GIUSEPPE RIVA (Ed.)
*Virtual Reality in Neuro-Psycho-Physiology*


# Virtual Reality Therapy: An Effective Treatment for Psychological Disorders

Max M. North, Sarah M. North, and Joseph R. Coble
*Virtual Reality Technology Laboratory*
*Clark Atlanta University*
*Atlanta Georgia, 30314*

**Abstract**. Behavioral therapy techniques for treating phobias often includes graded exposure of the patient to anxiety-producing stimuli (Systematic Desensitization). However, in utilizing systematic desensitization, research reviews demonstrate that many patients appear to have difficulty imagining the prescribed anxiety-evoking scene. They also express strong aversion to experiencing real situations.

This chapter describes the Virtual Reality Therapy (VRT), a new therapeutical approach that can be used to overcome some of the difficulties inherent in the traditional treatment of phobias. VRT, like current imaginal and in vivo modalities, can generate stimuli that could be utilized in desensitization therapy. Like systematic desensitization therapy, VRT can provide stimuli for patients who have difficulty in imagining scenes and/or are too phobic to experience real situations. Unlike in vivo systematic desensitization, VRT can be performed within the privacy of a room, thus avoiding public embarrassment and violation of patient confidentiality. VRT can generate stimuli of much greater magnitude than standard in vivo techniques. Since VRT is under patient control, it appears safer than in vivo desensitization and at the same time more realistic than imaginal desensitization. Finally, VRT adds the advantage of greater efficiency and economy in delivering the equivalent of in vivo systematic desensitization within the therapist's office.

The chapter also describes how to use virtual reality in the treatment of specific phobias: fear of flying, fear of heights, fear of being in certain situations (such as a dark barn, an enclosed bridge over a river, and in the presence of an animal [a black cat] in a dark room), and fear of public speaking.

## 1. Introduction

Behavioral therapy techniques for treating phobias often includes graded exposure of the patient to anxiety-producing stimuli (Systematic Desensitization). These stimuli are commonly generated either through the patient's imagination or in vivo (patient experiences real situations). In utilizing systematic desensitization, research reviews demonstrate that many patients appear to have difficulty imagining the prescribed anxiety-evoking scene. They also express strong aversion to experiencing real situations. This avoidance may be a learned behavior that lowers the anxiety of clients, thus reducing their public embarrassment.

Virtual Reality Therapy (VRT) may be utilized to overcome some of the difficulties inherent in the traditional treatment of phobias. VRT, like current imaginal and in vivo modalities, can generate stimuli that could be utilized in desensitization therapy. Like systematic desensitization therapy, VRT can provide stimuli for patients who have difficulty in imagining scenes and/or are too phobic to experience real situations. Unlike in vivo systematic desensitization, VRT can be performed within the privacy of a room, thus avoiding public embarrassment and violation of patient confidentiality. VRT can generate stimuli of much greater magnitude than standard in vivo techniques. Since VRT is under patient control, it appears safer than in vivo desensitization and at the same time more realistic than imaginal desensitization. Finally, VRT adds the advantage of greater efficiency and economy in delivering the equivalent of in vivo systematic desensitization within the therapist's office.

As far as we know, the idea of using virtual reality technology to combat psychological disorders was first conceived within the Human-Computer Interaction Group at Clark Atlanta University on November 1992. Since then, we have successfully conducted the first known pilot experiments in the use of virtual reality technologies in the treatment of specific phobias: fear of flying [1,2,3,4], fear of heights [2,5,10], fear of being in certain situations (such as a dark barn, an enclosed bridge over a river, and in the presence of an animal [a black cat] in a dark room) [2,6,7,8], and fear of public speaking [2,9].

## 2. Fear of Flying Experiments

Two case studies were conducted to assess the effectiveness of VRT for treatment of the fear of flying. The first experiment was our first pilot study which was conducted in late November 1992. The subject was a 32-year-old married woman, a human-computer interaction group researcher, who was diagnosed and treated for fear of flying utilizing an existing virtual scene. The virtual scene was a simulated city running on a Silicon Graphics computer. This scene originally was created to conduct research on an innovative navigational techniques for virtual environments. The subject participated in eight sessions, each lasting about 30 minutes. The subject reported a high level of anxiety at the beginning of each session, gradually reported lower anxiety levels after remaining in the situation for a few minutes and eventually reported an anxiety level of zero. To investigate the transfer effect of VRT to the real world, she was flown with the therapist accompanying her on a helicopter for approximately 10 minutes at low altitude over a beach on the Gulf of Mexico. As with the VRT sessions, she reported some anxiety at the beginning, but anxiety rapidly reduced to a reasonably comfortable level. Now the subject much more comfortably flies for long distances and experiences much less anxiety [1,2,3,4].

The second case study also involved the use of VRT in the treatment of a subject who suffered from aerophobia. In September of 1995, a 42-year-old married man who conducts research at Clark Atlanta University sought treatment for the fear of flying. The subject's anxiety and avoidance behavior were interfering with his normal activities. For example, he was unable to travel to professional conferences, visit relatives or take a vacation by air. The subject, accompanied by a virtual therapist, was placed in the cockpit of a virtual environment helicopter and flown over a simulated city for five sessions. The modified 11-point (0 for complete calm and 10 for complete panic) Subjective Units of Discomfort (SUD) scales rating measured the degree to which the subject was affected by VRT. In virtual reality therapy the subject's anxiety usually increased as he was exposed to more

challenging situations and decreased as the time in those new situations was increased. The subject experienced a number of physical and emotional anxiety-related symptoms during the VRT sessions. These symptoms included sweaty palms, loss of balance, weakness in the knees, etc. The VRT resulted in both a significant reduction of anxiety symptoms and the ability to face the phobic situation in the real world. The subject at this time is able to fly to the different geographical locations in reasonable comfort [2,3,4].

## 3. Agoraphobia Experiment

This experiment, in which we conducted the first known controlled comprehensive study on the effectiveness of the virtual environments technology in the treatment of psychological disorders, commenced on February 1, 1993. Specifically, we assessed the effectiveness of virtual environments in the treatment of agoraphobia, the fear of being in places or situations from which escape may be difficult or embarrassing. Sixty subjects were selected for this study. Thirty were placed in the experimental group and thirty subjects were placed in the control group. Only subjects in the experimental group were exposed to the VRT. VRT was effective in the treatment of subjects with agoraphobia. Negative attitudes toward agoraphobic situations decreased significantly for the VRT group but not for the control group. The average SUD scores decreased steadily across sessions, indicating habituation. For a complete and detailed report of this study, readers may refer to the publication in the Virtual Reality Therapy Book [1], CyberEdge [7], International Journal of Virtual Reality [6], or PRESENCE, Teleoperators and virtual environments [8].

## 4. Acrophobia, fear of heights, Experiments

The first acrophobia study was conducted in collaboration with others [10,11]. The goal of this study was to investigate the efficacy of virtual reality graded exposure in the treatment of acrophobia (fear of heights). Twenty college students with acrophobia were randomly assigned to virtual reality graded exposure treatment or to a waiting-list comparison group. Sessions were conducted individually over 8 weeks. Outcome was assessed by using measures of anxiety, avoidance, attitudes, and distress associated with exposure to heights before and after treatment. Significant differences between the subjects who completed the virtual reality treatment and subjects in the waiting list were found on all measures.

Another case study also demonstrated the effectiveness of VRT in the treatment of acrophobia. After obtaining informed consent, the subject was asked to rank order a list of acrophobic situations according to the degree of anxiety arousal. During the subject's first session, he was familiarized with the virtual environment technology through several demonstrations. For the subject's subsequent eight sessions, which were between 15 and 28 minutes each, individual VRT treatment was conducted in a standard format. The first session began with the least threatening level which was at the ground level near a bridge crossing a river in the middle of a simulated town. The SUD was administered periodically

every two to five minutes. The progress was totally under the control of the subject, with the exception that if the subject's SUD score was zero, the experimenter urged the subject to move up to the next level of the scene. At one month after treatment, the subject was asked to complete a ten-point rating scale (including degrees for worsening symptoms) rating the degree to which his acrophobia symptoms had changed since a pre-treatment test (SUD). The results indicated significant habituation of the subject with respect to both anxiety symptoms and the avoidance of anxiety-producing situations. Thus, we concluded that the virtual reality treatment was successful in reducing the fear of heights [2,5].

## 5. Fear of Public Speaking Experiment

The fear of public speaking often referred to as "social phobia" is a common disorder which affects many people in the world. This is the first known controlled study of the effectiveness of VRT in the treatment of subjects who suffered from fear of public speaking.

Research into this widespread phobia was conducted through the collaboration of Clark Atlanta University (CAU), the U.S. Army Research Laboratory and Boeing Computer Services, with special technical assistance from the Speech Improvement Company, Inc. The research will have far reaching benefits. With the assistance of the Speech Improvement Company, the research will have a positive impact on the clinical sessions of subjects suffering from the fear of public speaking. Additionally, the general population will benefit from the virtual reality research because the new technology provides greater access to a safe, confidential and economical approach to the treatment of psychological disorders.

Subjects who participated in the research were recruited from CAU Introductory Psychology classes. After an extensive two-stage screening process, sixteen subjects were selected from the pool. They were assigned to two treatment conditions: virtual reality therapy and a comparison group.

Apparatus for this study consisted of a Pentium based computer, head-mounted display and head-tracker (Virtual - I/O). Modeling was done by VREAM company under the direction of the researchers. A model of an auditorium located in the CAU Research Science Building was created. The virtual auditorium is 48 feet wide, 100 feet long and 55 feet high. The seating area has three sections of chairs and can accommodate over 100 people. Specialized features created for the facility include a virtual wooden podium with a speaker's stand. An amplifier with direct connection to the virtual reality software and hardware were used in the therapy sessions. This enabled the subjects to hear the echo of their voices. Simulation of the real echo in the auditorium was created by a headphone attached to the head-mounted display. The treatment schedule consisted of five weekly sessions. The sessions lasted 10 to 15 minutes.

Two assessment measures were used in this study. The first measure used was the Attitude Towards Public Speaking (ATPS) questionnaire which contains six items for assessment which range from 0-10 on a semantic differential scale. The second measure used was the eleven-point Subjective Units of Disturbance (SUD) scale (0 - no discomfort, 10 - panic level anxiety).

The subjects' anxiety and avoidance behavior were interfering with their normal activities. They were unable to participate in the social gatherings, classes, or professional conferences. The symptoms experienced by the subjects during virtual realty therapy included an increase in heart rate, feeling a lump in the throat, dry mouth, sweaty palms,

GIUSEPPE RIVA (Ed.)
*Virtual Reality in Neuro-Psycho-Physiology*
1997, 1998 © Ios Press: Amsterdam, Netherlands.

loss of balance, weakness in the knees, etc. These symptoms also appeared in the studies which dealt with the treatment given for acrophobia (height phobia), agrophobia, and fear of flying.

Similar to our first known controlled studies of VRT, the study of the fear of public speaking indicated that VRT was very effective in reducing self-reported anxiety. The VRT treatment resulted in both a significant reduction of anxiety symptoms (SUD and ATPS measurements) and the ability to face the phobic situations in the real world. At this time several of the subjects can comfortably speak in front of a crowed with better confidence.

## 6. Assertions Concerning VRT

Based on the data collected and subjects' verbal reports of the VRT experiments we make the following assertions concerning the Virtual Reality Therapy.

** A person's experience of a situation in a virtual environment may evoke the same reactions and emotions as the experience of a similar real-world situation.*

The results of all of our research studies of psychological treatment categories demonstrated that people who are agoraphobic in the real world are also agoraphobic in a virtual world. When subjected to virtual phobic-invoking situations, our subjects exhibited the same types of responses as would be exhibited in a real-world situation. These responses included anxiety, avoidance, and physical symptoms.

As a measure of anxiety, subjects were repeatedly asked to rate their current level of anxiety on a SUD scale. The relatively high SUD scores at the beginning of each treatment session indicated that the subjects' fear structures were invoked and the SUD scores (and thus fear levels) gradually decreased as subjects remained in the virtual scene.

A second measure of anxiety was actual subject behavior and verbalization. Examples of common subject behavior included subjects tightly gripping the rails, and displaying reluctance to let go of the rails. Verbal expressions recorded included: "The higher I get, the more worried I get," "I am really there!," "It feels like being in a real helicopter," "I am afraid to fall down!," "I do not like this at all!", "I am scared!," and "I feel like I am actually on the fiftieth floor!".

Physical symptoms reported by subjects included shakiness in the knees, heart palpitations, tenseness, sweaty palms, and dizziness.

** A person may experience a sense of virtual presence similar to the real world even when the virtual environment does not accurately or completely represent the real-world situation.*

Remarkably, subject reactions consistent with phobic stimuli were experienced in spite of the fact that their virtual experience did not correspond to the real-world experience in several ways. All environments were visually extremely less detailed than a real scene, and some environments included much simpler auditory and tactile cues such as engine sound and vibration of the Apache AH64 helicopter in the fear of flying study.

As stated previously, the subjects reported a number of physical and emotional anxiety-

related symptoms such as dizziness, sweaty palms, heart palpitations, etc. These feelings would not have been reported by subjects, if they did not perceive that they were experiencing a realistic situation even though the virtual environments were not exact copies of real world scenes.

* *Each person brings his/her own background into a virtual reality experience.*

It is important to recognize the fact that perception is in many ways just as much a product of our previous experiences as of current stimulation. Each subject is a unique, specific individual and with an independent experience of reality which is unique and different from the objective world, or the so-called world of reality. The implication for virtual reality is that the sense of virtual presence is dependent not only on the physical qualities (resolution, realism, interactivity, lag time) of the experience provided by the virtual reality, but also upon what the participant psychologically brings to the environment. The very nature of the act of perception causes each person to react differently to the same real or virtual experience.

This was evidenced by SUD, ATAQ and ATPS scores and the verbal comments of the subjects. Just as different individuals may react differently to a real world experience, our subjects exhibited different reactions to the same virtual world experience. This point was clearly demonstrated by the variety of responses among subjects to same phobic stimuli of the virtual scene. Several subjects went through several levels of the phobic situations without reporting any significant anxiety. On the other hand, many subjects reported differing amounts of anxiety in different levels of the virtual scene. There was major variation in the amount of time spent in each level of the virtual scenes by different subjects.

* *Experience with a virtual environment increases the participant's sense of virtual presence.*

The idea that a sense of presence may increase with experience has been suggested by several researchers [13,14,15,16]. Our experiments verified this hypothesis, in that the longer subjects stayed in the virtual scene the deeper they were pulled into the virtual world and the greater their sense of virtual presence.

Based on subjects' SUD, ATAQ and ATPS scores and verbal comments during the experiments, subjects initially felt some level of virtual presence in the phobic situation and their sense of virtual presence increased over time or at worst was maintained during all the sessions.

* *The sense of presence in virtual and physical environments is constant and subjects have to give up the sense of presence in on environment (e.g., physical environment) to achieve a stronger sense of presence in the other one (e.g., virtual world).*

This assertion is drawn based on the data (SPSVP--Sense of Presence Scale in the Virtual and the Physical environments questionnaire--and SUD) collected from subjects. Specifically, the SPSVP was designed to assess one's sense of presence of the virtual environment and physical environment, sense of interactivity with the virtual reality system, and one's perception of the real world in reflection to the virtual environment.

The subjective measures of sense of presence in the virtual environment increased gradually during each session. The subjective measures of sense of presence of the physical environment while attending the virtual reality decreased gradually within and between sessions. These results led to the conclusion that the longer subjects remained in the virtual environment the higher was the subject's sense of presence in the virtual reality (even when

using very minimal stimuli), while the sense of presence of the physical environment decreased. This supports a theory that the total sense of presence is constant, and subjects have to divide their overall sense of presence between the virtual and real worlds.

* *Subject concentration increases significantly in the virtual world as compared to in the physical world, when the subject has enough interaction to develop a strong sense of virtual presence.*

Each subject's interest level in the learning study was determined by a ten-point scale instrument administered at the end of each experiment. The scores ranged from very weak to very strong. The interest level and sense of control level in the virtual world were always higher than the scores in the physical world.

Based on the data and observation, it was obvious that each subject was excited, enthusiastic, and eager to be in virtual environment, rather than the physical environment. The main conclusion of this research was that memory span increased significantly in the virtual environment as compared to the span in the physical environment, and that the learner's motivation and interest levels may be maintained longer in the virtual environment. We hypothesize that at least a part of this effect may be due to the simplicity of the virtual environment, providing less distractions to the learner.

* *A person's perceptions of real-world situations and behavior in the real-world may be modified based on his experiences within a virtual world.*

Most applications of virtual reality are intended to augment human intelligence by either increasing or modifying a person's *intellectual understanding* of the structure or nature of objects or tasks [12]. A virtual environment can also modify users' perceptions of real world situations and thus behavior in those situations.

This conclusion is based on the reports of subjects who exposed themselves to real world phobic situations after receiving VRT treatment. What was learned and experienced in the virtual environment was transferred to real-world perception and behavior.

## 7. Safety Issues in VRT

While there are some potential risks associated with virtual reality technology, as pointed out by Stanney [17], definite steps must be taken in treatment to minimize these risks. According to Stanney, subjects at risk for psychological harm are primarily those who suffer from panic attacks, those with serious medical problems such as heart disease or epilepsy, and those who are (or have recently been) taking drugs with major physiological or psychological effects. As is clearly stated above, questions regarding these situations must be asked as a part of the screening process, and persons with these characteristics must be excluded from VRT experiences. Also, some people experience symptoms ranging from headache to epileptic seizure when exposed to visual stimuli which flicker at 8-12 Hz. In VRT, no frame update rates in this range must be used. Furthermore, patients have to be closely observed by therapist at all times, and if there are evidence of any significant physical or psychological distress, both the patient and the therapist must have the ability to

quickly terminate the virtual reality session.

We recommend that therapist asks the patients to sit on a chair rather standing up; use a modified head-mounted display so the patient could see her physical body partially; choose the head-mounted display with a narrower field of view; and most importantly keep the sessions brief (between 15 to 20 minutes long). This configuration reduces the degree of immersion but increases the physical and psychological safety of the patients.

There is still a great need for research in this area and we strongly recommend that researchers take appropriate steps in minimizing patient risks.

It must also be noted that symptoms of anxiety while under VRT are distinctly different from simulation sickness. The anxiety symptoms evoked under VRT are the same as the real world experience of the patient and include shortness of breath, heart palpitations (irregular or rapid heartbeat), trembling or shaking, choking, numbness, sweating, dizziness or loss of balance, feeling of detachment, being out of touch with self, hot flashes or chills, loss of control, abdominal distress, and nausea.

## 8. Complexity of VRT

VRT is different from simple desensitization and exposure therapy as described by the behavioral schools of thought. VRT appears to be oriented more toward neurophysiological information processing theory and the accelerated integrative information processing paradigm presented by Frances Shapiro [18]. Thus far, research have proven that VRT works very well with subjects who suffer from various kinds of phobias. Intuitive observation has also led to the belief that more than desensitization was at work. Patients were immersed in the virtual world; they typically would not communicate with therapists who reside in the physical world. They appeared to be reliving their previous disturbing or anxiety-provoking experiences even though the virtual world did not accurately match their existential world. They would usually look repeatedly at the same simple object or objects within the virtual world. Advanced graphics, while providing stronger immersion, seem to be distracting and overloading the human perceptual processing system and are not allowing the other cognitive processes, which are essential to problem solving and information reprocessing, to work efficiently. Based on our observation, the processes seem to be very similar to the treatment that Shapiro calls EMDR (Eye Movement Desensitization Reprocessing). Disturbing memory is stored by a picture, cognition, affect, and physical sensations. VRT reveals that these factors are stored by association and linked together. VRT appears to activate the visual memory, in case only visual stimuli are presented, and in turn activates other related memories and experiences such as cognition, affect, and physical sensation. Under VRT, many of the subjects report physical and emotional symptoms associated with these stored memories. They report having sweaty palms and shaking knees, feeling scared, and feeling uncomfortable. In general, VRT appears to provide a link between the reality of the client and the objective world. However, at this time there is no concrete or empirically based evidence to explain why and how VRT works. Thus the great need for researchers to investigate the psychological mechanics of VRT.

## 9. Ongoing Research: VRT Combating Other Psychological Disorders

Although results of the research projects covered in this chapter are impressive,

GIUSEPPE RIVA (Ed.)
*Virtual Reality in Neuro-Psycho-Physiology*
1997, 1998 © Ios Press: Amsterdam, Netherlands.

additional research is needed to more thoroughly explore the effectiveness of VRT and extend it to other psychological disorders. Additional studies must allow for both objective and subjective measurements of anxiety to ensure the validity of research outcomes. We recommend investigating the influence of subject variables (demo-graphic and personality characteristics) on the effectiveness of VRT. Such studies should include an imaginal systematic desensitization (ISD) conventional therapy group in addition to the no-treatment control group used in previous studies. In this section, we present our current and ongoing research in those areas, hoping it will be both informative and inspiring.

These projects include using virtual reality therapy to combat obsessive-compulsive disorders (OCD), attention deficit disorders (ADD), and post-traumatic stress disorders (PTSD).

### *9.1 Obsessive-Compulsive Disorders*

Approximately five million people just in United States, one in fifty Americans, suffer with obsessive-compulsive disorder (OCD) which affects their normal lives. For example, one might have an overwhelming urge to arrange a room's furniture, dishes in the cupboards, and books in shelves. Someone else will wash their hands repeatedly, regardless of how many times that day they had already done so. These compulsive behaviors definitely interfere with the every day activities of the patients and bring about disturbing thoughts that cause anxiety. Ironically, patients perform these repetitive behaviors to alleviate anxiety.

OCD can be found in men, women, and children of all races, and socioeconomic backgrounds. The most common obsessions include fear of contamination, fear of making mistakes, and fear of harm to another. Common compulsions include cleaning and washing, arranging and organizing, collecting, counting and repeating. Medication and behavior therapy are the most common treatments for OCD.

Since VRT appears to alleviate anxiety in patients with phobic disorders, it may also be useful in the treatment of OCD. For example, a scene can be created for a patient who compulsively rearranges books on the bookshelf until she sees that there is no point in continuing this behavior or basically becomes desensitized to it. Feelings of insecurity, shame, inadequacy, and powerlessness may not be as strong in the virtual scene as they are in the real world experience. Most OCD patients not only are ashamed of their uncontrollable repetitive behavior but are very much concerned with what other people think of them when seeing their obsessive-compulsive behavior. At the very least, VRT has the potential to reduce the patient's embarrassment and provide privacy. In turn, it offers the patient a chance to concentrate on the problem, thereby reducing information overload and releasing cognitive resources to seek an alternative to the obsessive-compulsive behavior.

For example, an OCD patient can work on changing her inner dialogue (self-talk) while under the influence of VRT. She can experience no adverse consequences in the virtual world, which may help to reassure her. A patient who in real life habitually and repeatedly retraces her driving route to make sure that she has not run over an animal or person can rest assured that the virtual roads in her virtual scene do not contain any other living objects. She can also be instructed to reduce the number of times she repeats her obsessive-compulsive behavior. Or she can use the alternative approach and repeat her behavior as long as she

wishes until she becomes desensitized. Also, when she feels the urge to repeat the compulsive behavior she can stop her virtual car whenever she wants to. That's not necessarily possible while driving on a busy highway in the real world; it would be too dangerous. In the virtual world, the patient can stop her car, and the other cars may also stop at her command. A patient who is obsessed with washing her hands repeatedly to avoid contamination can be assured that there is no contamination in the newly created virtual world that she is entering. This will provide a scenario that makes no sense to her in terms of her normal thought processes. VRT scenarios of this kind will prompt a patient to become willing to take a risk and allow herself to experience new ways of thinking, feeling, and acting. Of course, we are eager to test these hypotheses and scenarios in the months ahead.

Besides the medication approach, there are several behavior therapy approaches in the treatment of OCD. In this section only a few common ones are briefly introduced to allow readers to understand the possible use of VRT to combat OCD. For detailed information about the nature of OCD and its treatment, see the book by Edna Foa and Reid Wilson, 1991 [19], and the book by Edmund J. Bourne, 1995 [20] which can be found in the reference section of this chapter.

- *Accepting Obsessing*: The patient is placed in a virtual scene and allowed to accept her OCD, repeating the compulsive behavior until it passes. With the magnified stimuli that VRT techniques produce, this could lead to simple desensitization, reducing or ending the patient's distress.
- *Postponing Obsessing*: The patient is asked to intentionally delay obsessing for a short period of time. At first she may delay it for a minute, gradually lengthening the delay to several minutes or an hour or more. This can be easily done under VRT conditions, allowing the patient to gain a sense of control over her OCD.
- *Creative Distractions*: Channelling the attention of the patient to an interesting distraction, such as reading a book or watching a favorite movie, have proven helpful in treating some OCD patients. Of course, the very condition of virtual presence within VRT also distracts the patient's thoughts from the real world and allows her to ignore her obsessive behavior and become desensitized.
- *Experiencing the Worst*: Continuous exposure to the worst-case scenario has been helpful in desensitizing OCD patients. The VRT is a safe environment in which the patient can repeatedly perform the worst-case acts of compulsion and obsession until desensitized.

The patient in a virtual reality scene can safely and comfortably allow herself a time for rest and relaxation. She can repeat activities at a different pace, under her control, which has been shown to be helpful with most patients suffering from anxiety.

We have began to conduct several pilot case studies to test the effectiveness of VRT in patients with OCD.

### *9.2 Attention Deficit Disorders*

Attention Deficit Disorder (ADD) is common among children. Current research indicates that between five and ten percent of children suffer from this disorder. Many of these children are highly intelligent and creative despite wandering attention and impulsiveness. Because they have problems with short term memory and short attention spans, they have a hard time completing tasks. They have trouble concentrating, being easily distracted, mostly

by sights and sounds. They especially exhibit problems in a group situation [21]. In general, the ADD patients' problems are physical, academic, behavioral, emotional, and social.

Traditional treatment for ADD includes medications such as Methylphenidate (Ritalin), D-Amphetamine (Dexedrine), and Pemoline (Cylert). Behavioral management also includes punishment and reward techniques.

Several research studies in this book have shown that virtual reality technology provides specific stimuli that can be used in removing distractions and providing environments that get the subjects' attention and increases their concentration. Virtual reality technology can hold a patient's attention for a longer period of time than other methods can. These scenes may enhance the patient's short term memory and increase attention span. Researchers at CAU's Virtual Reality Technology Laboratory are developing several classroom situation scenes to extensively test these hypotheses. As a matter of fact, an informal pilot study conducted in this lab showed that a patient's mild ADD symptoms decreased while under VRT. Although we have used only visual stimuli, the preliminary observations are very encouraging. There is good evidence from our previous research that this kind of experience may be easily transferred to everyday activities. The ongoing ADD research will be extended to include other stimuli such as auditory and tactile. A scenario for social interaction is also under development, to test the effects of VRT in teaching patients the interaction needed to improve their social skills.

### *9.3 Post-Traumatic Stress Disorders*

During World War I, soldiers in combat were observed to suffer chronic anxiety, nightmare, and flashbacks that lasted for days and even years. Severe traumas such as war, earthquakes, tornadoes, car or plane crashes, assault and rape can produce intense fear, and feelings of helplessness. Disabling reactions to such traumatic events fall into the category of disorders known as post-traumatic stress disorder, or PTSD in short. PTSD causes a variety of symptoms, such as intense flash-backs, nightmares, and repetitive disturbing thoughts about the traumatic event. Other symptoms are feelings of detachment from others, being out of touch with one's own feelings, increased anxiety and, most importantly, avoidance of activities related to the trauma. Exposure therapy has been used to treat patients with PTSD, enabling them to work through the intense fear caused by the traumatic event [18].

There is a great deal of similarity between phobias (such as agoraphobia) and PTSD. However, PTSD is more intense. Just as VRT has been utilized to treat patients with various phobias, it may also be used to treat patient with PTSD. Virtual reality scenes can be created to match some of the salient cues provided by patients. Of course, based on our previous experience, it is not necessary to create a virtual world that exactly matches the real world events. Only a few important cues provided by the patient may be sufficient to recreate an experience in the patient's mind. A modification of our innovative VRT methodology for treating patients with agoraphobia may be useful in treating PTSD people, particularly if it can help them to reexperience the traumatic event in the safe environment of virtual reality. VRT makes it possible for a virtual therapist to accompany the patient while revisiting a traumatic scene. For example, a simplified scene of a Vietnam war zone is under development in our Laboratory. It mimics the dense jungle growth with plants and

trees similar to what grows in the actual physical location. In this virtual jungle scene, we will allow our subjects a walk-through while the virtual therapist goes with them and assures them that it is a safe place. The virtual jungle scene with minimal cues may evoke the original traumatic memory and allow the patient to become desensitized. By repeating the virtual experience the fear would be gradually reduced. As mentioned in earlier sections, in VRT patients gain a sense of self-control, regain self-esteem and become willing to take some risks. In doing so, they permit themselves to grow. Eventually more intense cues may be introduced into the virtual scene, such as the sound of machine guns heard from a distance. This may evoke other related traumatic events, allowing the patient to become more desensitized.

## Acknowledgement

The research projects described in this chapter were sponsored by several grants from Boeing Computer Services (Virtual Systems Department), U.S. Army Research Laboratory under contract DAAL03-92-6-0377, and supported by the Emory University and Georgia Institute of Technology Biomedical Technology Research Center (for the collaborative research of the fear of heights). The views contained in this document are those of the authors and should not be interpreted as representing the official policies of the U.S. government, either expressed or implied.

## References

[1] North, M.M., and North, S.M. (1994). Virtual environments and psychological disorders. Electronic Journal of Virtual Culture, 2(4), 37-42(ep.).

[2] North, M.M, North, S.M., and Coble, J.R. (1996). Virtual reality therapy, An innovative paradigm. CO: IPI Press.

[3] North, M.M., North, S.M., and Coble, J.R.(1996). Application: Psychotherapy, Flight Fear Flees, CyberEdge Journal, 6(1), 8-10.

[4] North, M.M., North, S.M., and Coble, J.R. (1997). Virtual environment psychotherapy: A case study of fear of flying disorder. PRESENCE, Teleoperators and Virtual Environments. 6(1).

[5] North, M.M., and North, S.M. (1996). Virtual psychotherapy. Journal of Medicine and Virtual Reality, 1(2), 28-32.

[6] North, M.M., North, S.M., and Coble, J.R. (1995). Effectiveness of virtual environment desensitization in the treatment of agoraphobia. International Journal of Virtual Reality, 1(2), 25-34.

[7] North, M.M., North, S.M., and Coble, J.R. (1995). An effective treatment for psychological disorders: Treating agoraphobia with virtual environment desensitization. CyberEdge Journal, 5(3), 12-13.

[8] North, M.M., North, S.M., and Coble, J.R. (1996). Effectiveness of virtual environment desensitization in the treatment of agoraphobia. PRESENCE, Teleoperators and Virtual Environments. 5(4).

[9] North, M.M., North, S.M., and Coble, J.R. (1997). Virtual Reality Therapy Combating Fear of Public Speaking. Submitted to APA (under review).

[10] Rothbaum, B., Hodges, L., Kooper, R., Opdykes, D., Williford, J., and North, M. (1995). Effectiveness of computer-generated (virtual reality) graded exposure in the treatment of acrophobia. American Journal of Psychiatry, 152(4), 626-628.

[11] Rothbaum, B.O., Hodges, L.F., Opdyke, D., Kooper, R., Williford, J.S., and North, M.M. (1995). Virtual reality graded exposure in the treatment of acrophobia: A case study. Journal of Behavior Therapy, 26(3), 547-554.

[12] Bajura, M. Fuchs, H., and Ohbuchi, R. (1992). Merging virtual objects with the real world: Seeing ultrasound imagery within the patient. Computer Graphics, 26(2), 203-210.

[13] Naiman, A. (1992). Presence, and other gifts. PRESENCE, Teleoperators and Virtual Environments, 1(1), 145-148.

[14] Held, R.M. and Durlach, N.I. (1992) Presence. PRESENCE, Teleoperators and Virtual Environments, 1(1), 109-112.

[15] Loomis, J.M. (1992) Distal attribution and presence. PRESENCE, Teleoperators and Virtual Environments, 1(1), 113-119.

[16] Loomis, J.M. (1993). Understanding synthetic experience must begin with the analysis of ordinary perceptual experience. IEEE Symposium on Research Frontiers in Virtual Reality (pp. 54-57). San Jose, California.

[17] Stanney, K. (1995). Realizing the full potential of virtual reality: Human factors issues that could stand in the way. IEEE Proceedings of Virtual Reality Annual International Symposium '95. Research Triangle Park, North Carolina, (pp. 28-34).

[18] Shapiro, F. (1995). Eye movement desensitization and reprocessing. New York: The Guilford Press.

[19] Foe, E., and Wilson, R. (1991). Stop obsessing: How to overcome your obsessions and compulsions. New York: Bantam.

[20] Bourne, E.J., (1995). The anxiety & phobia workbook (2nd ed.). Oakland, CA: New Harbinger Publications.

[21] Hunsucker, G. (1988). Attention deficit disorder. Fort Worth, TX: Forresst Publishing.