technologies that are involved in the Interreality vision and its clinical rationale. To illustrate the concept of Interreality in practice, a clinical scenario is also presented and discussed: Rosa, a 55-year-old nurse, involved in a major car accident.

Introduction

THE RECENT CONVERGENCE of technology and medicine[1] offers new methods and tools for behavioral health care.[2–6] Between them, an emerging trend is the use of virtual reality (VR) within the existing exposure-based protocols for anxiety disorders.[7–11] Despite its effectiveness, exposure-based therapy presents important limitations: (a) many patients are reticent to expose themselves to the real phobic stimulus or situation; (b) in vivo exposure can never be fully controlled by the therapist, and its intensity can be too much for the patient; and (c) this technique often requires that therapists accompany patients into anxiety-provoking situations in the real world at great cost to the patient and with great time expenditure on the part of both therapist and patient.[12,13]

For these reasons, in vivo exposure–based therapy has been progressively replaced with exposure using VR:[14,15] with this approach, therapists can provide in-office, controlled exposure therapy to anxious patients, mitigating many of the complications of in vivo exposure.[16] The specific characteristics of the VR experience make the patient "emotionally present" inside the virtual environment.[17–20] A recent meta-analysis[21] of virtual reality exposure (VRE) trials confirmed that in vivo treatment was not significantly more effective than VRE. In fact, there was a small effect size favoring VRE over in vivo conditions: Cohen's $d = 0.35$ ($SE = 0.15$, 95% CI: 0.05–0.65).

VRE therapy also has been extensively used in the treatment of posttraumatic stress disorders (PTSD). PTSD is more difficult to treat than other anxiety disorders: in vivo exposure–based therapy is usually not possible, and imaginal exposure requires that the patient recount his or her traumatic experience in the present tense to the therapist, a behavior that he or she tries to avoid.[22] VRE therapy allows the exposure treatment even with patients who fail to improve with traditional imaginal exposure therapy.[23–26] Since the seminal work by Rothbaum et al.,[27,28] different case studies,[29–32] and clinical trials[32–34] showed the efficacy of VRE therapy in the treatment of PTSD.

However, from the clinical viewpoint, the actual VRE protocols consider VR a "closed" experience, separated from the emotions and behaviors experienced by the patient in the real world. To address this issue, Fidopiastis et al. recently

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suggested using mixed reality (MR) to improve the efficacy of the treatment.[35]

The use of MR in clinical psychology is not new. Botella et al. used it for the treatment of small-animal phobias.[36–38] The main advantage of this approach is that in MR, virtual objects are integrated into the real world: during the therapy, the patient sees a real-world scene and a series of computer-generated objects that, at that same moment, are superimposed on the real physical environment.[36] As noted by Botella et al.,[36] this approach offers different advantages: it facilitates the experience of presence (the feeling of being there) and reality judgment (the fact of judging the experience as real), since the environment the patient sees is in fact the "reality."

In this work, we suggest that a further advancement can be offered by a new technological paradigm, Interreality: hybrid, closed-loop, empowering experience bridging the physical and virtual worlds.[39] The main feature of Interreality is a twofold link between the virtual and real worlds: (a) behavior in the physical world influences the experience in the virtual one; (b) behavior in the virtual world influences the experience in the real one.

We will start our analysis by discussing the pros and cons of the most used psychological treatment for PTSD: cognitive-behavior therapy (CBT).

Cognitive-Behavior Therapy and the Interreality Paradigm

Key features of cognitive-behavior therapy

CBT is a structured form of psychotherapy integrating behavior modification strategies with cognitive therapy.[40] As underlined by Blagys and Hilsenroth,[41] six distinctive processes characterize the different CBT approaches:

1. *Assigning homework outside of therapy sessions:* The purpose of homework within CBT is to practice skills learned in therapy and to generalize such skills to real-world situations.
2. *Directing session activity:* CB therapists were found to exhibit control over the process of therapy by setting an agenda and following a predefined protocol.
3. *Teaching skills to cope with symptoms:* CB therapists were found to adopt a psycho-educational role in helping clients reduce, manage or control their symptoms.
4. *Focusing on client's present and future experiences*.
5. *Providing information about a client's disorder:* CB therapists provided clients with an explicit rationale for their treatment.
6. *Focusing on a patient's illogical or irrational thoughts or beliefs (cognitive/intrapersonal experience):* The cognitive focus of CBT is based on testing, challenging, and changing a client's beliefs.

Even if CBT is the treatment of choice for several mental disorders, including anxiety disorders, major depression, and eating disorders, there is still room for improvement.[42] Specifically, there are three major issues underlined by clinicians using CBT:[42–44]

1. The protocol is not customized to the peculiar characteristics of the patient.
2. CBT focuses on patients' thoughts and behaviors but does not address relationship change and self-efficacy.
3. CBT tries to change cognitive content per se rather than changing the context in which cognitions are experienced.

This last limitation is clearly evident in the VR-based CBT protocol for PTSD. As we underlined before, in this protocol VR is a distinct realm, separate from the emotions and behaviors experienced by the patient in the real world: the behavior of the patient in VR has no direct effects on the real life experience; the emotions and problems experienced by the patient in the real world are not directly addressed in the VR exposure.

The Interreality paradigm

To overcome the limitations, we suggest a new paradigm for e-health, *Interreality*, that integrates contextualized assessment and treatment within a hybrid environment, bridging the physical and virtual worlds[39] (see Fig. 1).

Our claim is that bridging *virtual experiences*—fully controlled by the therapist, used to learn coping skills and emotional regulation—with *real experiences*—that allow both the identification of any critical stressors and the assessment of what has been learned—*using advanced technologies* (virtual worlds, advanced sensors and PDA/mobile phones) is a feasible way to address the limitations described previously.

In the standard CBT protocol for PTSD, "imagination and/or exposure evoke emotions, and the meaning of the associated feelings can be changed through reflection and relaxation." We suggest as an alternative that "controlled experience evokes emotions that result in meaningful new feelings that can be reflected upon and eventually changed through reflection and relaxation."

Although CBT focuses on directly modifying the content of dysfunctional thoughts through a rational and deliberate process, Interreality focuses on modifying the patient's relationship with his or her thinking through more contextualized experiential processes.

The patient is continuously assessed in the virtual and real worlds by tracking the behavioral and emotional status in the context of challenging tasks *(customization of the therapy according to the characteristics of the patient)*. Feedback is continuously provided to improve both the appraisal and the coping skills of the patient through a conditioned association between effective performance state and task execution behaviors *(improvement of self efficacy)*. In sum, from the clinical viewpoint, the Interreality paradigm may offer the following innovations to current VR and/or MR protocols for PTSD:

1. *Objective and quantitative assessment of symptoms using biosensors and behavioral analysis:* monitoring patient behavior and general and psychological status enables early detection of symptoms of critical evolutions and timely activation of feedback in a closed-loop approach.
2. *The decision support systems:* monitors patient response to treatment, managing the treatment, and supporting clinicians in their therapeutic decisions.
3. *Provision of warnings and motivating feedback to improve compliance and long-term outcome:* the sense of presence

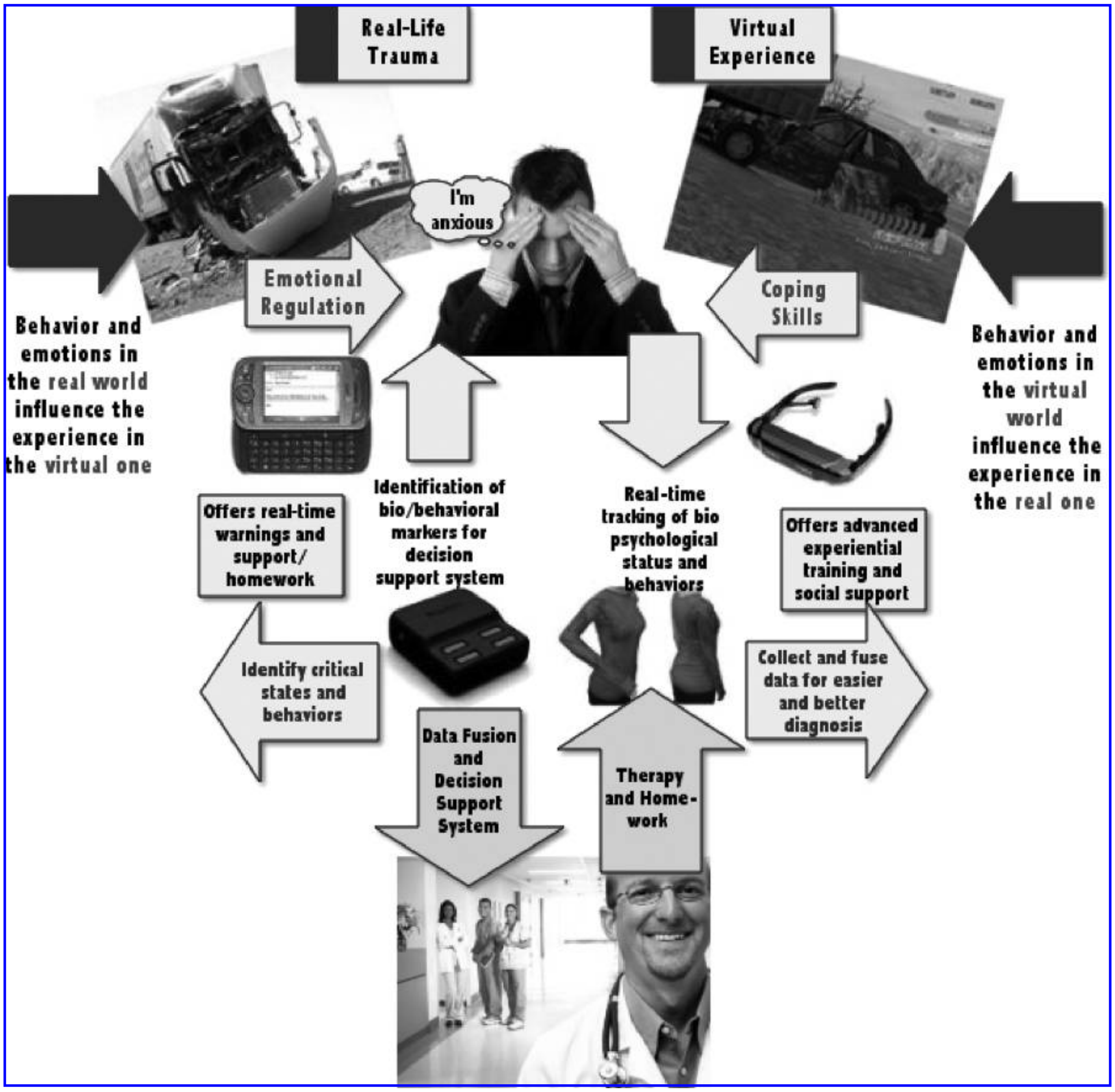

FIG. 1. The Interreality paradigm.

allowed by this approach affords the opportunity to deliver behavioral, emotional, and physiological self-regulation training in an entertaining and motivating fashion.

The Interreality approach provides a twofold feedback activity (Fig. 2):

1. *Behavior in the physical world influences the experience in the virtual world.* For example, if emotional regulation during the day was poor, some new experiences in the virtual world are unlocked to address this issue; if emotional regulation was okay, the virtual experience focuses on a different issue.
2. *Behavior in the virtual world influences the experience in the real world.* For example, by participating in the virtual support group, participants can use SMS (Short Message Service, or text messaging) to communicate among themselves. If coping skills in the virtual world were poor, the decision support system increases the chance of possible warnings in real life and provides additional homework assignments.

The technology behind the Interreality paradigm

From the technological viewpoint, Interreality is based on the following devices/platform (see Fig. 3):

1. *3D individual and/or shared virtual worlds* allow controlled exposure, objective assessment, and provision of motivating feedbacks.
2. *Personal digital assistants and/or mobile phones* (from the virtual to the real world) allow objective assessment, provision of warnings, and motivating feedbacks.
3. *Personal biomonitoring system* (from the real world to the virtual one) allows objective and quantitative assessment, decision support for treatment.

The clinical use of these technologies in the Interreality paradigm is based on a *closed-loop concept* that involves the

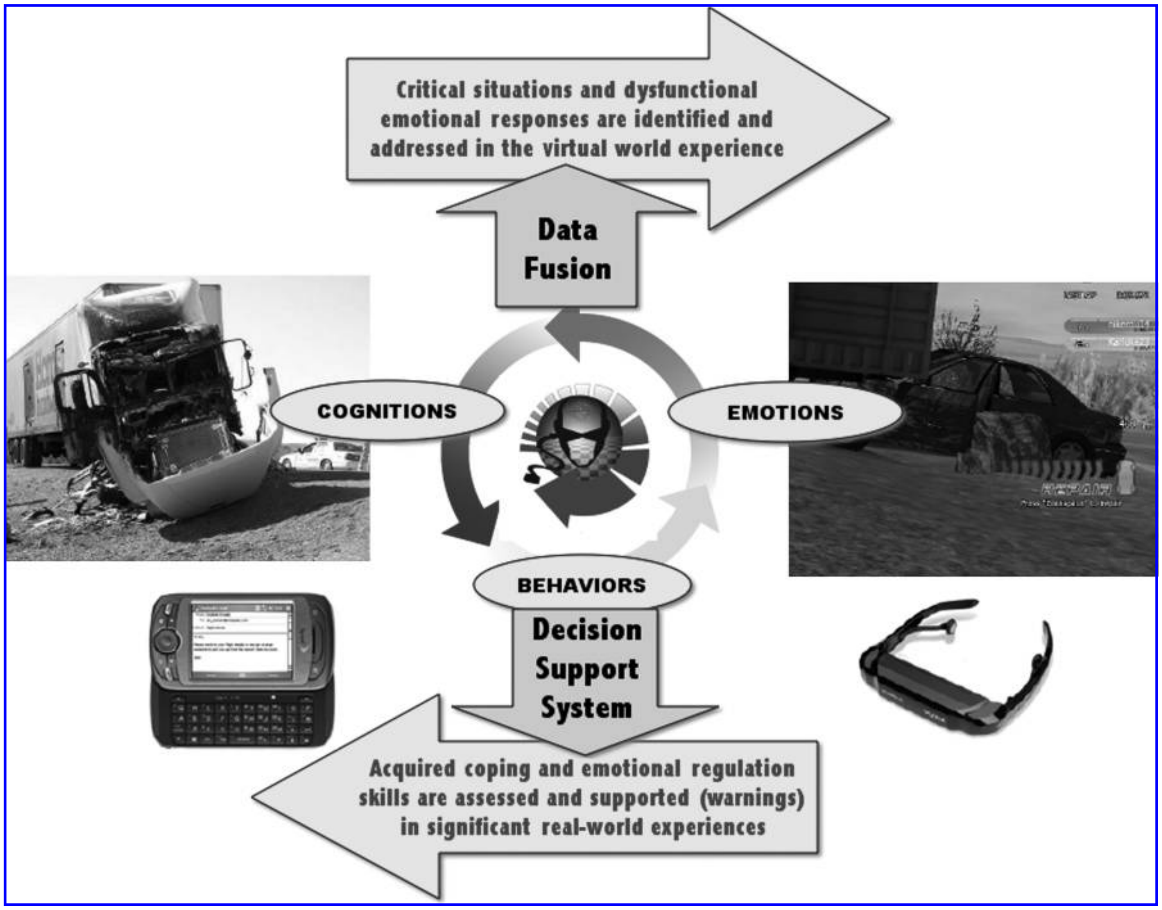

FIG. 2. Monitoring and feedback in the Interreality paradigm.

use of technology for assessing, adjusting, and/or modulating the emotional regulation of the patient, his or her coping skills, and appraisal of the environment—both virtual (under the control of a clinician) and real (facing actual stimuli)—based on a comparison of that patient's behavioral and physiological responses with a baseline or performance criterion.

These devices are integrated around two subsystems: the Clinical Platform (inpatient treatment, fully controlled by the therapist) and the Personal Mobile Platform (real-world support, available to the patient and connected to the therapist) that allow

1. Monitoring of the patient behavior and general and psychological status, early detection of symptoms of critical evolutions, and timely activation of feedbacks in a closed-loop approach;
2. Monitoring of the user's response to the treatment, management of the treatment, and support for therapists in their therapeutic decisions.

The virtual worlds. The virtual world component of the PTSD protocol is composed of different 3D individual and/or shared virtual worlds organized around three different but interconnected islands/areas: the Learning Island, the Community Island, and the Experience Island (Fig. 4).

1. The goal of the Learning Island is to use motivation provided by the virtual worlds to teach users how to improve their stress management skills. The Learning Island is organized around different learning areas both without and with teachers (classes). In this island, the users
   a. Learn the main causes of PTSD and how to recognize stress symptoms;
   b. Learn to become aware of and modify unhelpful thoughts and maladaptive thinking;
   c. Learn some stress relieving exercises (e.g., relaxation training or diaphragmatic breathing, use of emotional support);
   d. Get the information needed to succeed, with daily tips and expert ideas.
2. The goal of the Community Island is to use the strength of virtual communities to provide real-life insights aimed at reducing avoidance behaviors and unrealistic thinking. The Community Island is organized around different zones in which users discuss and share experiences among themselves with or without the supervision of an expert (physician, psychologist, therapist, etc.). In this island, the users
   a. Enjoy support and guidance;
   b. Learn successful and unsuccessful examples of problem-focused and emotion-focused coping strategies;
   c. Benefit from the exchange of practical experiences and tips from other patients.
3. The goal of the Experience Island is to use the feeling of presence provided by the virtual experience to practice

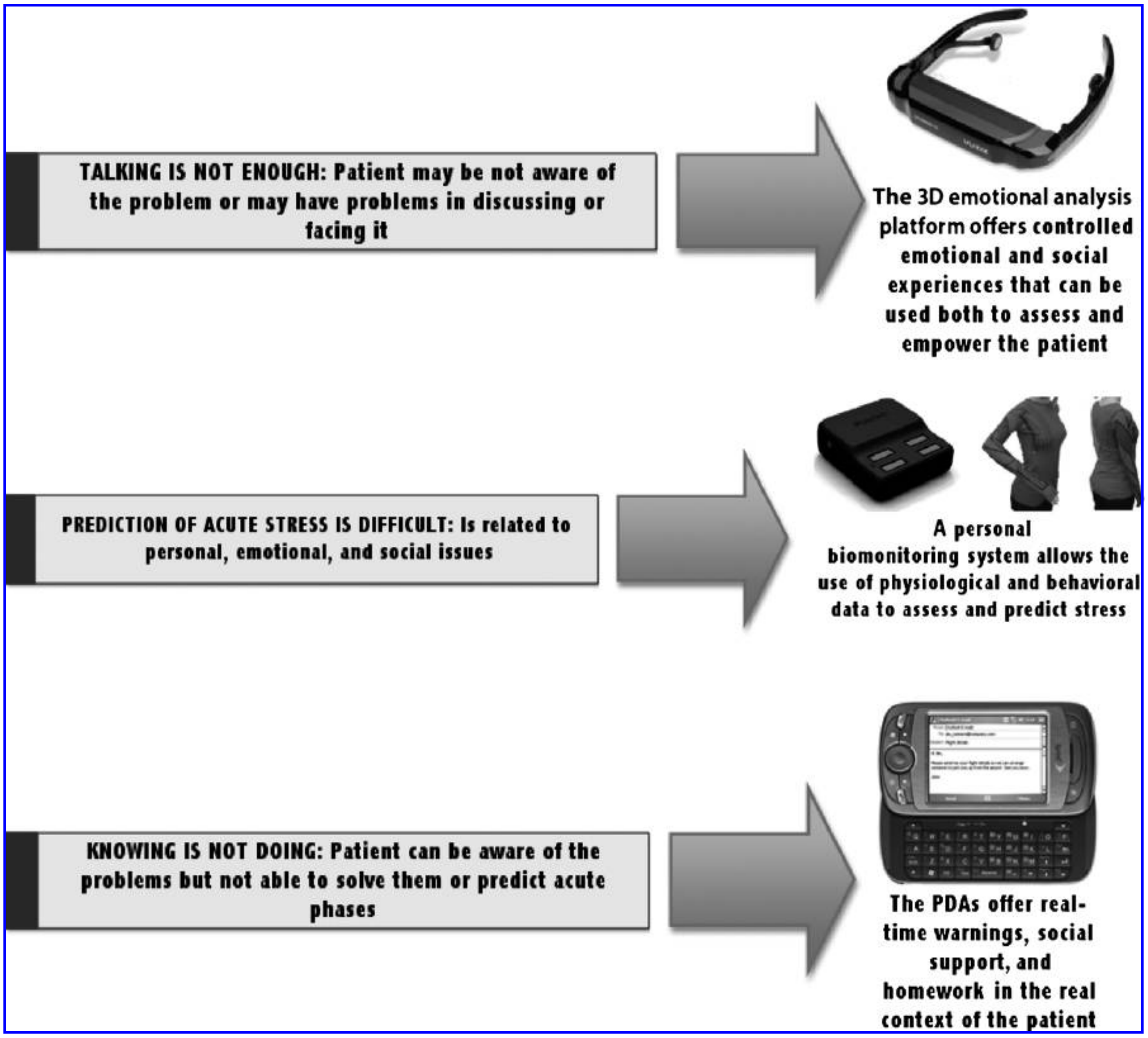

FIG. 3. The advantages for PTSD treatment offered by Interreality.

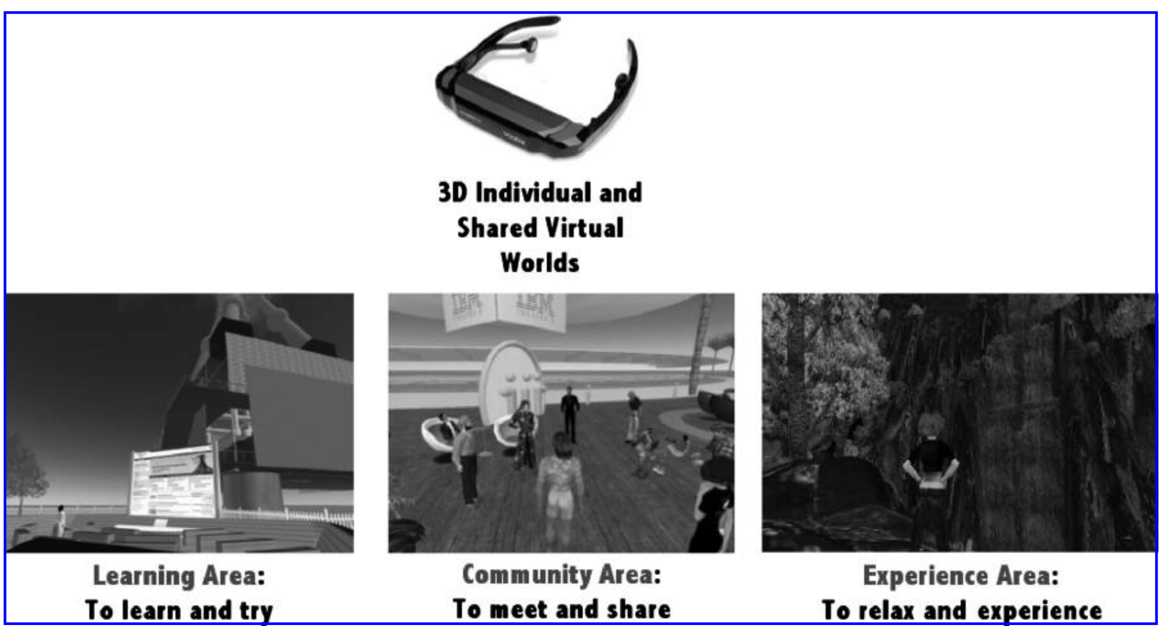

FIG. 4. The virtual worlds.

controlled exposure, emotional/relational management, general decision making, and problem-solving skills. The island includes different zones presenting critical situations related to the maintaining/relapse mechanisms and two relaxation areas. Each of these environments is experienced under supervision only. In the critical situation areas, the patient is exposed to specific/general stressful situations and helped in developing specific strategies for coping with them. After the experience, the therapist explores the patient's understanding of what happened in the virtual experience and the specific reactions—emotional and behavioral—

Table 1. Interreality Clinical Protocol

Sessions	*Therapeutic interventions*
1	• The therapist administers self-report questionnaires to verify the hypothesis that the patient's problem is due to a posttraumatic stress disorder. The therapist explains the term *posttraumatic stress disorder* by a description of the symptoms and course of the complaints; the main causes; and its effects on physical, psychological, and behavioral level, which can be reduced also by relaxation procedures. • The therapist introduces the course of treatment, which is structured into eight sessions (one per week, each lasting for 1 hour) wherein technologies are employed as teaching tools. Each session is divided into four parts: homework checking and dialogue with the patient on difficulties experienced in the week prior to the current session, relaxation training for baseline measures, exploration of virtual environments to practice coping skills during stressful situations (allows therapist to ascertain if the patient is accurately employing the coping skills), comments about the experience (debriefing and discussion of positive use of coping skills, areas of difficulty noted, and subjective perception of stress versus objective measurement of stress by the biosensors), and new homework assignments. • The therapist explains that some biosensors are worn to monitor physiological parameters, to track emotional and physical health status, and to influence experience in the virtual world. • The therapist introduces the Experience Island (a virtual environments connected to the user's problem). In the critical situation areas, the patient is exposed to stressful situations. Dysfunctional outcomes are identified by the therapist and used by the decision support system as a training set. • The therapist gives the patient a PDA (personal digital assistant) that is connected to biosensors to assess and improve the outcome of the virtual experience (follow up). The therapist explains that the PDA contains a decision support system providing positive feedback (in the form of an avatar) and/or warnings (also in the form of an avatar guide) according to differences detected between the patient's current and baseline profile. This system suggests to the patient what to do to cope with the actual problem. If the patient feels stressed, he or she can press a "stress" button in the PDA to record that experience and its context. This will be useful in discussions with the therapist and in helping to determine if the patient's self-perception (subjective experience) of stress is mismatched with the physiological experience of stress, thus indicating a need for further learning to be addressed.
2	• Log checking. • The therapist introduces the Learning Island, where the patient can learn different aspects related to the PTSD such as its main causes, its symptoms, stress-management strategies, and new emotion-focused coping strategies and stress-relieving exercises. • The patient enters again in the Experience Island. In the critical situation areas, the patient is exposed to traumatic situations and, under the therapist's guidance, is helped to develop specific coping strategies. • At the end of the session, the patient is assigned homework related to his or her outcome in the virtual worlds.
3	• Homework and log checking. • The VR environments of the Experience Island are used for graded exposure (i.e., more stressors are added systematically as the patient is able to cope) to traumatic situations to review the different relaxation techniques and the specific stressor-focused and emotion-focused coping skills. • In the Experience Island, the therapist teaches patients a relaxation method. • At the end of the session, the patient is asked to implement the relaxation exercises learned during virtual traumatic situations and to meet the therapist and other individuals with PTSD in the Community Island on specific days during the following week, where they will share their traumatic experiences and discuss successful and unsuccessful examples of coping strategies.
4–9	• Homework and log checking. • Relaxation training. • Coping strategies in graded exposure. • Comments about the experience (debriefing). • Homework assignment.
10	• Homework and log checking. • Relaxation training. • Coping strategies in graded exposure. • The session ends with advice on relapse prevention. • Follow-up 1, 3, 6, and 12 months later.

to the different situations experienced. If needed, some new strategies for coping with the situations are presented and discussed. In the relaxation areas, the patients enjoy a very relaxing environment (beach, waterfall, lake) and learn some basic relaxation procedures following a narrative voice.

The real-world interface: A PDA/mobile phone. In Interreality, patients' activity in the virtual world has a direct link at three levels with his or her life through a mobile phone/digital assistant:

1. *Follow-up (warnings and/or feedbacks):* It is possible to assess/improve the outcome of the virtual experience through the PDA/phone, eventually also using the information coming from the biosensors and activity sensors. For example, if the real-world outcome is poor after receiving a real-time warning, the user experiences again the same virtual environment. If it is good, the user receives real-time motivating feedback and can share his or her experience with other users.
2. *Training/homework:* Thanks to the advanced graphic/communication capabilities now available on PDAs/phone, they can be used as training/simulation devices to facilitate the real-world transfer of the knowledge acquired in the virtual world. The relaxation techniques learned in the virtual world can be experienced in the real-life context before or during stressful activities.
3. *Community:* The social links created in the virtual world can be continued in the real world even without revealing the real identity of the user. Users can use SMS with a virtual friend in their own real context to ask for support.

The personal biomonitoring system: Behavioral and physiological sensors. In Interreality, the dynamic behavioral profile of the user (contextualized behaviors and body dynamics) and the physiological response of the user to events (analysis of biosensors' data) is done through a personal biomonitoring system (PBS), consisting of independent wearable bands for the examination of the physiological and behavioral signs.

The PBS allows full-body motion tracking through a 3D, wearable motion analysis platform. The PBS integrates biosensors for the transduction of heart rate variability (HRV), electrodermal response (EDR), peripheral skin temperature, and electroencephalogram data. The PBS wirelessly integrates state-of-the-art miniature inertial sensors, wireless communication solutions, and bioelectrodes, as well as conductive elastomer-based paths directly screen-printed on each single band for the electrical connections. GPS data for location-tracking is obtained from the PDA.

The full PBS system will be used in the therapist's office only. To improve acceptance, the patient will use a Bluetooth wearable sensor only (HRV, EDR, skin temperature).

Interreality in Practice: A Clinical Scenario

To present the clinical value of the Interstress paradigm, we use a clinical scenario: Rosa, a 55-year-old nurse, involved in a major car accident.

The clinical scenario

Rosa, a 55-year-old nurse who works at a local hospital, has been married to Tom for 30 years. Rosa's mother, Susanne, has progressive senile dementia. Since her mother

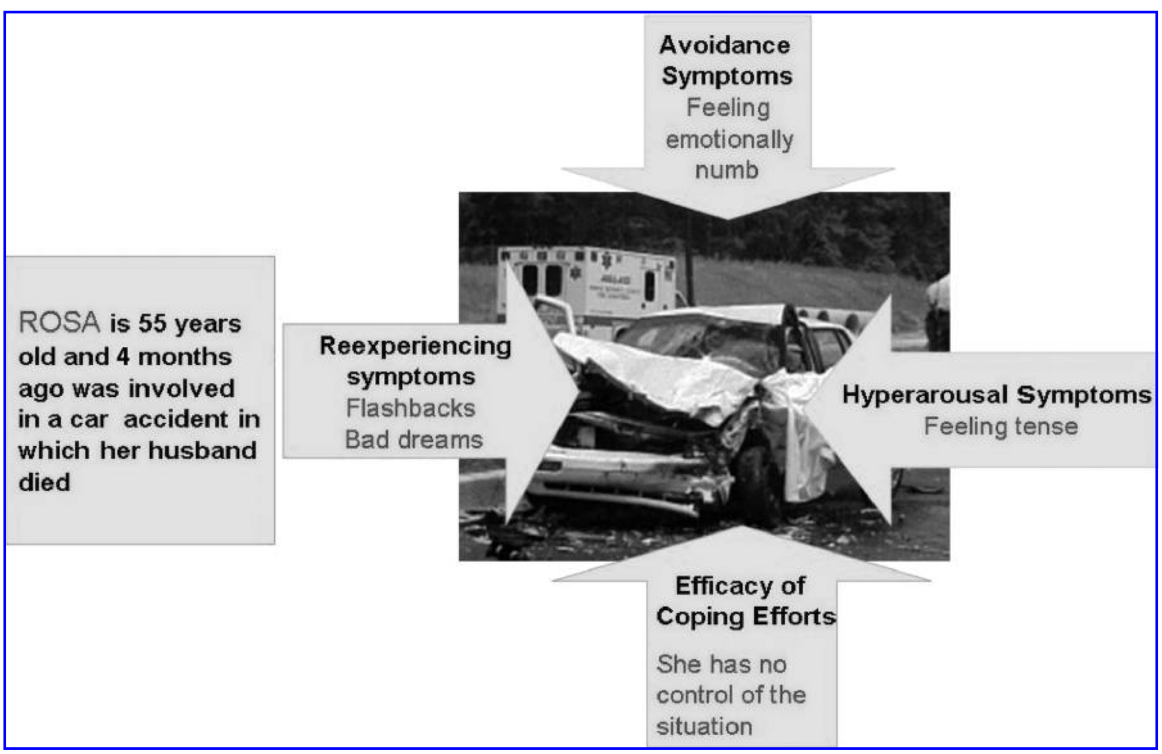

FIG. 5. Rosa: A possible clinical scenario.

received the diagnosis, Rosa's main activity after work has become providing care for her mother.

Four months ago, while returning from the hospital with her husband after visiting Susanne, a truck lost control and crashed into their car. The accident was horrific; Rosa had to be cut out of the car and flown by air ambulance to a trauma center.

She "woke up" 2 weeks later with no recollection of the accident, and the doctors told her that her husband had died. Rosa stayed in hospital for 2 more months, and when she returned home, she started having nightmares about the crash: waking up in a cold sweat to the sound of crunching metal and breaking glass. The sights and sounds of the accident haunted her constantly. She had trouble sleeping at night, and during the day she felt irritable and on edge. She jumped whenever she heard a siren or screeching tires, and she avoided all TV programs that might show a car chase or accident scene. Rosa also avoided driving whenever possible and refused to go near the site of the crash. This represented a problem for her because she had difficulties going to the hospital to work and to take care of her mother. She felt guilty, depressed, and worried. She had difficulty accepting what had happened, and she felt completely alone, thinking that no one could help her. Rosa showed the typical PTSD symptoms, such as intense fear, helplessness, flashback of images with a "past which is always present" (see Fig. 5).

Rosa first attempted to accept what she was going through, which required a cognitive restructuring activity that allowed her to reappraise the event. This strategy ideally should be followed by education and training of useful coping responses to the type of traumatic event she was dealing with. Rosa realized that her living conditions had become more stressful, and she did not know how to deal with its increasing pressure; she therefore decided to go to a therapist.

The clinical protocol

The therapist gave Rosa an immediate sense of being less alone. After a short assessment interview and some paper-and-pencil self-report questionnaires, the therapist explained to Rosa the Interreality therapy and protocol (see Table 1 for the full description of the protocol).

The therapist showed Rosa how to wear biosensors to monitor her physiological parameters. Then, the therapist put the noninvasive sensors on Rosa and explained their value to her, beginning the education process.

The therapist introduced Rosa to one of the virtual worlds, Experience Island, where she was exposed to a virtual trau-

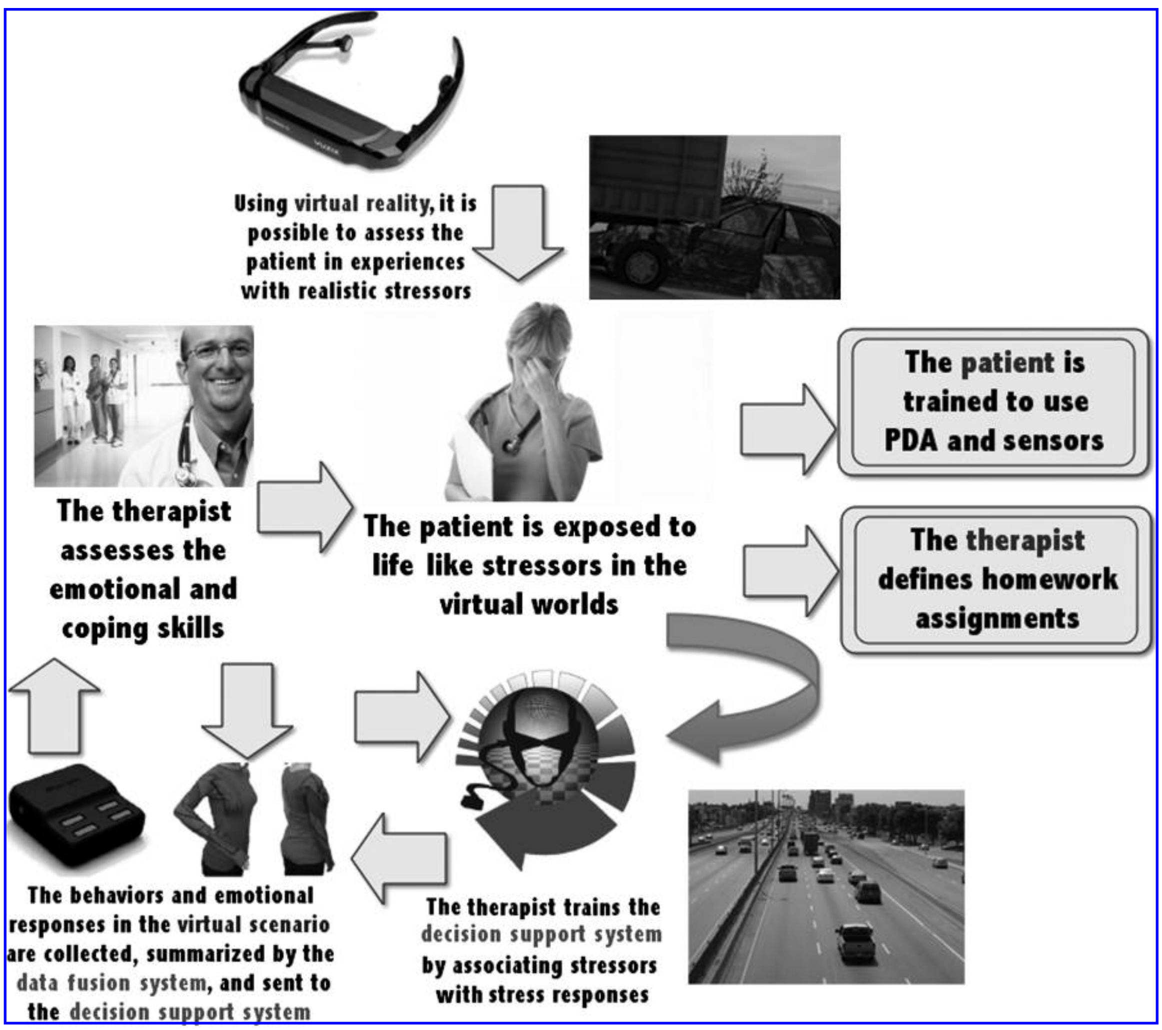

FIG. 6. Rosa: The first session.

matic situation similar to the real-life one that she had experienced. Within this virtual environment, Rosa had to drive on the highway. The data fusion system integrated all the biosensors' data in a single figure, allowing the therapist to directly index how the virtual situation was affecting Rosa's physiological responses and providing an objective assessment of the different stressors. The virtual exposure session was recorded and uploaded on the PDA for home exercises.

At the end of the clinical session, the therapist provided homework for Rosa. Home exercises allowed Rosa to practice the skills she was learning at the therapist's office, making them more readily available to her during stressful situations that recalled the traumatic event (see Fig. 6).

After the exposure to the virtual world displayed on her PDA, Rosa, for homework, was invited to go to the highway and observe the cars; during the in vivo exposure, the biosensors tracked her physiological responses. When Rosa felt that the situation was very stressing, she pressed a button on the PDA to record the experience. In this way, Rosa could effectively report to the therapist her stressful experience and the negative emotions associated with it. The data reported by the PDA were used by the therapist to schedule the type and content of the feedback provided by the decision support system.

In the next phase of the treatment, Rosa was invited to experience a virtual world, the Learning Island. Within this virtual scenario, Rosa learned about the main causes of PTSD, how to recognize its symptoms, and how to get the information needed to cope with the difficult aspects connected to the traumatic situation.

During the Experience Island phase, Rosa had the opportunity to reexperience the traumatic event (virtual exposure) and practice different coping mechanisms: relaxation techniques, emotional/relational management, general decision making, and problem-solving skills. For example, in the relaxation area, a green valley with a lake in the middle, she could learn some relaxation procedures. By practicing the skills and coping mechanisms suggested by the therapist, Rosa could more effectively manage her symptoms. Rosa was then invited to join the Community Island under therapist supervision (see Fig. 7), where she had the opportunity to share and discuss her experience with other patients who suffered from the same problems.

However, in some cases, Rosa experienced new critical situations that raised her stress level. When these situations occurred, the decision support system provided her with positive feedback (i.e., instructions to relax) and/or warnings.

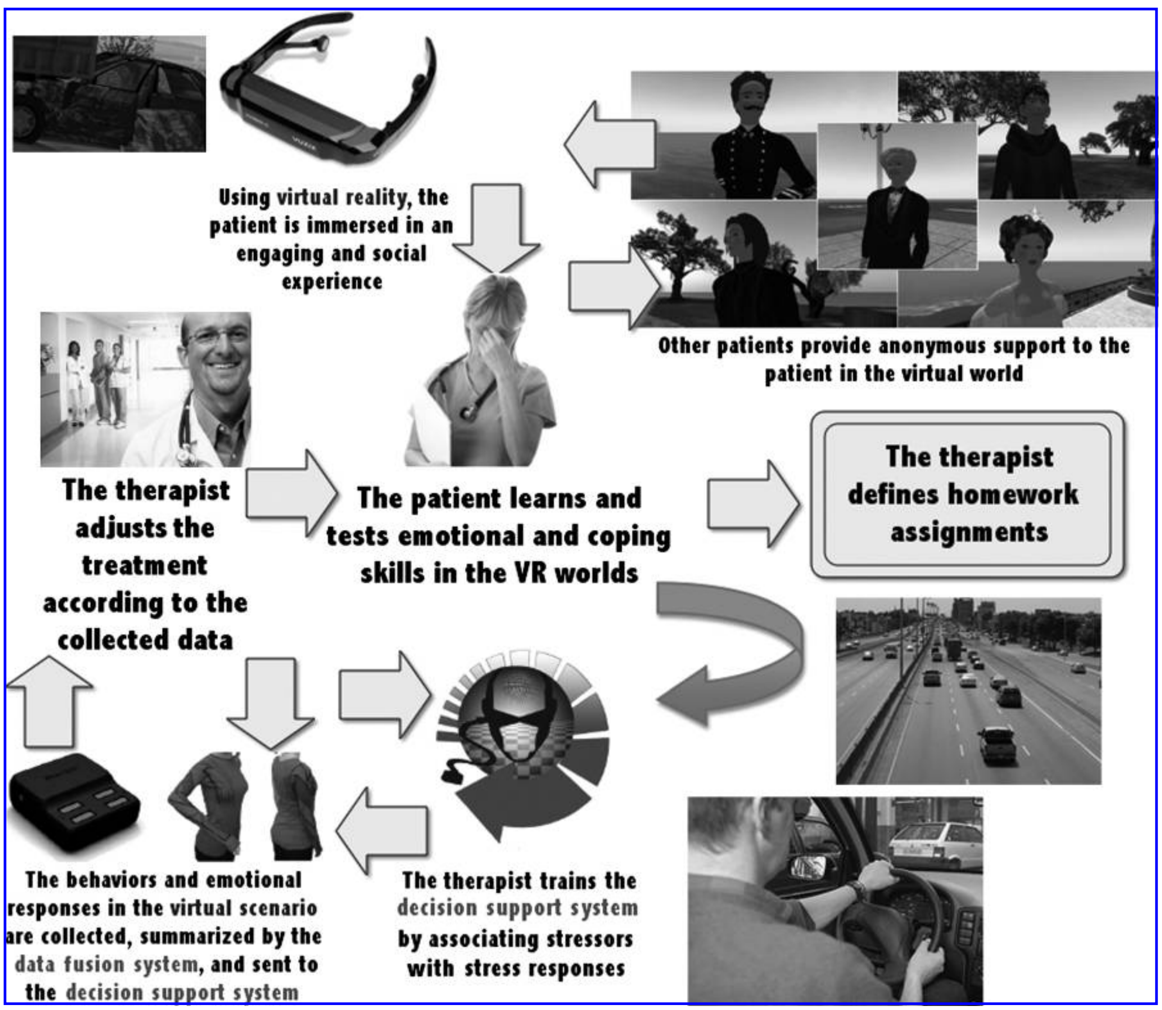

FIG. 7. Rosa: The other sessions.

At subsequent sessions, the therapist asked Rosa if the suggestions provided by the decision support system were helpful. Rosa affirmed that it gave her useful emotional support and helped her to remember the relaxation techniques she had previously learned.

Then the therapist asked Rosa about the issues she encountered in order to get information about Rosa's behavior, feelings, and reactions to the stressful event. Rosa reported to the therapist that while riding in a car with a friend, she noticed a truck similar to the one involved in her accident. This information was then compared to the data collected by the decision support system. The analysis helped the therapist to define the next phases of treatment.

In the following sessions, Rosa reported that she felt better thanks to the possibility of experiencing stressful situations related to her traumatic event within a safe virtual environment. She also reported that meeting other people in the Community Island helped her to find much-needed support and to discover new strategies to manage her negative emotions. Finally, having full-time support through the PDA made Rosa more confident. She could enter her car now, and she was planning to drive again. The last session ended with advice on the prevention of relapse.

Conclusions

VR is used to facilitate the activation of specific traumatic events during the exposure phase of a CBT protocol. However, the actual VR-based CBT protocol for PTSD does not address the following issues:

1. VR is a new and distinct realm, separate from the emotions and behaviors experienced by the patient in the real world;
2. The protocol is not customized to the particular characteristics of the patient.
3. CBT focuses on patients' thoughts and behaviors but does not address relationship change and self-efficacy.

The Interreality paradigm we propose integrates assessment and treatment within a hybrid environment, bridging the physical and virtual worlds.

The clinical use of Interreality is based on a closed-loop concept that involves the use of technology for assessing, adjusting, and/or modulating the emotional regulation of the patient, his or her coping skills, and appraisal of the environment based on a comparison of the patient's behavioral and physiological responses with a training or performance criterion:

1. The assessment is conducted continuously throughout the virtual and real experiences.
2. The information is constantly used to improve both the emotional management and the coping skills of the patient.

Although CBT focuses on directly modifying the content of dysfunctional thoughts through a rational and deliberate process, Interreality focuses on modifying an individual's relationship with his or her thinking through more contextualized experiential processes. The potential advantages offered to PTSD treatment by the Interreality approach are as follows:

1. *An extended sense of presence:* Interreality uses advanced simulations (virtual experiences) to transform health guidelines and provisions in experience. In Interreality, the patients do not receive abstract information but live meaningful experiences.
2. *An extended sense of community:* Interreality uses hybrid social interaction and dynamics of group sessions to provide users with targeted (but also anonymous, if required) social support in both the physical and virtual worlds.
3. *A real-time feedback between the physical and virtual worlds:* Interreality uses biosensors and activity sensors and devices (PDAs, mobile phones, etc) to track in real time the behavior and health status of the user and to provide targeted suggestions and guidelines.

Obviously, any new paradigm requires a lot of effort and time to be assessed and properly used. Without a real clinical trial with PTSD patients, the Interreality paradigm will remain an interesting but untested concept. However, a recently funded European project, Interstress—Interreality in the management and treatment of stress-related disorders (FP7-247685), will offer the right context to test and tune the presented ideas.

In conclusion, despite the lack of clinical data, we suggest the Interreality paradigm may represent a valid opportunity for improving the long-term outcome of PTSD treatments. Our hope is that the present work will stimulate a discussion within the clinical and research communities about the advantages and the possible risks that bridging the physical and virtual world offers to cybertherapy applications.

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Disclosure Statement

No competing financial interests exist.

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