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Lessons Learned From 600 Virtual Reality Sessions

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ABSTRACT

The Center for Advanced Multimedia Psychotherapy at the California School of Professional Psychology in San Diego was established to conduct research and provide clinical treatment to persons with phobias and other mental health disorders by using virtual environments as an adjunct to traditional cognitive–behavioral therapy. Observations made over the course of 600 virtual reality sessions are discussed in this article. Physiological and self-report data collected during treatment support the effectiveness of virtual reality exposure as a useful adjunct in the treatment of phobias. The use of immersive virtual environments appears to augment treatment success through the construct of "presence."

INTRODUCTION

In conducting over 600 sessions using virtual environments designed to treat specific phobias, we are beginning to realize that the individual response to the virtual world is more varied than first believed. The pace at which the patient progresses through virtual therapy also varies a great deal. Some patients show immediate immersion or "presence" in the virtual world, whereas others require several sessions to reach this state. Many researchers and clinicians are realizing the therapeutic value of this state of presence and, by measuring both subjective and objective arousal, are beginning to elucidate when this state is achieved. Many investigators report that high levels of presence seem to be correlated with increased responsiveness to therapy, more dramatic treatment success, and more prolonged positive effects of the therapy. In addition, as the clinic has expanded its "virtual therapy" from treating fear of flying to treating other phobias (such as fear of driving, claustrophobia, social phobia, and agoraphobia), we have noticed the therapeutic interaction with the patient while he or she is in the virtual environment differs dramatically between different phobias. Whereas the person with a fear of flying may prefer to become more immersed in the environment by not having the therapist ask for anxiety levels during exposure, the person with social phobia is able to verbalize quite frequently and still feel a part of the scene, experiencing arousal, as they maneuver through virtual social scenarios. It is important to adapt each virtual world scenario to the best clinical protocol for each patient.

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EVALUATIVE MEASURES

In assessing patients' progress through treatment, research has shown that a variety of measurement tools produce the best accuracy.[1] The measures used range from subjective to objective (Fig. 1) and include:

1. Subjective Units of Distress (SUDS): Based on a score of 0 (meaning no anxiety) and 100 (meaning maximal anxiety), the patient is asked at several points in time for a SUDS rating. The goal is to elicit some anxiety during exposure, and then to have that anxiety decrease both within session and between sessions.
2. Self-Report Scales: Depending on the phobia being treated, self-report questionnaires with appropriate reliability and validity are chosen to be given pre-treatment, mid-treatment, and post-treatment. Although the scales may be subject to such confounds as social desirability, they may give an indication of the patient's reduction in fear levels over the course of treatment.
3. Overt Behavioral Observation: The therapist needs to be aware of the patient's behavior during session—is the patient sitting quietly, unengaged; is the patient fidgeting and bracing in fear; is the patient hyperventilating; or is the patient interacting in an inquisitive manner with the virtual environment.
4. Physiology: Research has shown that physiological changes occur during exposure to phobic stimuli.[2] Based on this, heart rate, respiration rate, skin resistance (a measure of sweat gland activity), peripheral skin temperature, and brain wave activity are being measured both at baseline and during exposure for each treatment session.

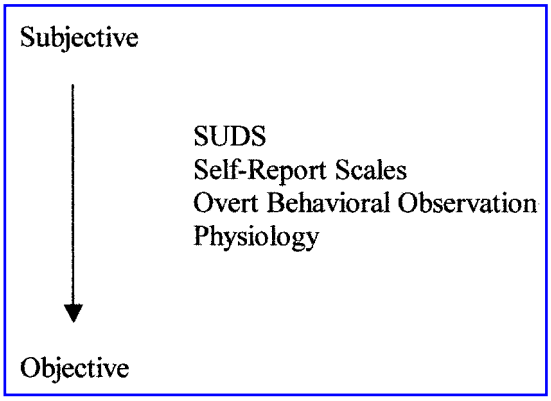

FIG. 1. Evaluative measures used during VR therapy.

Possible interrelationships

Prior studies have shown that the constructs of Hypnotizability and Absorption are highly correlated, as measured by the Hypnotic Induction Profile (HIP)[3] and the Tellegan Absorption Scale (TAS).[4] What is not definitively known is whether these constructs are also correlated with the concept of presence. Presence has been described as occurring when the person feels more a part of the computer-generated environment than the real world environment where they are physically located.[5] Maximal presence is thought to occur when the user feels immersed in the environment, feels capable of interacting with the environment, and has an interest in the environment or task portrayed.[6] It would intuitively seem that those high on the HIP and TAS would be more able to feel present in the virtual environment more quickly (Fig. 2). In our research and clinical sessions, we have seen a curvilinear relationship with absorption and hypnotizability and treatment success thus far. Those scoring as low and high in absorption and hypnotizability have had the best treatment outcome success, while those scoring "medium" have not been as successful in virtual therapy. In contrast, those scoring medium have done better in Imaginal Exposure Therapy (IET) than those scoring low or high. The meaning of this is not yet clear, but needs to be examined more closely, and may be useful when initially assessing a person's suitability for treatment or determining the projected length of treatment. Interesting to note, however, is the fact that all three groups still had better treatment outcomes in virtual reality therapy than in imaginal therapy.

Framework

As reported in Wiederhold and Wiederhold,[7] patients appear to be clustered into four subtypes when skin resistance (objective) and SUDS (subjective) ratings are compared in a 2×2 table. Shown in Figure 3, a person showing high subjective and objective arousal when

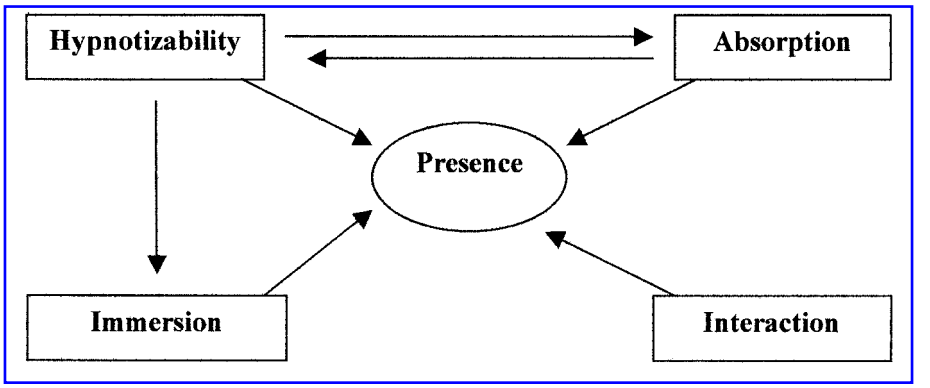

FIG. 2. Interrelationships among a person's level of presence, hypnotizability, absorption, immersion, and interaction.

placed into the virtual world would be labeled a "type 1." During therapy, this would be a patient who is highly phobic and is immersed or present enough in the virtual world to feel both subjective anxiety and physiological anxiety. A person showing high physiological arousal but reporting no subjective arousal would be labeled a "type 2." This appears to be a person having some type of "mind-body disconnect" and may be a person who is not "cognitively immersed" in the virtual world, although their physiology says otherwise. This person may not be aware of when they are experiencing physiological arousal and/or may be unable to admit that an "animated world" is causing some anxiety. A person labeled as a "type 3" would be someone who is experiencing no physiological arousal but is self-reporting arousal. This again might be someone who cognitively feels quite anxious but physiologically is not showing signs of anxiety. This person may also be unable to become immersed in the virtual world but unable to admit this to the therapist. A "type 4" in this framework would be someone who is neither physiologically or subjectively aroused upon being placed into

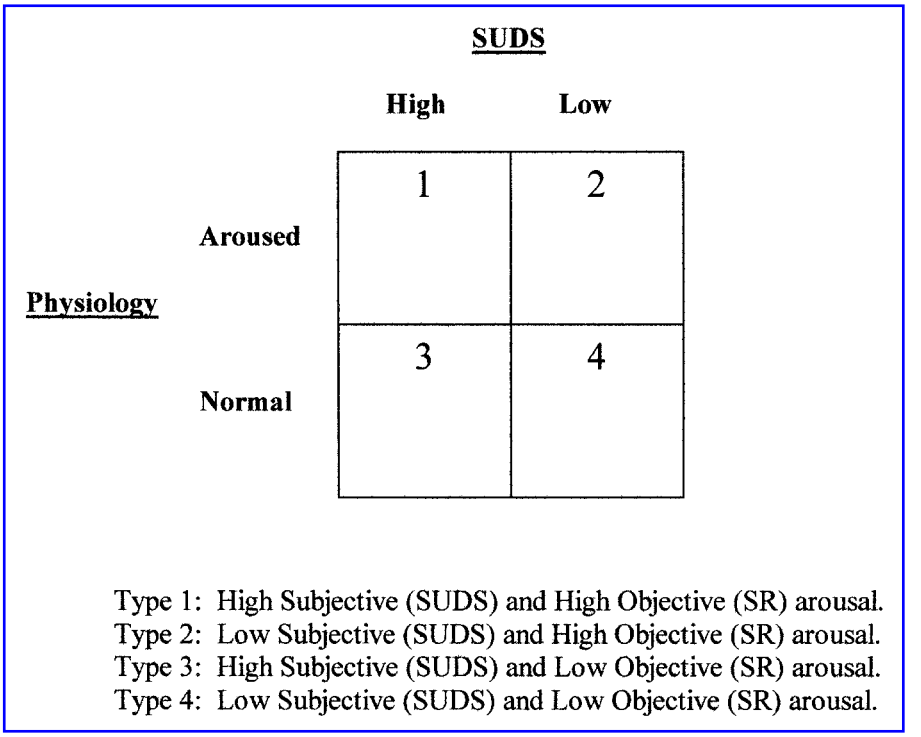

FIG. 3. A framework used to determine the subtype of a patient that is based on skin resistance (SR) levels (an objective measurement) and subjective units of distress (SUDS) (a subjective measurement).

the virtual world. This could be a non-phobic or someone who is not immersed and therefore unable to feel arousal, and who is able to admit that fact. Or, this is someone who has become desensitized through treatment and is no longer feeling arousal, either subjectively or objectively, in the virtual world and who now may be fully ready to attempt *in vivo* exposure.

As patients move through the therapy program, it appears that those who never become a type 1 are not able to achieve treatment success. As shown by previous researchers,[1,8,9] it is important to have both subjective and objective arousal during exposure with a decrement in arousal occurring both within session and across sessions. Those who never become a type 1 never experience arousal in both systems and therefore may not be able to achieve full habituation. It also appears that many IET participants never become a type 1 even though they may be a type 4 at the end of treatment, meaning they could never fully become immersed enough in the imaginal scenarios to experience the anxiety subjectively and objectively. It also appears that self-efficacy changes more for VRGET participants with a sense of mastery being achieved by the end of treatment. It may be that IET participants drift off task during exposure, possibly "cognitively avoiding" the stimulus during exposure, which prevents full processing and habituation.[10]

SUDS levels

In a study comparing virtual reality–graded exposure therapy (VRGET) to imaginal exposure therapy for the treatment of fear of flying, it was seen that patients in the VRGET group experienced much higher SUDS ratings during initial exposure sessions, with a subsequent drop in ratings during later sessions; whereas IET participants received lower SUDS ratings during initial exposure sessions, with a slight rise in ratings during session four and a drop again in sessions five and six.[18] Because studies have shown that in order to change the fear structure one must first access the fear structure, it would appear that IET participants were not able to feel the anxiety as strongly, and therefore the fear structure may not have been fully activated and changed during treatment.

Self-report questionnaires

In the same study, self-report questionnaires showed no differences between VRGET and IET groups, although post-treatment flying behavior differed dramatically. This points to a need to re-evaluate assessment methods and to realize that self-report measures may not be the most reliable way to assess treatment success, due to such factors as social desirability and regression to the mean.

Skin resistance

In a fear of flying comparison study, participants in the VRGET experienced an average 35% drop in skin resistance when placed in the virtual world the first time. They then showed less and less of a drop in skin resistance, and during the final exposure session (session 6) showed only a drop of 15% from baseline levels. In contrast, the IET group showed smaller drops in earlier sessions and actually had a 30% drop in SR levels during session 6, possibly meaning that they were only able to become fully immersed in the imaginal exposure after several sessions, and actually were still quite anxious physiologically by the end of treatment, not appearing to have achieved physiological stabilization and desensitization.[18]

Physiological findings

Both participants and patients seen over the past $2\frac{1}{2}$ years have overall not shown consistent or identifiable changes in peripheral skin temperature (PST) as a result of exposure to the virtual world. Although some individual patients have shown decreases in PST during exposure, this does not appear to occur in most persons. Heart rate also has not been a sensitive measure. Some patients have experienced panic attacks during exposure to the virtual stimuli, and this change in heart rate was observable. For the average anxious patient, the heart rate did not prove to be a sensitive measure. It has been suggested that heart rate variability might prove a more powerful predictor due to its in-

creased sensitivity.[11] Respiration rate has also not been sensitive to changes during exposure or across sessions when measured with an abdominal strain gauge. Skin resistance has been an accurate indicator, being the quickest to react during presentation of phobic stimuli and showing the most change over treatment as desensitization occurs.

Brain wave findings

Brain wave activity analysis is in the initial stages and appears to be showing some interesting trends. In the Beta Frequency Band (16-21 Hz), those labeled type 1 and type 3 in the framework who self-report subjective arousal, have a substantial drop in beta from baseline through virtual flight. Those self-reporting no arousal, type 2 and type 4, show no drop in this frequency band from baseline through flight. So, although type 1 and type 2 subjects are both showing physiological arousal, the brain activity is not reflecting these two groups as being equal.

In the SMR Frequency Band (13–15 Hz), again those in category 1 and 3 have a decrease in amplitude during the VRGET, whereas those in category 2 and 4 do not show this decrease. The Alpha Band (8–12 Hz) showed significant decreases in category 1 and 3 participants, whereas these significant decreases were not shown in category 2 and 4 participants. Increases in alpha amplitude are usually associated with increases in relaxation,[12] and, therefore, would show a decrease in highly anxious individuals such as that seen in category 1 and 3 participants who were also self-reporting anxiety. In the Theta Band (4–7 Hz), category 1 and 3 are again reflective of one another, both showing a decrease in theta during exposure. Category 2 and 4, in contrast, show an increase in theta during exposure. This increase is what we would expect in non-phobics based on previous work showing that when placed in a virtual world, theta amplitude increases, which reflects a more primitive form of processing.[13,19]

SYNCHRONY

The concept of synchrony as proposed by Hodgson & Rachman occurs when physiological and subjective measures move together over treatment. In their earlier studies a correlation between SR and SUDS was found, using the median correlation as a cut-off point between synchrony and desynchrony.[9] In trying to determine the usefulness of the proposed four-category framework, we also have chosen to use the median SUDS and SR changes as our cut-off point. This keeps in line with what Foa has discussed concerning the need for arousal to be both physiological and cognitive,[8] followed by a decrement in arousal in both system; and Lang[1] who reports that there must be both physiological and subjective arousal for treatment success. Rachman has reported that synchrony occurs more often in highly arousing situations[14] (such as *in vivo* exposure), and synchrony did appear to occur more often amongst VRGET participants than IET participants. When flying success was determined based on synchrony levels, using Rachman's method, we achieved a p of .035. When based on synchrony the cut-off point was determined using the framework. We also achieved $p = .035$. It, therefore, appears that the framework fits within established methods of assessment to determine treatment success.

COMPARISON TO NON-PHOBICS

By studying the physiological reactions of non-phobics when placed in the virtual environments, a baseline or normal response can be determined by which to compare phobics' reactions. The majority of non-phobics do get some arousal when first placed into the virtual world, but are able to stabilize their physiology over a 20-minute exposure period, with one study showing an overall 2% increase of skin resistance from baseline through virtual flight.[15] Another study showed that physiology was not fully stabilized after a 10-minute exposure period for most non-phobics.[16] Non-phobics respond very differently to the virtual world than phobics also. Most non-phobics enter the world and immediately begin exploring and interacting with the world. Most phobics enter the world and have to be invited to begin the exploration and interaction process,

with periodic reminders usually being necessary.[17]

OTHER FINDINGS

Overall, participants and patients alike have been very impressed by audio and vibratory stimuli provided by the various virtual environments. They have reported it as being "very realistic" and adding to their ability to become immersed. Although some patients can become immersed during the first exposure session, others take two or three sessions to feel fully present in the environment. Many patients subjectively report dislike of the "animated" visual stimuli and are amazed when they are able to feel anxious. A small percentage of patients have reported feeling drowsy during the virtual exposure. Classical conditioning might lead us to believe that because these patients had learned to experience drowsiness during real world flights due to taking Xanex prior to flying, the same response of drowsiness was elicited in the presence of the same stimuli of the virtual flight.

VIRTUAL ENVIRONMENTS

The virtual environments used to treat fear of flying patients at CAMP were developed by Dr. Larry Hodges at Georgia Tech and Dr. Barbara Rothbaum at Emory University. The virtual environments used to treat our patients with claustrophobia, social phobia, and panic disorder with agoraphobia were created by Dr. Giuseppe Riva at Istituto Auxologico Italiano in Verbania, Italy. All the environments run on a PC platform and use head-mounted displays and head trackers for greater interactivity and immersiveness. In addition, the environments created to treat patients with claustrophobia, social phobia, and panic disorder with agoraphobia make use of a joystick device to navigate through the virtual worlds.

The following case studies examine the individual experiences of patients as they move through the treatment using virtual reality exposure therapy in combination with traditional cognitive–behavioral therapy techniques.

CASE REPORT—CLAUSTROPHOBIA

The patient was a 75-year-old Caucasian female referred to our clinic by her primary care physician for treatment of claustrophobia. The treatment was necessary because of an upcoming MRI procedure. Because of other co-morbid medical conditions, she preferred not to have intravenous valium administered during the procedure. Upon initial consultation, it was learned that she had lived for the past 40 years with a fear of elevators and other small, enclosed spaces; choosing to climb as many as 15 flights of stairs rather than take an enclosed elevator. Since her hip replacement surgery 3 years prior, she had confined her activities to buildings and doctors' offices that were located no higher than the third floor. The exception to this avoidance was buildings with glass elevators, with which she had no problem. Initial intake history showed no co-morbid phobias or other mental health conditions and the patient appeared very motivated to overcome her fear.

During initial sessions, the patient was introduced to diaphragmatic breathing techniques with the use of visual physiological feedback to use during subsequent exposure sessions, as well as thought-stopping and cognitive distraction techniques. Because of her claustrophobia, it was initially unclear if she would be able to tolerate the HMD, but this did not prove to be a problem. The patient was acquainted with the virtual reality head-mounted display (HMD) and joystick, which was used for navigation in the virtual world, and practiced navigating in a virtual beach scene, which she found very relaxing. Having never touched a computer before nor played a video game, she adapted quite quickly to the VR world and found it quite enjoyable. She commented, "Now I can tell my grandsons that grandma knows what VR is!"

During the next session, after a baseline relaxation period, the patient was immersed into the virtual world and asked to walk forward, open the door, and enter the virtual elevator. At this time, she became quite anxious and did not want to proceed to opening the door. She commented, "That looks like a very small elevator—I don't want to go inside."

When asked for a SUDS rating, she reported

at 80. After standing facing the elevator doors for several minutes while doing diaphragmatic breathing, she was able to open the doors and with some encouragement, walk inside the elevator. She was able to stand inside the elevator, but only for a brief period before needing to exit. The rest of the session was focused on walking around the lobby, facing the elevator, entering the elevator, and closing the doors.

Subsequent sessions were spent first practicing in the virtual world and then going to the real elevator in the clinic's building, which is very old and slow moving. By the end of seven treatment sessions, the patient was able to successfully stand in the elevator 15 minutes with little or no anxiety. A call was received after the patient's MRI reporting that she had made it through the procedure successfully.

CASE REPORT—PANIC DISORDER WITH AGORAPHOBIA

The patient was an 18-year-old Caucasian male referred by his physician after being tested for an organic cause for his symptoms. He had continued to live at home while attending a local university, but after a few weeks of school was unable to attend class without his mother, then was unable to attend class at all. He subsequently also discontinued working because he could not stay at his job without his mother or a close friend being present the entire day. The patient was experiencing panic attacks several times a day without provocation and was only able to go two blocks from his home when he presented for treatment.

Treatment began with patient education, followed by breathing retraining and cognitive coping techniques, which remained a part of subsequent sessions. A hierarchy was then made of situations that successively provoked more anxiety. After the patient demonstrated a comprehension of these anxiety management techniques, exposure to the virtual world began. At first, the patient was placed in the HMD and allowed to navigate through nonthreatening environments with the use of a joystick. The patient was placed in a beach scene that he had said would cause little if any anxiety. Unfortunately, when he reached the edge of the sand and gazed out over the water, it reminded him of many years earlier when he had been on a sailboat and had a panic attack and had to be brought back to shore. The cues in the scene served to bring up past memories that, despite a thorough intake, had not been retrieved. The elicitation of additional comments allowed for processing of these memories to occur.

When placed into an open plaza area, the patient "walked" behind the buildings to where the open highway was and became very anxious. "I've never been here before—This looks like it is a long way from my home," was his comment.

The patient was guided through the beach scene, a restaurant scene, an office scene, a grocery store, and an open plaza scene. Homework practice served to mimic tasks successfully completed in the virtual world to provide further gains in self-efficacy and mastery. The patient is now being seen once a month for "booster sessions" and has begun working again; with plans to attempt college again in the Fall.

CASE STUDY—SOCIAL PHOBIA

The patient was a 32-year-old male who was self-referred to our clinic. He had increasingly become unable to attend more and more social functions, and had started to feel as though his phobia was holding him back from achieving his full potential both in his personal relationships and in his professional life. Treatment began with psycho-education, cognitive coping techniques, and breathing retraining. Treatment continued with the patient beginning to interact with people he encountered in the virtual worlds, making eye contact and small talk. Between sessions he was instructed to practice what he had learned in the session. He had come to our clinic prior to the holiday season and, because he and his wife both worked for large firms, he was provided with many opportunities to practice his new skills at holiday parties. He also was asked to practice eye contact and small talk with new people in the office setting.

Though not yet entirely comfortable with social situations, our patient has made substan-

tial gains since beginning treatment. As he stated, "I still feel a little uncomfortable, but I can do it now—I'm not avoiding things anymore."

CONCLUSIONS

Virtual reality therapy is effective and fits within established psychological theories and practice. Physiological measurements significantly aid in the verification of emotional processing. It seems that virtual environments may aid in the elicitation of new data from the patient despite an extensive intake and evaluation. Like hypnosis, virtual environments may allow the mind access to memories that are out of conscious awareness. Virtual environments are proving efficacious for varied disorders and with varied types of patients, from those who have never been exposed to computers before to those who grew up in the computer age. Continued validation with virtual environments is necessary for sustained growth and acceptance.

REFERENCES

1. Lang, P.J. (1985). The cognitive psychophysiology of emotion: Fear and anxiety. In Tuma, A.H. & Maser, J.D. (eds.) *Anxiety and the anxiety disorders* Hillsdale, NJ: Erlbaum, pp. 131–170.
2. Vermilyea, J.A., Boice, R., & Barlow, D.H. (1984). Rachman and Hodgson (1974) A decade later: How do desynchronous response systems relate to the treatment of agoraphobia? *Behavior Research and Therapy*, 22:615–621.
3. Frischholz, E.J., Spiegel, D., Trentalange, M.J., & Spiegel, H. (1987). The hypnotic induction profile and absorption. *American Journal of Clinical Hypnosis*, 30(2): 87–93.
4. Tellegen, A., & Atkinson, G. (1974). Openness to absorbing and self-altering experiences ("absorption"): A trait related to hypnotic susceptibility. *Journal of Abnormal Psychology*, 83:268–277.
5. Witmer, B.G., & Singer, M.J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence: Teleoperators and Virtual Environments*, 7(3):225–240.
6. Stark, L.W. (1994). Why virtual reality works: Top-down vision in humans and robots. In *ICAT '94 Proceedings: The Fourth International Conference on Artificial Reality and Tele-Existence*, Tokyo.
7. Wiederhold, B.K., & Wiederhold, M.D. (1999). Clinical observations during virtual reality therapy for specific phobias. *CyberPsychology & Behavior*, 2(2):161–168.
8. Foa, E.B., & Kozak, M.J. (1986). Emotional processing of fear: Exposure to corrective information. *Psychological Bulletin*, 99:20–35.
9. Hodgson, R., & Rachman, S. (1974). Desynchrony in measures of fear. *Behavior Research and Therapy*, 12:319–326.
10. Craske, M.G., & Rachman, S.J. (1987). Return of fear: Perceived skill and heart rate responsivity. *British Journal of Clinical Psychology*, 26:187–199.
11. Malik, M. (1996). Heart rate variability: Standards of measurement, physiological interpretation, and clinical use. *Circulation*, 93:1043–1065.
12. Coles, M.G.H., Donchin, E., & Porges, S.W. (Eds.). (1986). *Psychophysiology: Systems, processes, and applications*. New York: Guilford Press.
13. Strickland, D., & Chartier, D. (1997). EEG measurements in a virtual reality headset. *Presence*, 6(5):581–589.
14. Rachman, S., & Hodgson, R. (1974). Synchrony and desynchrony in fear and avoidance. *Behavior Research and Therapy*, 12:311–318.
15. Wiederhold, B.K., Miller, S., Gronskaya-Palesh, O., Lemke, J., & Wiederhold, M.D. (2000). Physiological responses to virtual environments. In *Proceedings of the Medicine Meets Virtual Reality 2000 Conference*, Newport Beach, California.
16. Wiederhold, B.K., Kaneda, M., Lurie, Y.M., Cabral, I., May, T., & Wiederhold, M.D. (2000). The use of physiological monitoring to determine the concepts of presence and immersion in virtual worlds. In *Proceedings of the Association for Applied Psychophysiology and Biofeedback Conference*. Denver, Colorado.
17. Wiederhold, B.K., Davis, R., & Wiederhold, M.D. (1998). The effects of immersiveness on physiology. In Riva, G., Wiederhold, B.K., & Molinari, E. (eds.) *Virtual environments in clinical psychology and neuroscience: Methods and techniques in advanced patient-therapist interaction*. Amsterdam: IOS Press, pp. 52–60.
18. Wiederhold, B.K. (1999). Comparison of imaginal exposure therapy and virtual reality exposure therapy in the treatment of fear of flying. An unpublished dissertation.
19. Wiederhold, B.K., Bosman, J., Estanol, L., & Wiederhold, M.D. (2000). The effects of visual input on EEG monitoring in a virtual environment. In *Proceedings of the Medicine Meets Virtual Reality 2000 Conference*, Newport Beach, California.

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1. Stuart J. Barnes, Jan Mattsson, Nicole Hartley. 2015. Assessing the value of real-life brands in Virtual Worlds. *Technological Forecasting and Social Change* **92**, 12-24. [CrossRef]
2. Laura Aymerich-Franch, RenÃ© F. Kizilcec, Jeremy N. Bailenson. 2014. The Relationship between Virtual Self Similarity and Social Anxiety. *Frontiers in Human Neuroscience* **8**. . [CrossRef]
3. Philip Grewe, Agnes Kohsik, David Flentge, Eugen Dyck, Mario Botsch, York Winter, Hans J Markowitsch, Christian G Bien, Martina Piefke. 2013. Learning real-life cognitive abilities in a novel 360°-virtual reality supermarket: a neuropsychological study of healthy participants and patients with epilepsy. *Journal of NeuroEngineering and Rehabilitation* **10**, 42. [CrossRef]
4. Bonnie A. Clough, Leanne M. Casey. 2011. Technological adjuncts to enhance current psychotherapy practices: A review. *Clinical Psychology Review* **31**, 279-292. [CrossRef]
5. David Michaliszyn, André Marchand, Stéphane Bouchard, Marc-Olivier Martel, Joannie Poirier-Bisson. 2010. A Randomized, Controlled Clinical Trial of In Virtuo and In Vivo Exposure for Spider Phobia. *Cyberpsychology, Behavior, and Social Networking* **13**:6, 689-695. [Abstract] [Full Text HTML] [Full Text PDF] [Full Text PDF with Links]
6. Mike Rinck, Linda Kwakkenbos, Ron Dotsch, Daniël H. J. Wigboldus, Eni S. Becker. 2010. Attentional and behavioural responses of spider fearfuls to virtual spiders. *Cognition & Emotion* **24**, 1199-1206. [CrossRef]
7. Brenda K. Wiederhold. 2010. Psychology Should Emulate Physics. *Cyberpsychology, Behavior, and Social Networking* **13**:3, 239-240. [Citation] [Full Text HTML] [Full Text PDF] [Full Text PDF with Links]
8. M Munih, D Novak, J Ziherl, A Olenšek, J Podobnik, T Bajd, M MiheljRobotic rehabilitation tasks and measurements of psychophysiological responses 4360-4365. [CrossRef]
9. Dennis Patrick Wood, Brenda K. Wiederhold, James Spira. 2010. Lessons Learned from 350 Virtual-Reality Sessions with Warriors Diagnosed with Combat-Related Posttraumatic Stress Disorder. *Cyberpsychology, Behavior, and Social Networking* **13**:1, 3-11. [Abstract] [Full Text HTML] [Full Text PDF] [Full Text PDF with Links]
10. Brenda K Wiederhold, Mark D Wiederhold. 2010. Virtual Reality Treatment of Posttraumatic Stress Disorder Due to Motor Vehicle Accident. *Cyberpsychology, Behavior, and Social Networking* **13**:1, 21-27. [Abstract] [Full Text HTML] [Full Text PDF] [Full Text PDF with Links]
11. 2009. Abstracts from CyberTherapy 14Designing the Future of Healthcare, June 21–23, 2009, Lago Maggiore, Verbania, Italy. *CyberPsychology & Behavior* **12**:5, 581-673. [Citation] [Full Text PDF] [Full Text PDF with Links]
12. Matjaz Mihelj, Domen Novak, Marko MunihEmotion-aware system for upper extremity rehabilitation 160-165. [CrossRef]
13. M. Munih, R. Riener, G. Colombo, L. Lunenburger, F. Muller, M. Slater, M. MiheljMIMICS: Multimodal immersive motion rehabilitation of upper and lower extremities by exploiting biocooperation principles 127-132. [CrossRef]
14. M. Munih, D. Novak, T. Bajd, M. MiheljBiocooperation in rehabilitation robotics of upper extremities 425-430. [CrossRef]
15. Jeffrey M. Pyne, Richard Gevirtz. 2009. Psychophysiologic Assessment and Combat Post Traumatic Stress Disorder. *Biofeedback* **37**, 18-23. [CrossRef]
16. Corinne G.C. Horlings, Mark G. Carpenter, Ursula M. Küng, Flurin Honegger, Brenda Wiederhold, John H.J. Allum. 2009. Influence of virtual reality on postural stability during movements of quiet stance. *Neuroscience Letters* **451**, 227-231. [CrossRef]
17. Brenda K. Wiederhold, Mark D. Wiederhold. 2008. Virtual reality with fMRI: a breakthrough cognitive treatment tool. *Virtual Reality* **12**, 259-267. [CrossRef]

18. Matthew M. Young, Michael J. A. Wohl, Kimberly Matheson, Steve Baumann, Hymie Anisman. 2008. The Desire to Gamble: The Influence of Outcomes on the Priming Effects of a Gambling Episode. *Journal of Gambling Studies* **24**, 275-293. [CrossRef]
19. T PARSONS, A RIZZO. 2008. Affective outcomes of virtual reality exposure therapy for anxiety and specific phobias: A meta-analysis. *Journal of Behavior Therapy and Experimental Psychiatry* **39**, 250-261. [CrossRef]
20. Mary F. Macedonio, Thomas D. Parsons, Raymond A. Digiuseppe, Brenda A. Weiderhold, Albert A. Rizzo. 2007. Immersiveness and Physiological Arousal within Panoramic Video-Based Virtual Reality. *CyberPsychology & Behavior* **10**:4, 508-515. [Abstract] [Full Text PDF] [Full Text PDF with Links]
21. Peter M. Monti, James MacKillopAdvances in the treatment of craving for alcohol and tobacco 211-237. [CrossRef]
22. Stéphane Bouchard, Sophie Côté, David C.S. RichardVirtual reality applications for exposure 347-388. [CrossRef]
23. Matthew Price, Page Anderson. 2007. The role of presence in virtual reality exposure therapy. *Journal of Anxiety Disorders* **21**, 742-751. [CrossRef]
24. M. Carmen Juan, Rosa Baños, Cristina Botella, David Pérez, Mariano Alcaníiz, Carlos Monserrat. 2006. An Augmented Reality System for the Treatment of Acrophobia: The Sense of Presence Using Immersive Photography. *Presence: Teleoperators and Virtual Environments* **15**, 393-402. [CrossRef]
25. 2005. Commentary on Riva, G., Virtual Reality in Psychotherapy: Review. *CyberPsychology & Behavior* **8**:3, 231-240. [Citation] [Full Text PDF] [Full Text PDF with Links]
26. Sing-Fai Tam, David Wai-Kwong Man, Yuk-Piu Chan, Pan-Ching Sze, Chi-Ming Wong. 2005. Evaluation of a Computer-Assisted, 2-D Virtual Reality System for Training People With Intellectual Disabilities on How to Shop. *Rehabilitation Psychology* **50**, 285-291. [CrossRef]
27. Jen K.Y. Wu, Wing W.S. Suen, Tony M.F. Ho, Billy K.H. Yeung, Alan S.F. Tam. 2005. Effectiveness of two dimensional virtual reality programme and computer-assisted instructional programme in training Mass Transit Railway (MTR) skills for persons with mental handicap: A pilot study. *Hong Kong Journal of Occupational Therapy* **15**, 8-15. [CrossRef]
28. M Krijn, P.M.G Emmelkamp, R.P Olafsson, R Biemond. 2004. Virtual reality exposure therapy of anxiety disorders: A review. *Clinical Psychology Review* **24**, 259-281. [CrossRef]
29. Kate Cavanagh, David A. Shapiro. 2004. Computer treatment for common mental health problems. *Journal of Clinical Psychology* **60**:10.1002/jclp.v60:3, 239-251. [CrossRef]
30. Merel Krijn, Paul M.G Emmelkamp, Roeline Biemond, Claudius de Wilde de Ligny, Martijn J Schuemie, Charles A.P.G van der Mast. 2004. Treatment of acrophobia in virtual reality: The role of immersion and presence. *Behaviour Research and Therapy* **42**, 229-239. [CrossRef]
31. Anja Rutten, Sue Cobb, Helen Neale, Steven Kerr, Anne Leonard, Sarah Parsons, Peter Mitchell. 2003. The AS interactive project: single-user and collaborative virtual environments for people with high-functioning autistic spectrum disorders. *The Journal of Visualization and Computer Animation* **14**:10.1002/vis.v14:5, 233-241. [CrossRef]
32. Stephen Baumann, Chris Neff, Scott Fetzick, Gregg Stangl, Lee Basler, Ray Vereneck, Walter Schneider. 2003. A Virtual Reality System for Neurobehavioral and Functional MRI Studies. *CyberPsychology & Behavior* **6**:3, 259-266. [Abstract] [Full Text PDF] [Full Text PDF with Links]
33. Robert L. Glueckauf, Treven C. Pickett, Timothy U. Ketterson, Jeffrey S. Loomis, Ronald H. Rozensky. 2003. Preparation for the delivery of telehealth services: A self-study framework for expansion of practice. *Professional Psychology: Research and Practice* **34**, 159-163. [CrossRef]
34. Thomas G. Plante, Arianna Aldridge, Denise Su, Ryan Bogdan, Martha Belo, Kamran Kahn. 2003. Does Virtual Reality Enhance the Management of Stress When Paired With Exercise? An Exploratory Study. *International Journal of Stress Management* **10**, 203-216. [CrossRef]

35. Ivan L. Beale. 2002. An Evaluation Model for Psychoeducational Interventions Using Interactive Multimedia. *CyberPsychology & Behavior* **5**:6, 565-580. [Abstract] [Full Text PDF] [Full Text PDF with Links]

36. B.K. Wiederhold, D.P. Jang, R.G. Gevirtz, S.I. Kim, I.Y. Kim, M.D. Wiederhold. 2002. The treatment of fear of flying: a controlled study of imaginal and virtual reality graded exposure therapy. *IEEE Transactions on Information Technology in Biomedicine* **6**, 218-223. [CrossRef]

37. Keely Moore, Brenda K. Wiederhold, Mark D. Wiederhold, Giuseppe Riva. 2002. Panic and Agoraphobia in a Virtual World. *CyberPsychology & Behavior* **5**:3, 197-202. [Abstract] [Full Text PDF] [Full Text PDF with Links]

38. Luigi Pugnetti, Michael Meehan, Laura Mendozzi. 2001. Psychophysiological Correlates of Virtual Reality: A Review. *Presence: Teleoperators and Virtual Environments* **10**, 384-400. [CrossRef]