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Overcoming Phobias by Virtual Exposure

It is not surprising that phobia treatment would be one of the first successful mental health uses for VR. The sense of being immersed in another setting is particularly valuable in exposure therapy, a treatment technique for phobias. Exposure therapy involves subjecting the patient to anxiety-producing stimuli while allowing the anxiety to attenuate. These stimuli have traditionally been generated by presenting the patient with actual physical situations (in vivo exposure) or by having the patient imagine the stimulus.

VR allows a third option of exposure in a virtual setting that is safer, less embarrassing, and less costly then reproducing the real-world situations and more realistic than imagining the danger. An additional advantage of computer-controlled stimuli is that the patient can more easily regulate the level of the induced anxiety by modifying the parameters of the world to reduce or increase fear to match individual tolerance. All phobia treatment studies to date have used a headset to reproduce the feeling of presence in an anxiety-producing situation.

Fear of Heights

The first phobia studies conducted during late 1993 were for acrophobia—the fear of heights. This phobia is characterized by a marked anxiety upon exposure to heights, avoidance of heights, and interference in normal everyday activities as a result of the fear. In exposure therapy situations the pattern is for patients' anxiety to increase as they are exposed to more threatening situations, then for anxiety to decrease as they spend more time in each situation.

Initial research was a collaborative effort by computer scientists and therapists from three Atlanta universities: Georgia Tech, Clark Atlanta, and Emory [2]. Out of 478 students initially screened for acrophobia, 20 entered the study; 17 completed it. Subjects were randomly assigned to either a treatment group or a wait-list control group. The treatment group had one pre-treatment VR equipment session and seven weekly 35- to 45-minute sessions during which they were exposed to three virtual height situations—-a virtual elevator, a series of virtual bridges, and a series of virtual balconies. Anxiety, avoidance, distress, and negative attitudes towards height decreased significantly for the treatment group but not for the wait-list group. By all measures, significant improvement in the phobia response was found among the subjects who completed the VR treatment. Seven of the 10 treatment completes exposed themselves to height situations in real life during the treatment period although they were not specifically instructed to do so.

It is interesting to note these results were obtained despite primitive computer worlds and poor headset

image quality. The tests at times involved teleporting the patient from one location to another. Although patients were aware of the artificial nature of the scenes, they still felt enough sense of presence to exhibit the phobic responses while in the headset. Physical symptoms included sweaty palms, loss of balance, and weakness in the knees. Patients indicated that a sense of reality in the virtual setting was aided by haptic props. For example, when riding a glass elevator, a metal bar matching the bar location in the virtual headset was provided for the subject to hold in the real world. In the spider phobia discussed later, this same type of prop matches the "feel" of the virtual to the real world.

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Max and Sarah North and Joseph Coble from Clark Atlanta's Virtual Technology Laboratory, have done a follow up, in-depth case study [6]. A subject was asked to rank a list of acrophobic situations according to the degree of anxiety arousal. The subject was placed near a virtual bridge that crossed a river in the middle of a simulated town. The study consisted of one pre-test exposure and eight 15- to 28-minute sessions. The subject started at the least threatening situation and then progressed, under his own control, to the next level of arousal. An anxiety measurement was taken every two to five minutes. At one month post-treatment, the subject was asked to complete an 11-point rating scale to measure the degree of phobic response change. The patient experienced significant habituation of anxiety symptoms and exercised less avoidance of phobic situations after the VR treatment.

Larry Hodges from Georgia Tech's Graphics, Visualization and Usability Center and Barbara Rothbaum from Emory led another follow-up case study using what they term VR Exposure (VRE) therapy to treat a 19-year-old undergraduate student with a fear of heights and in particular a fear of glass elevators. Twice-weekly exposure therapy sessions were conducted for three weeks on a VR glass-enclosed elevator (Figure 2). Time in each exposure was approximately 35 minutes. Outcome was assessed on measures of anxiety, avoidance, attitude, distress, and a behavioral avoidance test. VR graded exposure was successful in reducing fear of heights on all measures.

At about the same time researchers in Atlanta were conducting their acrophobia studies, Ralph Lamson, a physician at Kaiser Permanente, was doing similar work in California in collaboration with the VR company Division Inc. [3]. Acrophobia patients were recruited through newspaper ads. Each subject was exposed to one, 50-minute session where he or she completed a chosen task such as crossing the Golden

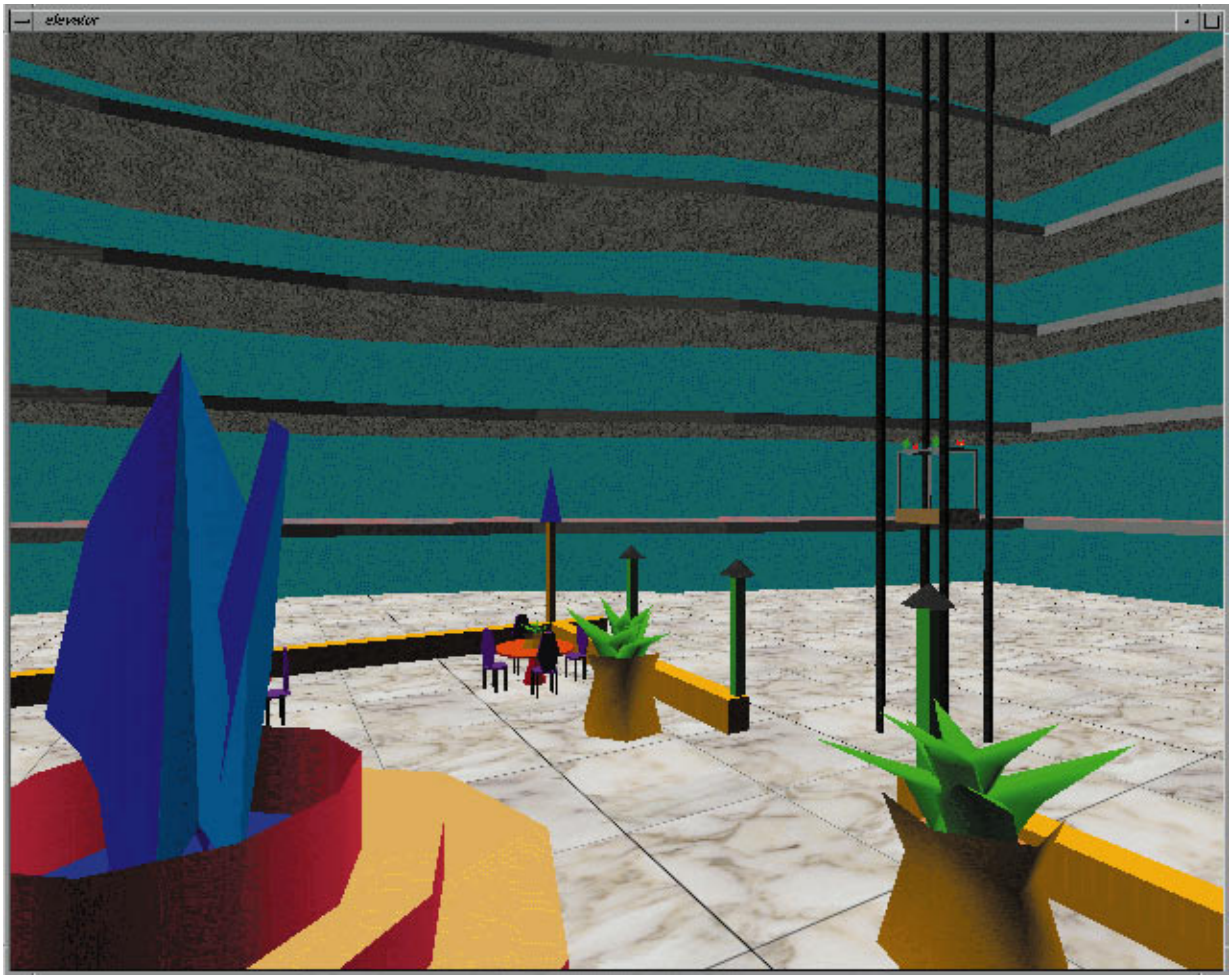

Figure 1. A virtual fear-of-heights treatment scene showing a hotel lobby as viewed from a glass elevator

Gate Bridge or riding in a glass-enclosed elevator. According to Lamson, all 40 of the subjects were able to complete the task of riding up and down a glass elevator while looking outside after a single VR treatment.

One result of the numerous fear-of-heights studies was to generate an interest in trying this technology with a variety of other phobias.

Fear of Flying

Both Georgia Tech and Clark Atlanta followed up the acrophobia research with independent fear-of-flying studies. Georgia Tech conducted a case study using a virtual airplane which duplicated a passenger seated by the window in a standard commercial jet [7]. The passenger could look out the window and see the ground and changing sky scenes (Figure 2). The patient was a 42-year-old female with a debilitating fear and avoidance of flying. As an outpatient for seven sessions, she was taught traditional anxiety management techniques. At that point it was mutually decided between the doctor and the patient that exposure therapy would be beneficial. VR sessions were held twice weekly with each session lasting approximately 35 to 45 minutes. A total of six sessions were conducted. During each virtual exposure, the subject was allowed to progress at her own pace along a natural progression of scenarios—sitting on the plane with engines off, sitting on a plane with engines on, taxiing the runway, smooth takeoff, smooth flight, close pass over the airport, landing, rough takeoff, turbulent flight, and rough landing.

Two days following the last exposure therapy session the subject completed a planned, cross-country flight with her family. Although the contribution of the VR treatment to her improvement is not possible to determine given the prior inclusion of the anxiety management techniques, the computer-generated simulations were considered significant for several reasons. First, the patient's reported anxiety on all measures decreased following exposure to the virtual plane. Second, she was able to complete a long flight,

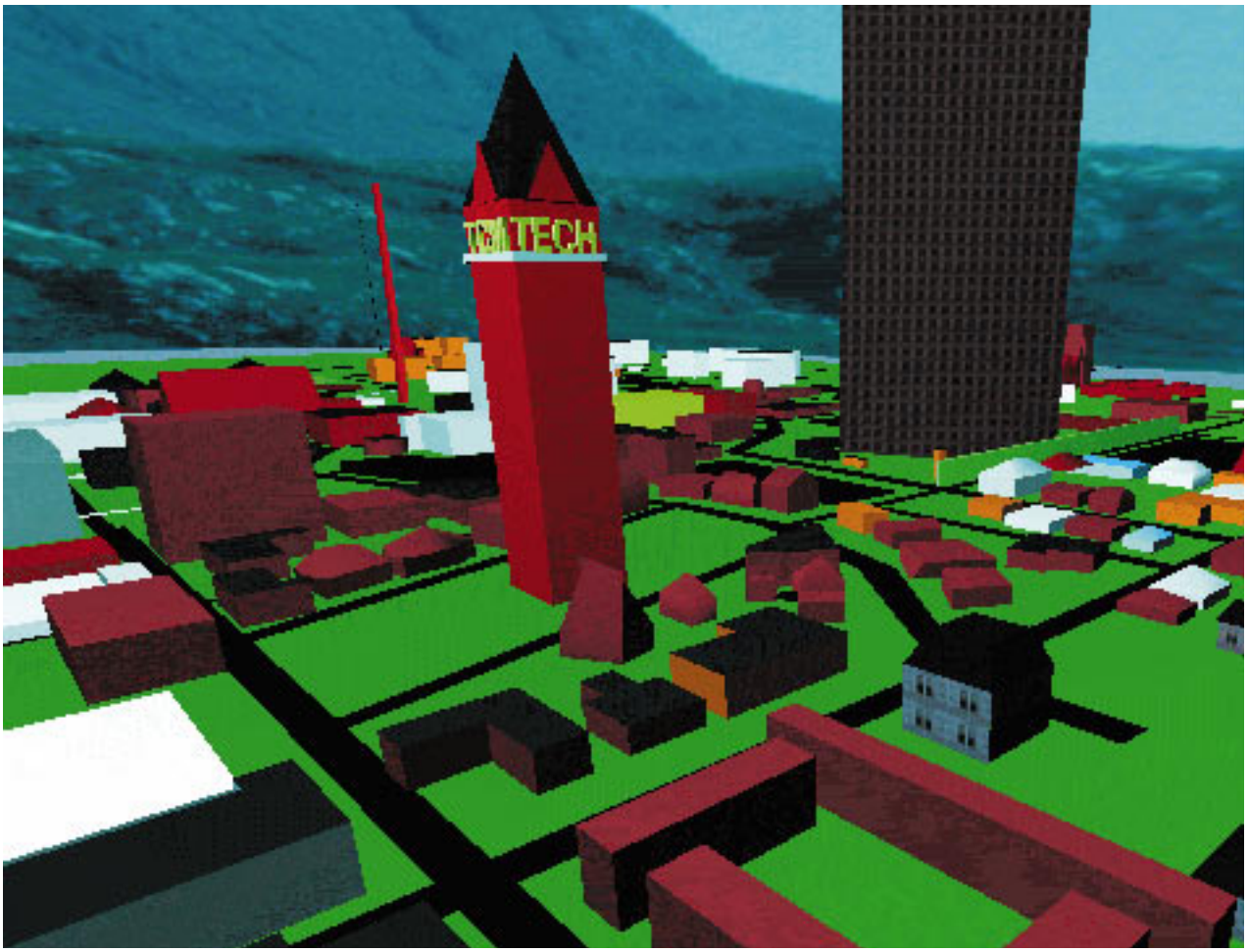

Figure 2. A virtual fear-of-flying treatment environment looking over Atlanta

one she had avoided for two years. Third, the usual treatment for fear of flying includes a combination of anxiety management techniques and exposure. Had VR exposure not been available, this therapy would have included exposure to actual airplanes, possibly with the therapist flying with the patient before she flew with her family. This study raises the issue that VR therapy may be most effective when combined with traditional treatment techniques.

In an effort to move VR exposure therapy from the laboratory to everyday clinical use, Georgia Tech and Emory University are jointly developing a fear-of-flying system based on either a PC or low-end workstation that will be in a realistic price range for clinical practice. This system will be field tested in a number of clinics in Atlanta and other U.S. cities this year.

The Norths did two independent case studies for fear of flying [4]. These studies are interesting in part because the subjects were already familiar with VR systems so the novelty effect of the equipment should not have been a factor. One subject was a 32-year-old woman and another a 42-year-old man, both clinically diagnosed as having a fear of flying. The VR scenes simulated an Apache helicopter departing and then flying over an airport and a city scene. A virtual therapist, with whom the patient could communicate during the trials, rode in a seat next to the patient in the computer-generated scenes. Sound and vibration were included for realism.

The female patient participated in eight VR exposures which lasted for approximately 30 minutes each over 10 weeks. The male had five 30-minute sessions over 5 weeks. Both subjects reported a high level of anxiety at the beginning of each session and gradually reported lower levels after remaining in the situation for a few minutes. Each was left in the scene until reporting an anxiety level of zero. Researchers recorded physical symptoms such as sweaty palms as well as taking subjective discomfort ratings from the subjects. After the tests ended, the female patient, with the therapist, was flown in a helicopter to mea-

sure any change in flying anxiety. The flight lasted approximately 10 minutes and was conducted at low altitude over a beach on the Gulf of Mexico. Similar to the VR therapy exposures, the subject reported some anxiety at the beginning; however, the anxiety rapidly declined to a reasonably comfortable level. Currently the woman claims to be much more comfortable flying for long distances and experiences much less anxiety. The male subject also reports a significant reduction in anxiety symptoms after VR therapy sessions and is now able to fly comfortably.

The recent phobia studies at Clark Atlanta have been conducted on a PC with a low-cost headset and head tracker, mouse, joystick, data glove, and VREAM software. The total system cost was under $10,000, even when bought from an outside company who integrated the commercial programs and hardware into a package.

Agoraphobia

Agoraphobia is an unhealthy fear of being caught in places or situations from which escape may be difficult or embarrassing (such as being in a crowd, traveling in an automobile, bus, plane, or being in an elevator). The result is that these individuals are fearful of leaving their homes to work or even to run simple errands. North chose 60 subjects for an agoraphobia study with VR therapy [5]. Thirty were placed in the experimental group and 30 in the control group. The experimental group received eight exposures over eight weeks to a variety of scenes. Each test lasted approximately 20 minutes. The control group received no therapy. The Agoraphobia Questionnaire and the Subjective Unit of Discomfort Scale (SUDS) tests were used to measure therapy effectiveness. The students exposed to VR therapy reported significant improvement while the control group showed no change.

Fear of Spiders

Researchers at the Human Interface Technology Lab at the University of Washington are investigating the effects on immersive "presence" of physically touching objects in a VE. Hunter Hoffman, Al Carlin, and Suzanne Weghorst evoked a stronger sense of presence by placing a real object (a plate or a rubber ball) within the participant's grasp and registering the location of the corresponding virtual object. They call this technique "tactile augmentation" and have used it to treat a person with spider phobia [1].

In a clinical case study with a patient who had long-term debilitating fear of spiders, the researchers systematically introduced visually more fearful spider representations and behaviors into both a virtual kitchen environment and a virtual replica of the laboratory environment. By simultaneously introducing a large fuzzy plastic spider precisely registered with a spatially tracked matching virtual spider created using Alias software, they demonstrated the use of tactile augmentation and significantly enhanced the effectiveness of the VR exposure treatment. After 12 weekly 30-minute sessions using a Division Provision 100 system with a Virtual Research VR4 HMD and Polhemus 6D trackers attached to the head, hand, and spider, the patient's ratings of fear of spiders, as measured by self-report and a survey, decreased to the point where she was able to resume outdoor camping activities.

Fear of Public Speaking

Frequently identified among the top most prevalent phobias, fear of public speaking was the subject of another study at Clark Atlanta University. Comparing control and test groups of undergraduates, subjects were placed in front of a virtual auditorium that gradually filled with virtual people. Simulation of room and crowd noise included laughter, commentary, and applause. The treatment schedule consisted of eight, 10- to 15-minute weekly sessions. Symptoms experienced by the subjects during VR therapy mirrored those which most speakers experience during public presentations. They include increased heart rate, lump in the throat, dry mouth, sweaty palms, loss of balance, and weakness in the knees. Two assessment measurements, the Attitude Toward Public Speaking and SUDS scale, showed significant reduction of anxiety symptoms and the ability to face the phobic situations after virtual therapy treatment. Subjects now report the ability to speak comfortably in front of large groups of people.

Fear of Driving

Several other phobia treatments are in the initial stages of development. Andrew Berger of Virtual Psychology Company is conducting a controlled study to determine how effective a VR driving system for the treatment of head injury is in treating the fear of driving. Eighty subjects have been recruited through newspaper ads for a comparison of four different therapies. Twenty subjects are using the Pentium-based system with a low-cost headset and customized Imago VR driving simulation software. The driving scenes progress from pulling out of a driveway and driving on a side street to more stressful highway exposure. The schedule is two 30- to 40-minute treatments twice a week for 12 sessions. This study does not yet have publishable results.

Summary

These studies indicate VR scenes can produce a variety of phobic symptoms. While vision alone in a headset appears to create phobic anxiety, most of the researchers mentioned introduced sound into their later research and found it heightened the effect. Where applicable, haptic cues such as a hand bar in an elevator or a furry spider seems to add to the experience greatly.

Although these studies provide encouragement, they raise many questions the research is just beginning to address:

- How do patients treated with VR therapy compare to control groups using standard exposure therapies?
- How well do any positive benefits transfer to the real world, and how long do these benefits last once the patient is no longer receiving therapy? Early research indicates the sense of fear in the virtual headset scene is measurably different from the actual experience. In a study with 40 undergraduates at two universities in Germany, Thomas Schubert and Frank Friedmann developed a questionnaire to assess feelings and experiences after headset immersion on a 15-foot diameter platform at a 25-foot height. After 20 minutes of immersion, the users answered the questionnaire assessing the fear they experienced. Their preliminary results indicate fear of height is higher if a person perceives his or her own body as a part of the VE, but that the effect varies depending on other factors. Several phobia researchers have mentioned similar anecdotal results.
- Is the headset critical to the effect, or could the same results be obtained with less-expensive flat screen VR systems? James Patten at the University of Virginia has measured how HMD-based VR differs from desktop 3D graphics in inducing physiological responses. Using heart rate variability to compare arousal in the nervous system when a subject rides a virtual platform attached to the side of a building in both types of systems, they found greater sympathetic arousal in the head-tracked condition, though subjects exhibit this change to differing degrees.
- What are the different effects of the lengths of exposures for the various tests? Is one, 50-minute exposure as beneficial as eight, 15-minute exposures? For safety reasons, can most patients tolerate 50 continuous minutes in a virtual scene? At least one researcher had to redesign his tests to shorten patient exposure times after several subjects became violently ill from spending an hour wearing the headset. Hopefully future phobia research will benefit from the ongoing safety research (see Viire, Stanney and Kennedy articles in this section).

Despite these and other questions, phobia treatment appears to be the most easily implemented and convincing example of a beneficial use of VR therapy. When compared to training spiders and renting airplanes, the computer is more controllable and inexpensive than the conventional in vivo treatment technique. A common thread in all the present applications is the ease with which they can be implemented on present computers. Most researchers are now using PCs in their labs to create the phobia images. Several groups are developing customized low-cost systems for sale to clinicians. With these more affordable VR tools, the best measure of the effectiveness of exposure therapy may take place in doctor's offices across the country. C

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