Virtual Reality Technology (VR)
As Treatment for Anxiety Disorders

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Flight simulator – Pilots honing their skills in a virtual environment.
Photo courtesy of Link Simulation & Training.

The writers of the old television show *Star Trek: The Next Generation* created a recreation center on their spaceship called the *holodeck*. Through 3-D holographic projections, a crew member could tell a computer to re-create any place they could imagine and place them in the middle of it. Some chose to go to a remote paradise and soak up sun on a beach while others chose to participate in an active sport such as cliff diving or kayaking. Other staff looked for interpersonal encounters such as a game of chess against a chess master, an encounter with an old friend or meeting up with a missed lover.

The Nature of Virtual Reality

The depiction of the *holodeck*, though fiction, serves as a good example of what is meant by virtual environments. Virtual environments are computer-generated places where humans interact in meaningful ways. Virtual reality technology (VR) produces a structured environment where visual, auditory and kinesthetic sensory information allow for seemingly lifelike experiences for the participant. People interact within these environments in purposeful ways, typically through kinesthetics. A known example of VR application in industry is the development of flight simulators where both military and commercial pilots hone their skills in a simulated environment. Although originally mechanical devices, simulators are now heavily electronic and computer based. The machine's visual simulations, instrument feedback and physical movements can create various flying scenarios, including dire weather conditions and aircraft malfunctions, to which pilots must respond in order to maintain proper control of their aircraft. To train in these extreme circumstances in reality could have deadly consequences. The virtual environment thus is a place to safely test and explore.

VR and Behavior Therapy

A few years back, the authors were able to assemble our first VR laboratory with a number of associates, including Andrew Berger, Ph.D., and Nicholas Rose, Ph.D., under the banner of Virtual Psychology Systems. As a group of clinical psychologists, we reasoned that if situations could be computer generated, simulating those situations in which our patients had difficulties, then VR might serve as a controlled treatment environment that would have benefits in our work as behavior therapists. During typical outpatient exposure therapy, also known as "imaginal flooding," patients are guided to experience stimuli, typically through imagery, which provoke powerful emotional responses. Images are structured by behavior therapists through talk and suggestion without the use of any simulators or computers. During these sessions, avoidance responses by patients are not allowed to take place, as they often do in daily life. For example, an individual with a serious phobia of dogs will tend to avoid friends' houses and walking in places where they believe dogs may be present, even if this means coming up with wild excuses to not visit or circuitous routes to get to places. During exposure therapy, while imagining themselves in perceived "threatening" situations, patients are not allowed to engage in these types of avoidance behaviors. Anxiety is found to reduce as people become confident in facing situations without any dire consequences occurring.

In standard behavior therapy practice using therapist-guided images, it is

noted that some patients, due to a variety of factors [e.g., low motivation, poor imaging abilities, limited therapist skills (e.g., therapist not trained in producing evocative imagery with patients)], are unable to create or maintain sufficient imagery to allow for the exposure therapy to take hold and cause a diminishment of their anxious feelings. Thus VR was proposed to provide a structured sensory environment that is not subject to motivational or other limiting factors such as therapist skill. Our team of investigators put forth two general hypotheses for a study. Based upon the VR literature, we proposed that a virtual environment would cause anxiety in individuals who found the particular situation presented aversive. Furthermore, we wished to assess the concept of "presence"— a VR literature term that suggests that people become immersed in VR environments perceiving them as realistic. Presence appears to occur despite technological limitations such as the environment being represented by cartoon-like images. Therefore, we hypothesized that our VR participants would experience significant levels of immersion, particularly those for whom the virtual environment was aversive.

Testing VR

In order to test the efficacy of VR for anxiety treatment purposes, the study asked whether a VR-based environment could cause emotional arousal in people using a clinical population (a group often seen in psychotherapy). We chose a common phobia with which all of the investigators had treatment experience. Driving phobia is a disabling disorder for those who live on Long Island and are highly dependent on automobiles for transportation. Thus, we agreed to select a group of individuals with characteristics of driving phobia.

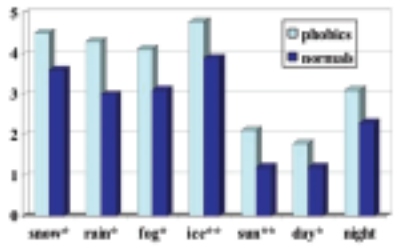
Next, we needed to create the VR environment. First, the essential components were gathered from a variety of suppliers. Fortunately, small businesses have produced hardware and software products that allow VR environments to be created in labs and offices without needing to invest millions of dollars in development, as the military, airline and medical industries have. We purchased a computer with advanced graphic capabilities and a head mounted display (HMD) that provides sound and projects images directly in front of the participant's eyes. Additionally, the HMD is designed to allow the displayed image to change in response to head movement; a concept known as head tracking. We rented rehabilitation software from a company that developed an automobile driving scenario designed for patients recovering from neurological medical conditions. Other equipment was purchased, including an over-the-counter blood pressure device, a video game steering wheel controller and pedals, a seat from a Saab automobile, and a steering wheel from a Ford Mustang. Lastly, we constructed a platform from wood with proper ergonomic proportions to simulate a car with an adjustable length seat. With the Mustang steering wheel retrofitted to the video game controller and pedals attached to the platform, our "VR car" was born.

Based upon screening questions, 8 driving phobic participants and 9 normal (non-phobic) drivers were recruited from the psychology undergraduate subject pool. Participants, who received class credit for participation, were 14 females and 3 males distributed across conditions. The phobic group had answered "yes" to each of the following questions: 1) Do you drive? 2) Does driving make you nervous or fearful? 3) Do you ever actually avoid driving due to fear? The driving "normals" answered "no" to the last two questions. On a 7-point fear scale (where 1 was anchored as "total comfort" and 7 represented "terror") the phobic group gave ratings to "driving a car" averaging at 5.5, significantly higher than the average 2.0 rating for the normals. The phobic group reported avoiding driving due to fear for an average of 21.9 months, whereas the normal group reported avoiding driving due to fear for an average of just .67 of a month. These data suggest that the normals may have had an experience, e.g., an accident, which caused them to briefly avoid driving whereas the phobics have long periods of avoiding driving. Other data collected during the study validated the differences between these two groups of participants. When giving fear ratings to typical weather conditions, time of day, and places people drive, the phobic group rated significantly more fearful than the normals in most every condition. The two exceptions were driving at night and through tunnels, which were statistically equivalent for both groups.

The participants experienced a virtual reality driving environment while sitting in the VR car. The steering

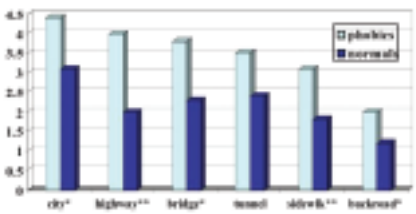
Thrustmaster T2 Driving Control, modified with a Ford Mustang steering wheel. The seat is from a Saab.

Figure 1. Weather/Time of Day Self-Report Ratings



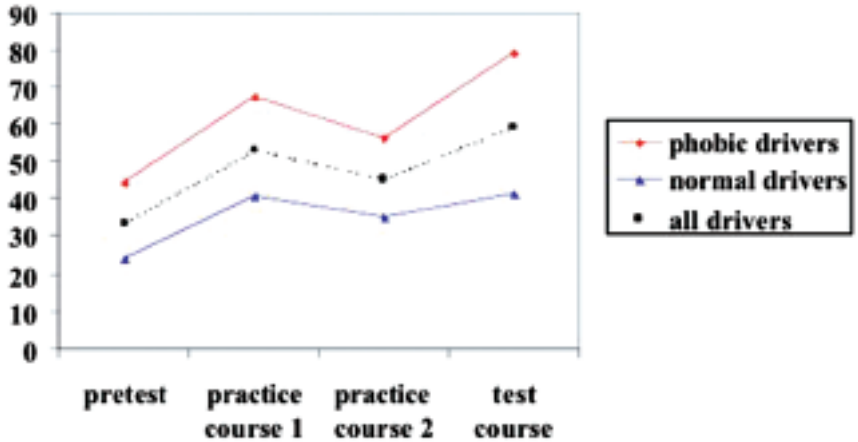
Note: higher ratings=more fear, *=p<.05, **=p<.01

Figure 2. Roads & Crossings Self-Report Ratings



Note: higher ratings=more fear, *=p<.05, **=p<.01

Figure 3. Mean SUDS Ratings by Group



wheel, gas pedal acceleration, braking and head movements all affected the VR images. Engine sound changed in relationship to acceleration and braking, including squeals from abrupt braking. All participants drove two repetitions of a practice course followed by the test course. The practice course contained typical road markings and signage but required few stops and had little traffic. The test course was a more complex image containing many buildings, more traffic and clear hazard situations. The dependent variables of subjective units of distress (SUDS), a 100-point rating scale where a higher rating indicates a greater experience of anxiety, and pulse rate and blood pressure were administered by an experimenter prior to driving and subsequent to each course being completed as anxiety measures. A driving experience form with questions concerning the dimensions of: 1) emotional experience, 2) driving comfort, and 3) general immersion was administered after all driving was completed in order to assess presence.

Experimental Outcomes

SUDS ratings found that despite the increase in subjective anxiety among all subjects from baseline to after the initial driving of either course, the phobic group found the experience significantly and consistently more anxiety producing than the normal driver group. These differences were found to be statistically significant. Also, an interesting pattern emerged in the downward trend in anxiety ratings following the second repetition of the practice course as seen in figure 3. These data showing a decrease in anxiety following repeated exposure to a feared situation suggest exactly what is expected in exposure therapy. These results may be due either to an extinction of fear effect or habituation to the novelty of the stimulus. As seen in figure 3, anxiety was again reported at higher levels following the test course. This is not surprising as the test course, being more complex, presents a new and difficult challenge to the drivers, thus, a novelty effect. If the test course had been repeated, it is likely that the same pattern would have emerged as in the second driving of the practice course. Overall, these data support our hypothesis that VR was able to create an environment that caused strong emotional reactivity especially among persons who found that environment aversive. Additionally, the data suggest that VR may enable practitioners to use virtual environments for repeated imaginal exposure as during typical exposure psychotherapy sessions.

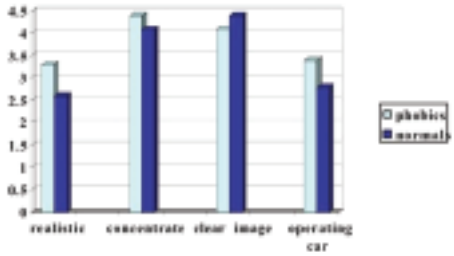
Stop Sign Intersection with Car Interior
Photo courtesy of Imago Systems, Inc.

Road Hazard
Photo courtesy of Imago Systems, Inc.

However, while the SUDS data supported our hypothesis that VR was able to produce an emotionally reactive environment, especially for those who perceived this situation as aversive, the cardiovascular data showed no such pattern of results and did not discriminate between the phobic and normal drivers. Either the cardiovascular measures were not sufficiently sensitive to detect differences among the participant groups and their driving experiences or (as the investigators speculate) our measurement equipment was not able to detect differences that may have existed.

On the measures of driving experience, phobics acknowledged significantly higher levels of anxiety than the normal drivers but reported similar levels of depression and hostile feelings. These data are an additional confirmation of the emotional differences found between the two groups of drivers. They consistently differ on self-reported levels of anxiety related to driving but not on other emotions. The two participant groups did not differ on their experience of driving comfort, finding the seat somewhat good, the headset moderate and the pedals not comfortable. Overall, the participants' level of immersion in the experience could be characterized as moderate to weak. They were able to concentrate on the task and perceive a clear image but found the task somewhat unrealistic and not like driving a real car.

Figure 5. Immersion Ratings of the VR Driving Experience



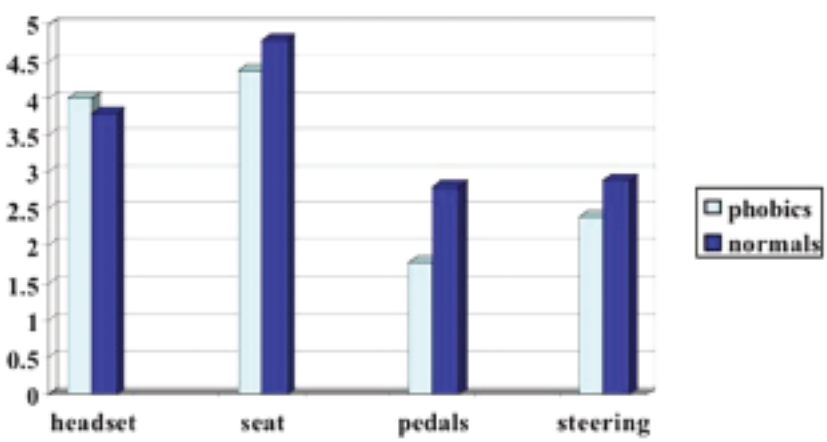
Note: higher scores indicate a greater level of immersion in the VR imagery. 7 is maximum possible rating.

The findings of this experiment suggest that phobic drivers do indeed experience an anxious event when subjected to driving under VR conditions that is significantly different from that of normal drivers. As we had hypothesized, the phobic drivers consistently reported higher levels of anxiety than the control group. Additionally the pattern of results for each trial of driving suggests that repeated exposure to driving courses may result in the same diminishment of anxiety that is typically expected during exposure therapy done without VR equipment. From this we conclude that VR may be quite efficacious in exposure therapy.

While subjective anxiety is felt and acknowledged by the participants through self-report measures, our equipment may have been too insensitive or not been optimized to detect psychophysiological changes such as minute changes in heart rate or systolic blood pressure. For example, we did not have the capability to continually monitor these changes *while* the driving was occurring.

The measures of experience in the VR car suggest that improvements in its design, particularly the gas and brake pedals, may help to make this experience more realistic for all participants. Our hypothesis suggesting a greater level of immersion for the phobic participants was not supported, suggesting that immersion is somewhat related to the physical reality of the experience. Clearly these results speak to the importance of how realistically the model is designed and should be considered important criteria for constructing better VR simulators. Overall, better equipment and software should improve immersion.

Figure 4. Comfort Ratings of the VR Driving Experience



Note: higher scores indicate a more comfortable experience, 7 is the maximum possible rating.

A New Beginning

Thanks to a generous gift from Mrs. Patricia Zarb, chairperson of the Saltzman Community Services Center Advisory Board, a VR laboratory has since been established in the Psychological Evaluation, Research & Counseling (PERC) Clinic. This facility has been treating individuals with a variety of anxiety disorders since September 2004. Better software and equipment has helped us to improve the sense of presence necessary for the VR environments to be effective. Additionally, our VR research is branching out in a number of directions. One upcoming project studies the efficacy of treating aviophobia, the fear of flying, by using a simulated interior of a commercial airliner. We are grateful to Delta Airlines for its recent donation of airline seats to our laboratory. Another study in preparation merges the interests of two Saltzman Center clinics, the

PERC Clinic and the Speech-Language-Hearing Clinic. Using VR software developed for the treatment of glossophobia, public speaking anxiety, an innovative project is being prepared to treat the anxiety component found to cause stuttering in many individuals.

VR is a technology likely to have a strong future in Behavior Therapy. Many virtual environments are being constructed around the world to treat a greater variety of anxiety disorders. Already, innovative research projects are underway for pain management, for teaching self-control skills to children with attention-deficit/hyperactivity disorder and for neurological rehabilitation. Here at Hofstra, we are happy to be on the cutting edge of this new technology.

Mitchell Schare holds the rank of professor and is director of the Ph.D. Program in Combined Clinical & School Psychology at Hofstra. In 1985 he completed a doctorate in clinical psychology, with specialization in substance abuse behaviors, at the State University of New York-Binghamton, following an internship at the Brown University Medical School Consortium in Providence, Rhode Island. Dr. Schare holds a Diplomate from the American Board of Cognitive & Behavioral Psychology.

Dr. Schare has published more than 30 articles in scientific journals or books and has presented more than 70 professional papers both nationally and internationally, maintaining regular contacts with colleagues in Russia and India. He is an active member of the American Psychological Association, the Association for the Advancement of Behavior Therapy, the New York State Psychological Association and various graduate school training councils, and has presented many times at meetings of these groups. Dr. Schare is often interviewed by media organizations and has been quoted in newspaper and magazine articles as well as on television.

As a consultant, Dr. Schare has developed therapy or educational programs for a number of major institutions in the metropolitan New York City community, including Pilgrim Psychiatric Center, the U.S. Navy, Creedmoor Psychiatric Center, St. John's Episcopalian Health Services and Bronx Psychiatric Center. He serves as a lecturer for the SUNY Medical Program of the Health Science Center at Brooklyn (Downstate) as well as the Ross University Medical School. For a number of years, Dr. Schare has participated on the Tobacco Action Coalition of Long Island.

Since 1987, Mitchell has maintained an active private practice in Commack (western Suffolk county) where he resides with his family. His areas of clinical expertise include substance abuse disorders (particularly alcohol and cigarette dependencies), anxiety disorders (including phobias, stress management, post-traumatic stress disorders), sexual disorders (both dysfunction and paraphilias), marital problems, and mental retardation. Dr. Schare is licensed to practice by the state of New York.

Joseph Scardapane has been a teacher, researcher and psychologist at Hofstra since 1991. Currently, Dr. Scardapane is acting director of the Joan and Arnold Saltzman Community Services Center and director of the Psychological Evaluation, Research and Counseling (PERC) Clinic. He has previously held the positions of school psychologist for the Board of Cooperative Educational Services for Southern Westchester, New York, and chief clinical psychologist at the Southeast Nassau Guidance Center in Seaford, New York.

Dr. Scardapane received a B.A. in psychology from New York University in 1978, an M.A. in psychology from Hofstra University in 1979 and, in 1983, a Ph.D. in clinical-school psychology from Hofstra. Since 1984, Dr. Scardapane has held a private practice in psychology; he is certified by the state of New York as both a psychologist and a school psychologist. Additionally, Dr. Scardapane is certified in rational-emotive behavior therapy.

As director of the PERC Clinic, Dr. Scardapane serves two doctoral programs by teaching and supervising students in psychological assessment and cognitive-behavioral therapy. He also oversees the counseling services provided for Hofstra University students. Under Dr. Scardapane's direction, the PERC Clinic also consults with and provides psychological assessment and intervention for local schools.

Dr. Scardapane has made numerous presentations both nationally and internationally on topics ranging from the intellectual assessment of bilingual children to the use of acceptance-based techniques in cognitive-behavioral therapy. His presentations include, "The Use of Mindfulness Meditation in the Treatment of Chronic Pain, Chronic Fatigue Syndrome and Anxiety," and "The Use of In Vivo Barbing in the Treatment of Anger in Children." Both papers were presented at the international seminar *Eastern and Western Ideas on Mind and Consciousness in Psychological Health* in Pune, India. Along with his doctoral students, Dr. Scardapane is currently investigating the use of virtual reality therapy in the treatment of verbal avoidance in people who stutter. He credits the Saltzman Center's multidisciplinary approach to treatment for the opportunity to work in this new area.