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A Review of Virtual Reality as a Psychotherapeutic Tool

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ABSTRACT

Simulations of reality have been used for over 30 years by the military for training and performance evaluations in a variety of tasks. Expensive and sophisticated systems today are used for training and certification of both commercial and military airline pilots. The interest in virtual reality by the entertainment industry has helped the emergence and development of low-cost virtual reality systems for use by the general public. Because of the unique nature of virtual environments, many investigators have begun to ask questions concerning the use of virtual environments for medical applications. Advanced simulators for surgical training are one example of a well-developed application using virtual reality techniques. In this article, we review the literature and explore the possibility of using virtual reality as a psychotherapeutic tool. Initial studies treating simple phobias with virtual reality techniques are described. Issues relating to potential applications and possible side effects, as well as clinical outcomes and cost effectiveness, are also discussed.

THE VERY NATURE OF VIRTUAL REALITY suggests a variety of interesting tools and approaches that can be used to understand human emotional response and the psyche. The ability to control an artificial environment and then introduce a predetermined set of stimuli or challenges can in theory parallel the standard model of office-based psychotherapy. The additional capabilities that are inherent in virtual worlds can lead to greater creativity and flexibility in the exploration and greater understanding of a patient's individual problems, concerns, and underlying health-related issues. Before this approach can be widely used, however, several important issues must be addressed, and a greater understanding of the effects of virtual worlds on "normal" individuals must be determined. Nonetheless, several important and interesting studies have already been completed that demonstrate successful use of virtual reality for the treatment of simple phobias.[1–9]

Driven primarily by the entertainment industry, low-cost virtual-reality simulators have resulted in wide exposure of the general population to virtual worlds. Although some short-term side effects such as "simulator sickness" are being recognized, the long-term potential effects are largely unknown.[10–14]

In this article, we explore the results of initial studies that have demonstrated both physical and psychological effects secondary to exposure to simulated environments. Before virtual reality can be widely used as a new therapeutic modality, any unforeseen or possible long-term negative effects must be factored in to any decisions impacting on clinical use.

VIRTUAL-REALITY TREATMENT OF ANXIETY DISORDERS

Simple phobias

Several studies have been conducted using virtual-reality graded-exposure therapy (VR-

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GET) to treat simple phobias. These include treatment of acrophobia (fear of heights), fear of flying, fear of driving, and fear of spiders.

Fear of heights. Recent full-immersion virtual-reality studies done with subjects who suffered from acrophobia have produced impressive results.[1,6,7] Historically, behavioral treatment of acrophobia has included some form of exposure-based therapy—either systematic desensitization (whereby imaginal exposure, i.e., the subject visualizes the feared height situations, and relaxation are combined) or in vivo exposure (where the subject is actually exposed to real height situations). In that imaginal exposure has not been shown to work as well as in vivo exposure for the treatment of acrophobia and in vivo exposure requires actually leaving the therapist's office (running the risk of loss of confidentiality and leading to added cost and time for therapy), it was suggested that virtual reality might be a viable alternative, giving both the therapist and the patient more control over the graded-exposure therapy and stimuli presented in the course of treatment. It was also proposed that virtual reality would reduce the cost and time needed for therapy.

In a case study using virtual treatment for fear of heights, a subject was given an acrophobia questionnaire to ascertain whether he met the *Diagnostic and Statistical Manual of Mental Disorders* (3rd ed., rev.; *DSM-III-R*) criteria for acrophobia. He was also given a behavioral avoidance test, pre- and posttreatment, and rated his subjective units of discomfort (SUDs) while ascending in a virtual glass elevator.

Virtual-reality graded exposure was conducted twice a week for 3 weeks (for a total of five sessions, each 35–45 min in length). The subject's scores at posttreatment showed a significant reduction in anxiety, avoidance, and distress. Obviously, because this is a case report, it lacks generalizability, but given the results, it does lend itself to further investigation.[7]

A controlled study involving 17 undergraduate students further supported the effectiveness of virtual-reality therapy in the treatment of acrophobia. Three virtual height situations (a glass elevator, a series of bridges with varying heights and degrees of stability, and a series of balconies with varying heights) were used for the experiment. Subjects were given a screening questionnaire to ascertain whether they fit the criteria for a simple phobia as described in the *DSM-III-R*. If they met the criteria, they were then given an acrophobia questionnaire with scales measuring anxiety and avoidance. The questionnaire by Cohen has been shown to discriminate between phobic and nonphobic persons. An attitude-toward-heights questionnaire and a fear questionnaire were also administered. During therapy sessions, the SUDs were used. The subjects were divided into two groups, one receiving the treatment just described and a wait-list control group. Both groups took the pretreatment assessment tests. The control group also took the same assessments 7 weeks later. The treatment group received 35- to 45-min sessions weekly for 7 weeks. Subjects were exposed to height situations according to the hierarchy of distressing height situations each subject completed at pretreatment assessment. The therapist monitored each subject's exposure on a video monitor and could inquire as to how the subject was feeling while in the virtual environment. SUDs ratings were taken every 5 min during the therapy session to determine if the virtual environment was actually evoking a feeling of presence in an actual height situation. At posttreatment, subjective ratings of fear, anxiety, and avoidance had decreased significantly for the treatment group but had remained virtually unchanged for the control group. Some of those in the treatment group even exposed themselves to real-world height situations, even though they were not required to do so. This seems to show that training in the virtual world does carry over to the real world. Exposure therapy using a virtual environment provides a safe, confidential setting in which to become desensitized to one's fears and phobias. Successful results occurred at a much faster rate than with traditional exposure therapy and desensitization.[1,6] In today's environment of managed care and cost-cutting measures, treatments that are reliable and also more cost effective should attract significant interest.

These studies relied on the individual's subjective feelings of distress. It would be inter-

esting to begin quantitative, objective measures of stress responses such as heart rate, blood pressure, or blood levels of epinephrine or cortisol. The ability to obtain objective measurements in real time, correlated to the virtual-reality experience, would also give useful data on psychophysiological aspects of therapy.

Fear of flying. The *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*) classifies fear of flying as a specific phobia, situational subtype, which is included in the larger classification of anxiety disorders.[15] The *DSM-IV* lists lifetime prevalence rates for specific phobias as 10%–11.3%, with other surveys estimating that fear of flying exists in 10%–20% of the population. Persons with fear of flying as a specific phobia fear crashing, whereas those who develop fear of flying as part of agoraphobia fear having a panic attack while on an airplane.[15,16]

There have been two case studies reported in the literature indicating that VRGET can be used as an alternative treatment for fear of flying.[2,4,5,8,9] In the first study, an individual who had become increasingly fearful of flying and had not flown at all for 2 years due to her fear was first given seven sessions of anxiety management techniques and then given six sessions of VRGET. The virtual-flight scenarios included a fixed-wing aircraft that performed a sequence of events including sitting at the runway, taxiing, taking off, flying at altitude, and landing. After completion of the VRGET, the subject was able to complete an actual flight with her family and reported less fear upon exposure.[2,8,9]

The second study involved an individual who had previously received VRGET for his fear of heights. The individual received five exposure sessions in a virtual helicopter, accompanied by a virtual therapist. The subject's SUDs ratings decreased over the course of treatment, indicating a reduction in fear. Long-term follow-up is pending in this case report.[4,5]

Fear of spiders. Carlin, Hoffman, and Weghorst conducted a case study to determine the effectiveness of VRGET in the treatment of fear of spiders.[3] The subject treated had battled a fear of spiders for 20 years. She was first given therapy sessions to discuss the nature of her anxiety and help reconceptualize her anxiety as a conditioned response capable of being modified. After initial therapy, several exposure sessions followed in which she viewed photographs of spiders and plastic replicas of spiders. Then the subject received twelve 50-min VRGET sessions, which included touching a replica of a spider while actually interacting with a virtual spider. After completion of therapy, the subject was able to go camping (an activity she had not done for 16 years due to her fear of spiders), and she killed a spider found in her home (although not specifically instructed by the researchers to do so).[3]

Fear of driving. A study to treat fear of driving is currently being conducted by Berger and his colleagues. This study will treat one group with VRGET and one group with conventional exposure therapy.[17] The lifetime prevalence rate for a Simple Phobia as reported by the *DSM-IV* is between 10% and 11.3%. The lifetime prevalence rate for agoraphobia is between 1.5% and 3.5%. Because a fear of driving may be present alone as a specific phobia, or may be part of agoraphobic symptoms, this treatment has the potential to help in the treatment of a large number of individuals.[15]

OTHER ANXIETY DISORDERS

VRGET is also being explored for other anxiety disorders such as agoraphobia, social phobia (with emphasis on fear of public speaking), posttraumatic stress disorder (PTSD), and obsessive-compulsive disorder. In those disorders where drug therapy is available, it would be useful to consider a pharmacological arm of the study.[5,18–20]

PTSD. Some 15% to 25% of survivors of traumatic events suffer symptoms associated with chronic PTSD.[21] Of Vietnam veterans, 450,000 (15%) meet the *DSM-IV* criteria for PTSD at 15 years post-Vietnam.[22] Because of its varied symptomatology and resistance to treatment, many treatment modalities have been investigated. In a review of treatment modalities for PTSD, it was shown that most studies have used some form of exposure therapy to treat PTSD and that partial improvement has occurred in most cases.[21]

Virtual reality has also been investigated for use in those suffering from PTSD. Because ex-

posure-based therapy has been proven to work with PTSD, by interspersing pleasant scenes in a virtual environment, one could more easily provide the patient with a tool to work through the trauma more slowly.[18]

In a 1983 study, Vietnam veterans suffering from PTSD were compared to veterans not suffering from PTSD and to veterans suffering from other psychological disorders. The three groups were assessed on behavioral, physiological, and self-report measures. It was found that the group suffering from PTSD differed from the other two groups when exposed to audiovisual stimuli of a combat nature but not when exposed to a neutral audiovisual stimuli. They displayed a greater increase in heart rate, a greater avoidance response (wanting to terminate the stimuli as evidenced by pressing a button), and greater self-report levels of anxiety and fear than did the other two groups.[23]

By having physiological feedback available in the virtual world via noninvasive sensors, the computer or therapist could know exactly when to switch off the traumatic scene and avoid causing the patient too much distress. Currently the therapist must rely on the patient's subjective feelings (and the therapist's perception of these feelings) to guide the length of therapy and exposure.

A group headed by Hodges and Rothbaum has just begun work on treating PTSD with virtual-reality exposure therapy. The study will include Vietnam veterans at the Veteran's Administration Hospital in Atlanta. Because of the varied symptoms suffered by veterans experiencing PTSD, this study will serve to stretch the limits of current virtual-reality technology.[20]

Agoraphobia. According to the *DSM-IV*, agoraphobia involves "anxiety about being in places or situations from which escape might be difficult (or embarrassing) or in which help may not be available in the event of having an unexpected or situationally predisposed Panic Attack or panic-like symptoms." Because of this anxiety, the person with agoraphobia may become avoidant of certain situations or will endure those situations with much distress.[15]

In an interesting study, 30 undergraduate students with agoraphobia were treated with VRGET. Inclusion in the study was based on meeting minimum criteria of agoraphobia by completion of a questionnaire. Subjects were treated with eight 15-min sessions consisting of exposure to eight different virtual scenes: balconies, an empty room, a dark barn, a dark barn with a black cat, a covered bridge, an elevator, a canyon with a series of bridges, and a series of hot-air balloons at different heights. No attempt was made to customize or individualize scenes for each participant. After completion of the VRGET, 24 subjects experienced a decrease in both SUDs scores and scores on an agoraphobia questionnaire. Because the specific fears individuals may have can include diverse subject matter, one can see the inherent advantage and flexibility of using a virtual-reality world for desensitization. It appears that VRGET may be useful in treating this disorder; however, quantitative measures of physiology and long-term follow-up should be used to help refine future studies.[5]

Social phobia

In a preliminary report, a group at Clark Atlanta University has used virtual reality to treat subjects with a fear of public speaking. Subjects were placed in front of a virtual audience and experienced many of the same symptoms as subjects do when in front of a real audience, such as a dry mouth, increased heart rate, and sweaty palms. A SUDs scale and an Attitude Toward Public Speaking questionnaire were used to assess anxiety. Self-reported anxiety decreased after treatment.[19] Studies are also underway by the group at Clark Atlanta University to test the effectiveness of virtual reality in the treatment of obsessive-compulsive disorder.[5]

OTHER APPLICATION AREAS

Eating disorders

In addition to work with anxiety disorders, work has been done in the application of virtual-reality technologies to other psychological disorders such as eating disorders, including anorexia nervosa, bulimia nervosa, and obesity.

The Virtual Environment for Body Image Modification (VEBIM) is a system being devel-

oped in Italy by Riva and his associates to treat body dissatisfaction and body-image disturbances that may be present in eating disorders. The two most commonly used methods of treatment for eating disorders are cognitive-behavioral therapy and visuaomotor therapy. The VEBIM system seeks to incorporate both methods to offer a more effective treatment system. The system consists of a set of "zones" the subject can pass through after performing certain tasks. Some zones give the subject the opportunity to "eat" and some zones require that the subject weight himself or herself before exiting to the next zone. The subject's real body is digitized into the virtual-reality world, and the subject can view this body while in the virtual world and also create an image of his or her ideal body by using a morphing system. Finally, the subject must choose among various-sized doors, one of which corresponds to the subject's real body size, before being allowed to exit to the final zone.

The system has been tested on a nonclinical sample of 71 subjects to determine what effects the virtual-reality system would have on blood pressure, heart rate, and body image. Subjects were given one 8- to 10-min virtual-reality session and were asked to pass through different zones. Blood pressure and heart rate measurements were taken before the virtual experience, immediately after treatment, and then again 10 min posttreatment. Prior to treatment, subjects were asked to complete body experience scales that seek information on the subjects' perception of current body size and ideal size. After the virtual-reality session, subjects' scores showed a reduction in body dissatisfaction and a smaller discrepancy between ideal and actual body image. There was no significant change between blood pressure and heart rate measurements before treatment, immediately after treatment, or 10 min posttreatment.[24]

Issues related to body image are very common in the United States, with the prevalence for anorexia reported at 0.5% to 1%, bulimia at 1% to 3%, and obesity at 25% (34 million Americans).[15,25] Although comprising the smallest group, those suffering from anorexia have the worst prognosis, with 10%–20% progressing to severe morbidity or morality. Virtual-reality therapy promises to offer an alternate treatment approach for this difficult clinical problem.[26]

Social skills training

In a 1994 article by Muscott and Gifford, it was proposed that virtual reality be used to enhance social skills training for children and youth.[27] Currently social skills training programs involve such techniques as behavior modeling and directive teaching strategies. Although it is recognized that prosocial skills are learned by students involved in such programs, it is also widely acknowledged that behaviors fail to transfer to natural environments, such as the playground, classroom, and community. It is thought that virtual reality would allow for more transfer of learning due to its immersive quality that allows the user to experience a sense of presence. It would also allow more flexibility in teaching social skills due to such advantages as visualization, multiple users, scaling, and active problem-solving capacity. Students could test their skills in the virtual world by reacting to scenarios and having the virtual world change depending on their actions. This would teach the child how different behavioral choices may result in different consequences. Scaling could allow a student's size to be enlarged or made smaller to convince him or her that fighting may be unnecessary.[27]

In a related article, access to advanced technology such as television, video, and other multimedia was offered as an explanation for increasing improvement on standard intelligence tests over the past 50 years. Contrary to popular belief, advanced and possible immersive multimedia technology may actually confer an advantage in learning.[28]

ADVANTAGES OF VIRTUAL ENVIRONMENTS

The virtual environment is very nonjudgmental, and a person may find it much less threatening than the real world. Moving in the direction of the "virtual therapist," a software program called the Therapeutic Learning Program (TLP) was developed by Gould, a psychiatrist at UCLA. It is a self-administered com-

puterized psychotherapy program that is completed in 10 sessions. One recent study divided 100 patients with depression and anxiety into a treatment group (TLP) and a control group using random assignment procedures. Pre- and posttreatment measures were performed to ascertain severity of depression and anxiety.

The study found that both groups had significant improvement at the end of treatment and at a 6-month follow-up evaluation. The TLP group was given the new computer-generated 10-session treatment and included a 10- to 15-min interaction after each session with a therapist to clarify information and answer questions. Therapeutic conversations were strictly avoided. The control group was given 10 hr of standard therapy (10 sessions) with a psychologist.

In that both groups demonstrated similar improvement at follow-up, the use of computer-generated programs may augment the standard practice of psychotherapy. This study has helped to fuel speculation of delivery of psychological services over the Internet. Low-cost interactive video including use of a customized "video therapy room" may have future application in the delivery of mental health services. The ability to utilize a therapist's time more effectively could improve efficiency and reduce costs. Reducing the cost of psychotherapy would help to make it available to a wider range of patients.[29]

PRECAUTIONS OF VIRTUAL ENVIRONMENT USE

Virtual-reality techniques may not be applicable to all psychological disorders or to all patients. It has been suggested that because schizophrenics suffer from a detachment from reality, placing them in virtual worlds for therapy, then exposing them back to reality, could actually increase their level of confusion.[30] For those who suffer from claustrophobia, the confinement of a head-mounted display may actually increase their symptoms. Those who suffer from agoraphobia may experience anxiety at viewing a virtual world with infinite horizons. Prescreening of patients may be necessary to determine those individuals who are at increased risk to adverse events in virtual systems.

In light of the recent debate over "implanted memories," the possibility that a virtual experience may become ingrained in one's memory and be indistinguishable from a real experience is possible. During exposure therapy to desensitize an individual who has been traumatized, care must be taken to avoid adding additional traumatic memories.[3] Others who may be at risk are drug abusers or others with addictive personalities, those with various other mental illnesses, and those who are emotionally unstable.[30]

In a virtual world, there is deliberate manipulation of a person's senses and the possibility for disembodiment, gender swapping, multiple identities, and parallel communications. If someone were dissatisified with their current reality, they may prefer this new virtual reality to real life, causing social alienation and loneliness.[30] As technology continues to improve, the quality and believability of virtual worlds will continue to increase. Could the virtual world become indistinguishable from the real world? If this were the case, there would be no distinction between fantasy and reality. The consequences of this situation are unknown at this time but raise significant questions for discussion.

The risk of becoming more socially isolated also is possible with virtual reality. Will our sense of community and neighborhood diminish? Without direct human interaction, will rudeness, violence, or other negative consequences occur? If we are able to have virtual sex, interact with other persons in cyberspace, and use our modem to communicate with our office, will normal societal interaction as we known it cease? These are interesting questions that can provoke discussion and further investigation.[31] In addition, a variety of physical problems can occur in virtual environments. These problems include simulator sickness, eyestrain, flashbacks, tendonitis, and possible addiction.[10–14,32–34]

CONCLUSION

Virtual-reality techniques will provide many novel avenues for the evaluation and treatment

of psychological conditions. Several studies have already shown benefit in the treatment of simple phobias. This improvement in symptoms was shown to exist 6 months posttreatment.[6] It is clear, however, that some issues and concerns must be addressed before widespread implementation of virtual therapy becomes commonplace. It is not clear, for example, that all individuals will be able to relate or function in a virtual environment. Because the virtual world is so enveloping, it is not clear how to provide patients with a predictable means of escape or some other methodology in which the patient can maintain control of the session and environment. (One could always, however, remove the headset.)

An interesting approach is provided by the Virtual I/O multimedia company. In this virtual world, if the patient looks to the far right or far left, a video screen can be viewed. During therapy, the patient could either view a pleasant scene or a real-time video image of the therapist if connection to "real reality" is desired. (This of course begs the existential question of what is reality.) Another issue is allowing the patient to construct the virtual world, inviting the therapist into the virtual world to experience what the patient thinks is important. This process could redefine the nature of the doctor–patient interaction. It would be interesting to speculate on how nonverbal information and cues could be enhanced in virtual space in a way that gives more meaningful information to both the patient and the therapist. It is hoped that the virtual world will provide an extension of established psychotherapeutic techniques and assist in the generation of new approaches for both evaluation and treatment.

REFERENCES

1. Hodges, L.F., Kooper, R., Rothbaum, B.O., Opdyke, D., de Graaff, J.J., Williford, J.S., & North, M.M. (1995). Virtual environments for treating the fear of heights. *Computer Innovative Technology for Computer Professionals, 28*(7), 27–34.
2. Hodges, L.F., Rothbaum, B.O., Watson, B.A., Kessler, G.D., & Opdyke, D. (1996). Virtually conquering fear of flying. *IEEE Computer Graphics & Applications, 16*(6), 42–49.
3. Carlin, A.S., Hoffman, H.G., & Weghorst, S. (1997). Virtual reality and tactile augmentation in the treatment of spider phobia: A case report. *Behavioral Research Therapy, 35*(2), 153–158.
4. North, M.M., North, S.M., & Coble, J.R. (1996). Virtual environments psychotherapy: A case study of fear of flying disorder. *Presence, 6*(1), 127–132.
5. North, M.M., North, S.M., & Coble, J.R. (1996). *Virtual reality therapy.* Colorado Springs: IPI Press.
6. Rothbaum, B.O., Hodges, L.F., Kooper, R., Opdyke, D., Williford, J.S., & North, M. (1995). Effectiveness of computer-generated (virtual reality) graded exposure in the treatment of acrophobia. *American Journal of Psychiatry, 152,* 626–628.
7. Rothbaum, B.O., Hodges, L.F., Kooper, R., Opdyke, D., Williford, J.S., North, M. (1995). Virtual reality graded exposure in the treatment of acrophobia: A case report. *Behavior Therapy, 26,* 547–554.
8. Rothbaum, B.O., Hodges, L., Watson, B.A., Kessler, G.D., & Opdyke, D. (1996). Virtual reality exposure therapy in the treatment of fear of flying: A Case report. *Behavioral Research Therapy, 34*(5/6), 477–481.
9. Rothbaum, B.O., Hodges, L., & Kooper, R. (1997). Virtual reality exposure therapy. *Journal of Psychotherapy Practice and Research, 6*(3), 291–296.
10. Regan, E.C., & Price, K.R. (1994). The frequency of occurrence and severity of side-effects of immersion virtual reality. *Aviation, Space, and Environmental Medicine, 65*(6), 527–530.
11. Baltzley, D.R., Kennedy, R.S., Berbaum, K.S., & Lilienthal, M.G. (1989). The time course of postflight simulator sickness symptoms. *Aviation, Space, and Environmental Medicine, 60*(11), 1043–1048.
12. Viirre, E. (1994, July–August). A survey of medical issues and virtual reality technology. *Virtual Reality World,* pp. 16–20.
13. Johnston, R. (1995, May–June). Losing everything to VR: Simulator sickness. *Virtual Reality Special Report,* pp. 25–28.
14. Mon-Williams, M., Wann, J.P., & Rushton, S. (1993). Binocular vision in a virtual world: Visual deficits following the wearing of a head-mounted display. *Ophthalmic and Physiological Optics, 13*(4), 387–391.
15. American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.
16. Agras, S., Sylvester, D., & Oliveau, D. (1969). The epidemiology of common fears and phobias. *Comprehensive Psychiatry, 10,* 151–156.
17. Glantz, K., Durlach, N.I., Barnett, R.C., & Aviles, W.A. (1997). Virtual reality (VR) and psychotherapy: Opportunities and challenges. *Presence, 6*(1), 87–105.
18. Henderson, J.V. (1991, Summer). "Virtual realities" as instructional technology. *Journal of Interactive Instruction Development,* pp. 24–30.
19. Virtual reality combats fear of public speaking. (1997, July). *Real Time Graphics,* p. S1.
20. Salyer, S. (1997, July 18–20). The dawn of "virtual therapy." *USA Weekend,* p. 10.
21. Shalev, A.Y., Bonne, O., & Eth, S. (1996). Treatment

of posttraumatic stress disorder: A review. *Psychosomatic Medicine, 58,* 165–182.
22. Kizer, K.W. (1996). Progress on posttraumatic stress disorder. *Journal of the American Medical Association, 275*(15), 1149.
23. Malloy, P.F., Fairbank, J.A., & Keane, T.M. (1983). Validation of a multimethod assessment of posttraumatic stress disorders in Vietnam veterans. *Journal of Consulting and Clinical Psychology, 51,* 488–494.
24. Riva, G. (1997). The virtual environment for body-image modification (VEBIM): Development and preliminary evaluation. *Presence, 6*(1), 106–117.
25. Kuczmarski, R.J. (1992). Prevalence of overweight and weight gain in the United States. *American Journal of Clinical Nutrition, 55,* 495S–502S.
26. Hsu, G., & Crisp, A. (1979). Outcome of anorexia nervosa. *Lancet, 1,* 61–65.
27. Muscott, H.S., & Gifford, T. (1994). Virtual reality and social skills training for students with behavioral disorders: Applications, challenges and promising practices. *Education and Treatment of Children, 17*(3), 417–434.
28. Neisser, U. (1997). Rising scores on intelligence tests. *American Scientist, 85,* 440–447.
29. Jacobs, M., Christensen, A., Huber, A., & Polterock, A. (1995, March). Computer-assisted individual therapy v. standard brief individual therapy. In M. Jacobs (Chair), *Computer-psychotherapy: Wave of the future?* Symposium conducted at the meeting of the Western Psychological Association, Los Angeles.
30. Cartwright, G.F. (1994, March–April). Virtual or real? The mind in cyberspace. *The Futurist,* pp. 22–26.
31. Romanyshyn, R.D. (1994, July–August). Dream body cyberspace. *Magical Blend,* pp. 59–64, 104.
32. Friedland, R.P., & St. John, J.N. (1984). Video-game palsy: Distal ulnar neuropathy in a video-game enthusiast. *New England Journal of Medicine, 311,* 58–59.
33. McCowan, T.C. (1981). Space-invaders wrist. *New England Journal of Medicine, 304,* 1368.
34. Reinstein, L. (1983). De Quervain's stenosing tenosynovitis in a video game's player. *Archives of Physical Medicine and Rehabilitaiton, 63,* 434–435.

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2. D. J.- F. de Quervain, D. Bentz, T. Michael, O. C. Bolt, B. K. Wiederhold, J. Margraf, F. H. Wilhelm. 2011. From the Cover: Glucocorticoids enhance extinction-based psychotherapy. *Proceedings of the National Academy of Sciences* **108**:16, 6621-6625. [CrossRef]
3. Michael FenichelOnline Behavior, Communication, and Experience 3-20. [CrossRef]
4. Olivier Christmann, Noëlle Carbonell, Simon Richir. 2010. Visual search in dynamic 3D visualisations of unstructured picture collections. *Interacting with Computers* **22**:5, 399-416. [CrossRef]
5. 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]
6. Cristina Botella, Azucena García-Palacios, Veronica Guillen, Rosa Maria Baños, Soledad Quero, Mariano Alcaniz. 2010. An Adaptive Display for the Treatment of Diverse Trauma PTSD Victims. *Cyberpsychology, Behavior, and Social Networking* **13**:1, 67-71. [Abstract] [Full Text HTML] [Full Text PDF] [Full Text PDF with Links]
7. Patrice L. Weiss, Heidi Sveistrup, Debbie Rand, Rachel Kizony. 2009. Video capture virtual reality: A decade of rehabilitation assessment and intervention. *Physical Therapy Reviews* **14**:5, 307-321. [CrossRef]
8. Alessandra Gorini, Giuseppe Riva. 2008. Virtual reality in anxiety disorders: the past and the future. *Expert Review of Neurotherapeutics* **8**:2, 215-233. [CrossRef]
9. Albert "Skip" Rizzo, Gerard Jounghyun Kim. 2005. A SWOT Analysis of the Field of Virtual Reality Rehabilitation and Therapy. *Presence: Teleoperators and Virtual Environments* **14**:2, 119-146. [CrossRef]
10. Albert Rizzo, Maria Schultheis, Kimberly Kerns, Catherine Mateer. 2004. Analysis of assets for virtual reality applications in neuropsychology. *Neuropsychological Rehabilitation* **14**:1, 207-239. [CrossRef]
11. Kalman Glanz, Albert (Skip) Rizzo, Ken Graap. 2003. Virtual reality for psychotherapy: Current reality and future possibilities. *Psychotherapy: Theory, Research, Practice, Training* **40**:1-2, 55-67. [CrossRef]
12. 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]
13. Sandra R. Harris, Robert L. Kemmerling, Max M. North. 2002. Brief Virtual Reality Therapy for Public Speaking Anxiety. *CyberPsychology & Behavior* **5**:6, 543-550. [Abstract] [Full Text PDF] [Full Text PDF with Links]
14. Michael Fenichel, John Suler, Azy Barak, Elizabeth Zelvin, Gill Jones, Kali Munro, Vagdevi Meunier, Willadene Walker-Schmucker. 2002. Myths and Realities of Online Clinical Work. *CyberPsychology & Behavior* **5**:5, 481-497. [Abstract] [Full Text PDF] [Full Text PDF with Links]
15. 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]
16. D. Perani, F. Fazio, N.A. Borghese, M. Tettamanti, S. Ferrari, J. Decety, M.C. Gilardi. 2001. Different Brain Correlates for Watching Real and Virtual Hand Actions. *NeuroImage* **14**:3, 749-758. [CrossRef]
17. Luigi Pugnetti, Michael Meehan, Laura Mendozzi. 2001. Psychophysiological Correlates of Virtual Reality: A Review. *Presence: Teleoperators and Virtual Environments* **10**:4, 384-400. [CrossRef]
18. Maria T. Schultheis, Albert A. Rizzo. 2001. The application of virtual reality technology in rehabilitation. *Rehabilitation Psychology* **46**:3, 296-311. [CrossRef]
19. Norman E. Alessi, Milton P. Huang. 2000. Evolution of the Virtual Human: From Term to Potential Application in Psychiatry. *CyberPsychology & Behavior* **3**:3, 321-326. [Abstract] [Full Text PDF] [Full Text PDF with Links]
20. John R. Suler. 2000. Psychotherapy in Cyberspace: A 5-Dimensional Model of Online and Computer-Mediated Psychotherapy. *CyberPsychology & Behavior* **3**:2, 151-159. [Abstract] [Full Text PDF] [Full Text PDF with Links]
21. JOAN McCOMAS, JAYNE PIVIK, MARC LAFLAMME. 1998. Children's Transfer of Spatial Learning from Virtual Reality to Real Environments. *CyberPsychology & Behavior* **1**:2, 121-128. [Abstract] [Full Text PDF] [Full Text PDF with Links]
22. 1998. General Reviews of Virtual Reality and Neuropsychology. *CyberPsychology & Behavior* **1**:4, 413-425. [Citation] [Full Text PDF] [Full Text PDF with Links]

23. ANNE PARENT, GUY THIBAULT. 1998. A Task Analysis Tool for the Creation of Psychotherapeutic Virtual Environments. *CyberPsychology & Behavior* **1**:3, 225-235. [Abstract] [Full Text PDF] [Full Text PDF with Links]