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Clinical Observations During Virtual Reality Therapy for Specific Phobias

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ABSTRACT

Virtual environments offer a new method of providing exposure therapy to patients with specific phobias. Although the stimuli (three-dimensional computer simulations) is new, the method of systematically desensitizing the patient to phobic stimuli until habituation occurs is a concept that was formally introduced by Joseph Wolpe over 40 years ago. Our article discusses some of the clinical observations that have been made during nearly 500 virtual reality exposure therapy sessions with patients and research participants who have come to our center in the past 15 months with a fear of flying or driving.

INTRODUCTION

OVER THE PAST 15 MONTHS (October 1997 to January 1999) we have completed nearly 500 virtual reality (VR) therapy sessions with patients and research participants. Although some of the reactions that we have observed when patients enter the virtual world have been somewhat predictable, others have been completely unexpected.

We believe it is important to carefully and accurately observe and measure the patient's response to virtual environments. We therefore use a variety of measurement techniques. These measurements range from subjective to objective and include:

1. Subjective Units of Discomfort (SUDS). The patient is asked to rate their anxiety on a scale from 0 to 100, with 0 being no anxiety and 100 being the most anxiety they have ever felt.
2. Self-report. Several self-report measures are employed to get a feel for how the patient personally rates themselves on anxiety and fear of flying scales. Scales employed include the State-Trait Anxiety Inventory,[1] the Fear of Flying Inventory,[2] the Questionnaire on Attitudes Towards Flying,[3] and the Self-Survey of Stress Responses.[4] In addition, the patient is asked to respond to an absorption questionnaire, the Tellagan Absorption Scale,[5] that asks about the patient's ability to become absorbed into a different environment, for instance a book or a movie. The therapist, in addition, administers a Hypnotic Induction Profile[6] to see how hypnotizable the patient might be. This scale may be a reasonable predictor for how immersed in the VR environment the patient may become or how quickly the patient can become immersed.
3. Overt behavior. The therapist is observant of whether the patient is sitting quietly in a

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relaxed manner and is not interacting with the virtual world, fidgeting and anxiously gripping the chair arms as the virtual environment unfolds, or interacting in a calm manner with the virtual world. Patient comments and facial expressions are also noted.

4. Physiology. On the more objective end of the spectrum, real-time physiology is monitored and measured during the entire session. This includes measurement of heart rate, respiration rate, peripheral skin temperature, skin resistance (a measure of sweat gland activity), and brain wave activity at two different sites (Cz and O1). Skin resistance has been shown to decrease as physiological arousal and anxiety increase and as sweat glands are activated.[7]

In Figure 1 we have outlined the scale of the different types of evaluative measures that were used, which span the continuum from subjective to objective.

According to Lang's[8] 1985 proposal, anxiety assessment should include subjective and objective measures. He hypothesized that anxiety involves three systems—physiology, overt behavior, and subjective experience. He also stated that the motor program of fear (as evidenced by physiological arousal) must be activated in order to change the person's fear structure and have resulting behavioral change.[8] We have therefore included self-report measures and subjective units of discomfort to measure the participant's subjective experience, physiological measures to determine if physiological arousal is experienced by the participant when exposed to the phobic stimuli, and overt behavioral observations to determine if the participant is outwardly experiencing anxiety or attempting to avoid the stimuli.

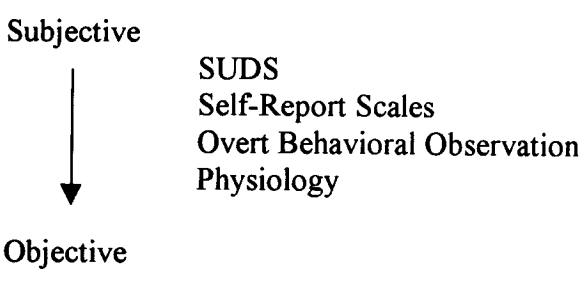

FIG. 1. Evaluative Measures used during VR therapy.

Foa and Kozak[9] speak of the "emotional processing" of fear and indicate that in order to change the person's fear, the fear structure must be activated and incompatible information must be provided. For example, if a person is fearful of being bitten by a dog, yet is exposed to a dog numerous times without being bitten, this incompatible information would allow for a change in the fear structure. This change could be seen as a reduction in the person's avoidance of dogs. Foa and Kozak[9] further put forth that, to determine if a person's fear structure has been activated, physiological arousal as well as subjective anxiety must occur. In addition, as treatment continues and habituation occurs, there should be a lessening of arousal, both subjectively and objectively. By including both subjective and objective measures in our study, we have the ability to determine if the person's fear structure has been activated and is therefore open to change (i.e., if emotional processing of the fear has occurred).[9]

Because individual patients exhibit wide variation in their responses to virtual environments, we are exploring those factors and characteristics that might effect therapeutic success. Some of these factors include hypnotizability and absorption, which correlate quite strongly with one another as is known from previous studies.[6] We are looking at how these measures might effect one's sense of presence in VR as well as how they might effect one's ability to become immersed in the virtual world (Fig. 2).

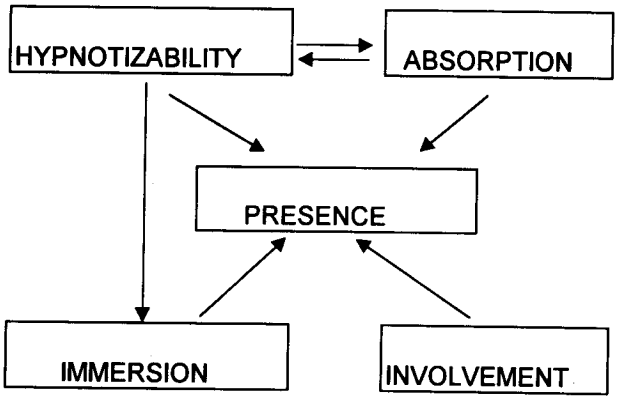

FIG. 2. The possible interrelationships among an individual's degree of hypnotizability, ability to become absorbed, and the constructs of presence, immersion, and involvement.

We are also trying to determine what effects immersion and involvement might have on one's sense of presence.

In beginning to understand how patients respond to and interact with the virtual world, we have constructed an initial theoretical framework. In this model, patients are assigned to one of four groups based on their subjective and objective reactions to the virtual world.

We are basing the subjective arm of the framework on the patient's self-report SUDS scores, and the objective arm of the framework on the patient's skin resistance changes from baseline through a 20-minute VR exposure session (Fig. 3).

This effort is an initial attempt to integrate both subjective and objective data into a clinical model that will be useful to predict successful entrance and passage of patients through the virtual world scenarios. The model may be useful in predicting therapeutic successfulness of patients in virtual environments. We are beginning to see interesting patterns emerge from the large number of patients who have undergone VR therapy.

CASE EXAMPLE OF GROUP 1 PARTICIPANT

Persons who fall into the Group 1 category tend to exhibit high subjective and objective arousal in the virtual world (Fig. 4). We see these persons as being highly phobic and capable of becoming highly immersed in the VR environment. Because of this feeling of presence and ability to become immersed, it appears that the person's fear structure is accessed as evidenced by the subjective and objective arousal obtained from the virtual

		SUDS HIGH	SUDS LOW
PHYSIOLOGY	AROUSED	1	2
	NORMAL	3	4

FIG. 3. A framework used to determine what category a patient falls into based on subjective anxiety (measured by SUDS) and objective anxiety (measured by skin resistance).

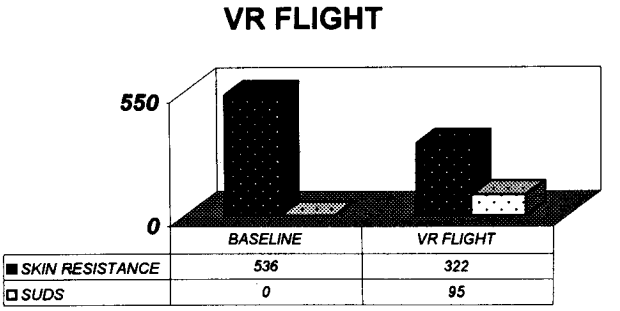

FIG. 4. The subjective and objective responses of an individual in Group 1 of the framework.

stimuli.[9] It would appear from studies done thus far that this is the candidate who will be treated most quickly and effectively using the virtual environment. Whereas those in other categories may take several sessions to feel fully immersed in the virtual environment, patients in this category become easily immersed during the first session and continue a high level of immersion and involvement throughout therapy.

For example, a Group 1 patient had experienced a fear of flying for the past 27 years. In particular, the fear was of the plane crashing. When tested on the Hypnotic Induction Profile and the Tellegan Absorption Scale, the person scored high on both. This patient, therefore, had the ability to become highly absorbed into whatever was occurring, whether it be reading a book or watching a movie.

After two sessions of relaxation and breathing re-training to use as a coping technique when entering the virtual environment, the participant was exposed to the VR flight during the third session. At baseline, skin resistance was 536 and SUDS was 0. A 20-minute VR flight then occurred whereupon skin resistance levels fell 40% to 322 and SUDS levels increased to 95, indicating both high subjective and high objective arousal. This person reported that they were "on the plane," experiencing the same sensations experienced on a real-life airplane flight.

This has been the most typical response we have seen when phobics have been placed into the virtual world. This participant was exposed to the VR flight experience for five more sessions, for a total of six 20-minute exposure flights, and has now flown successfully on four

round-trip flights—one of which was coast-to-coast. As therapy progressed, her SUDS level decreased and her skin resistance increased, indicating that she was habituating to the initially anxiety-provoking VR flight. At this point, she would be said to fall into Category 4 of the framework—low subjective and low objective arousal. This seems to follow what has been purported by Foa and Kozak[9] in emotional processing theory. There was initial physiological and subjective arousal followed by a decrement in both systems of arousal. It could be assumed that the fear structure had been activated and changed during the course of exposure therapy.

CASE EXAMPLE OF GROUP 2 PARTICIPANT

Patients in Group 2 show a high level of physiological arousal but low subjective arousal (Fig. 5). People in this group might be experiencing emotional numbing or a disconnect between what their bodies experience and how the mind perceives that experience; or perhaps these people are not being totally honest with either themselves or their therapists, or both, for whatever reason. Some patients try to appear "macho" and do not want to admit a computer-generated environment could elicit anxiety. These patients have only experienced one part of emotional processing, and it appears they must experience the processing of subjective fear as well as objective fear in order for a decrement in fear to occur.

A patient who fit the criteria for Group 2 had experienced a fear of flying since the first airline flight taken 8 years prior. In particular, the fear centered on having a panic attack on the plane and not being able to escape. The participant was given two sessions of relaxation and breathing re-training and was then placed into the virtual environment for a 20-minute VR flight.

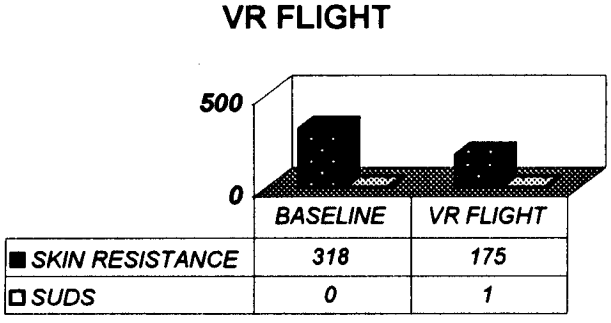

FIG. 5. The subjective and objective responses of an individual in Group 2 of the framework.

The participant's skin resistance decreased by 45% (from 318 to 175) when placed into the virtual world, indicating a very strong physiological response of arousal, but the SUDs score only rose to 1, indicating no real subjective anxiety from the experience. The participant did continue treatment and was able to admit to a subjective feeling of anxiety in future sessions. The participant was also able to verbalize the embarrassment felt initially over having such a strong response to a computer-generated, somewhat cartoonish, virtual world. With further therapy, the patient did admit to having a high SUDs score during the simulation, effectively transforming this patient into a "Group 1-like" individual. After dealing with the fear, this participant was eventually able to fly.

CASE EXAMPLE OF GROUP 3 PARTICIPANT

In Group 3 participants, despite high levels of subjective discomfort, little or no physiological arousal is experienced when placed in the virtual world (Fig. 6). A number of explanations could explain these findings, however, likely scenarios include social desirability, secondary gain, or possibly a disconnect. Social desirability might lead to a person reporting high subjective anxiety if they have read or been told how others have received help from this treatment and if they have been told that others can easily become immersed in the virtual world. Not wanting to disappoint their therapist or report something different, they also subjectively report feeling anxious even though they are not physiologically feeling any anxiety. They may have simply been unable to become fully immersed and involved in the virtual world and therefore may be getting little arousal from it.

Secondary gain might also cause someone to report high subjective anxiety. For instance, in

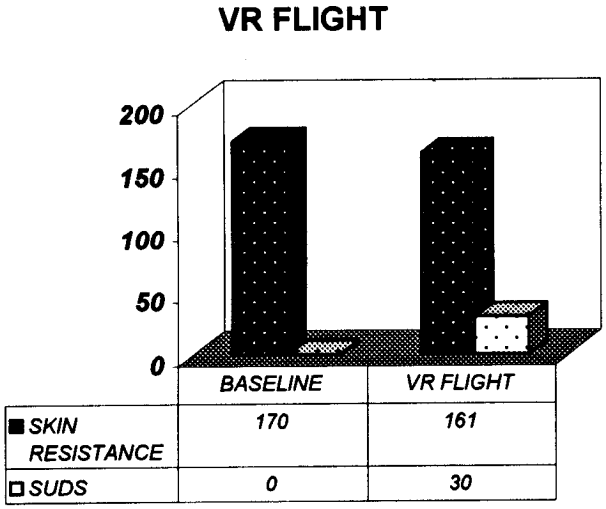

FIG. 6. The subjective and objective responses of an individual in Group 3 of the framework.

a lawsuit, if someone were claiming to be anxious about driving after an automobile accident, they may find it advantageous to subjectively verbalize anxiety even though objectively no physiological arousal is observed when placed into the virtual driving environment. Also persons in this category might experience a disconnect between what their mind witnesses and what their body feels.

A participant that met the Group 3 description came to us after having a fear of flying for 30 years. The fear focused on a fear of crashing, and the participant had tried numerous "quick fix" psychological treatments; none of which had provided relief from the fear. The participant had seen the VR treatment explained on a television program and had heard that it had a high rate of success in treating persons with a fear of flying. The participant traveled a long distance to our clinic to seek treatment. After learning breathing and relaxation exercises, the person was placed into the virtual world and reported feeling moderate anxiety, although very little changed physiologically. After finishing the 20-minute exposure session, we talked with the participant and discussed the lack of physiological arousal. At this point a "confession" was forthcoming. The participant had felt no real anxiety and had been unable to become immersed in the world. It was explained that this was completely normal—some persons took two or three sessions to become fully immersed in the virtual world. After realizing this was an "acceptable" response, the participant relaxed and in future sessions was able to become immersed in the virtual world and experience physiological arousal as well as "real" subjective arousal. Again, the participant was able to convert to the "Group 1-like" category. Six sessions were completed, and the participant who had traveled to our Center by train was able to take an airline flight to return home.

CASE EXAMPLE OF GROUP 4 PARTICIPANT

Among phobics, persons in Group 4 appear to be rare and may reflect those with an inability to become immersed in the virtual world—like those in Group 3. Although, unlike those in Group 3, these persons report a truer picture of their subjective arousal and anxiety (Fig. 7). If a person cannot become immersed and feel present in the virtual world, then the fear structure may not be accessed and arousal may not occur. The only persons we have seen in this category thus far, however, have been nonphobics. When placed in the virtual environment of an airline flight no fear structure is accessed and therefore no arousal occurs because these people are not fearful of flying.

One of our nonphobic participants came to us and self-reported that flying was tremendously satisfying for her. She actually found it quite relaxing and enjoyable. When placed into the virtual world her skin resistance actually increased above baseline levels indicating physiological relaxation, and her SUDS of 0 reflected no subjective anxiety.

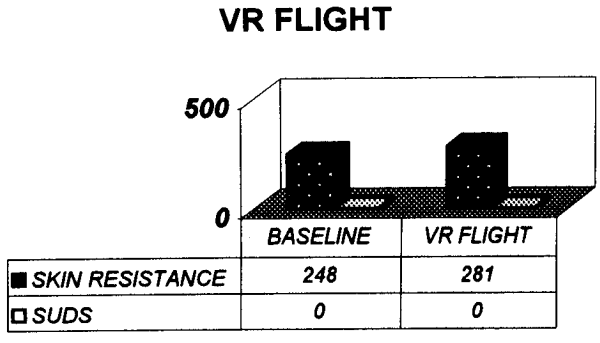

FIG. 7. The subjective and objective responses of an individual in Group 4 of the framework.

OTHER OBSERVATIONS

Two other very significant observations made while doing virtual therapy thus far are a panic attack elicited by the VR/flying scenario and a flashback elicited by the VR/driving scenario.

Panic attack example

The person experiencing a panic attack had experienced a fear of flying for over 10 years before coming to us for treatment. Having tried imaginal therapy with no success, there was some skepticism on the person's part about the success of VR exposure therapy. The patient was taught breathing retraining was then placed into the virtual world for treatment. Two sessions were completed with moderate anxiety and physiological arousal (Group 1 of the framework). During the third VR session, the participant's heart rate increased from 80 to 120 beats per minute within a 15-second time period. When asked if everything was okay, the participant stated that a panic attack was occurring. The participant chose to stay in the virtual world and breathe through the panic attack. This served two important roles. The participant, who was scared of going on a plane and having a panic attack and being embarrassed, learned that outwardly no one could see a panic attack was occurring. The only way the therapist knew an attack was underway was because the heart rate was being monitored and showed a very sudden and dramatic increase. The participant also learned that, with the use of a new breathing skill that could serve as a coping technique, the panic attack was under control and heart rate had been stabilized within 2 minutes. This empowered the participant and self-efficacy was improved, allowing therapeutic improvement to continue. The participant successfully flew in a plane upon completion of the VR exposure therapy.

Flashback example

The patient who had a flashback had been involved in a very bad traffic accident and had been unable to drive for 5 years following the accident due to intrusive thoughts, an inability to successfully illicit anxiety during imaginal therapy, and a refusal to try *in vivo* exposure because of a feeling of lack of control and safety. After learning breathing and relaxation skills, VR exposure therapy was begun. The patient did quite well and had begun to physiologically stabilize when driving down the straight road and amongst buildings in the VR world. Right turns were then attempted and again, success was achieved. During the fifth session, the patient was asked to negotiate a left turn, which caused a re-experiencing of the traumatic traffic accident. The patient had been a passenger in a taxicab and the taxicab driver had fallen asleep and veered left into oncoming traffic. Turning left in the VR world brought all the memories of the accident flooding back. The patient asked to be removed from the VR scenario and processing of the experience occurred during the remainder of the treatment session. After this, the patient quit having nightmares about the accident and after several more VR sessions was able to begin *in vivo* driving once again.

FEEDBACK ON IMMERSION AND PRESENCE

It is clear that different individuals experience different degrees of immersion in the virtual world. The degree of immersion experienced by patients also appears to vary as treatment progresses. We believe a person's ability to become immersed quickly may depend on the degree of hypnotizability. Therefore, we feel it is important to perform a Hypnotic Induction Profile (HIP)[6] and administer a Tellegan Absorption Scale (TAS)[5] self-report questionnaire to each participant. In addition, participants should complete a Simulator Sickness Questionnaire, a Questionnaire on Presence and Realism (QP&R), and a Virtual Environment Usability Questionnaire, all of which were developed by Anne Parent[10] (Canada) and have been revised only slightly for our study. The HIP, TAS, and QP&R should help determine which factors influence an individual's feelings of presence and immersion in virtual worlds. In addition, the usability questionnaire should provide some insight for system developers on what factors are most important ergonomically in the construction of virtual worlds.

Researchers have noted that a sense of presence or "being there" is what distinguishes a virtual environment from a non-interactive multimedia experience. Although users may intuitively "know" that they are not actually in an airplane, they often subjectively report that they are "there." Presence is thought to be optimal when an individual feels immersed in the environment, feels able to interact with the world, and has an interest in the environment portrayed.[11] The participants in the study received immersion via a head-mounted display that did not allow for the outside world to be seen once it was placed on the user's head. The participants were also able to interact with the VR world through use of a tracker mounted on the display. When the participant turned his or her head to the left, the left airplane wing outside the plane window could be seen. When he or she turned to the "straight forward" position, the seat back and tray table of the airline seat in the row in front could be seen as well as the tops of the other rows of seats in the plane. When the head was turned to the right, he or she could look around the passenger cabin of the plane and also out the right airplane window. Looking down and to the right, a virtual magazine could be seen. Because the virtual world provided visual, auditory, vestibular, and vibratory cues to participants, almost all reported a subjective feeling of presence; although the time it took for total immersion to occur varied by individual as did amount of presence experienced.

FURTHER COMMENTS ABOUT THE VIRTUAL WORLD

As interesting as the physiological responses and self-report of anxiety to the virtual world have been, the individual comments participants have made have provided further insight of how unique the virtual experience may be for different individuals. Because each individual brings his or her own personality and past experiences into the virtual world, different and individual experience can be felt by each person.[12] Our experiences has been that each individual appears to begin "filling in the pieces" in the environment as treatment progresses; personalizing the environment and making it "their own" VR world.

Some of the comments participants have made include:

"Oh my! I was on the plane, and when the program ended, I was like 'Hello, you're only sitting in a chair in the therapist's office! You're not really on a plane.' But until then, I was on that plane, feeling all that anxiety I feel when I really fly."

"I knew I was in your office, and I knew it was just a computer program, but I thought to myself, 'If I tell her my SUDS are lower, the plane is going to takeoff and then I'm going to be stuck up in the air.' One part of me seemed to know that wasn't true, yet another part of me really believed that would be the consequence."

"I didn't even question that I was on a plane."

"The whole time I was going through treatment, it seemed totally unrealistic and cartoonish to me. I really didn't think it had helped at all. But when I got on a real plane and we were sitting on the runway, I just shut my eyes and began imagining that silly music in the VR world. Then, I started doing my breathing and before I knew it we were flying at altitude. It all seemed so familiar to me that I didn't even get scared."

"I have flown four times now with no drugs and no alcohol—this program has given me a whole new lift."

"I didn't want to admit that a computer program could make me feel anxious, but it did."

"It's in your face—you can't avoid it the way you can visualization."

CONCLUSION

In conclusion, we are beginning to see a variety of interesting patterns emerge when patients are treated in virtual worlds. Our goal is to recognize these patterns and develop therapy-specific protocols that will more effectively and successfully be applied across a diverse patient population.

As one can see, many patients have a very strong subjective and objective reaction to the VR environment. It is therefore important to

stress that the VR environment as well as the physiological monitoring processes are only tools for clinicians to use as an adjunct to their clinical skills. The addition of these technologies into the clinical session does not in any way take the place of good clinical skills but rather should serve to enhance those skills. Therapists must have the appropriate skills to help the patient begin to process the reactions that may occur when exposed to the phobic stimuli in the VR world.

REFERENCES

1. Spielberger, C.D., Gorsuch, R.L., and Lushene, R.E. (1970). *Manual for the State-Trait Anxiety Inventory (Self-Evaluation Questionnaire).* Palo Alto, CA: MindGarden, Inc.
2. Scott, W. (1987). A fear of flying inventory. In P. Kellar and S. Hayman (Eds.). *Innovations of clinical practice* (vol. 7). Florida: Professional Resource Exchange.
3. Howard, W.A., Mattick, R.P., and Clarke, J.C. (1982). *The nature of fears of flying.* Unpublished manuscript, University of New South Wales.
4. Forgione, A.G., and Bauer, F.M. (1980). *Fearless flying: The complete program for relaxed air travel.* Boston: Houghton Mifflin.
5. Tellegen, A., and Atkinson, G. (1974). Openness to absorbing and self-altering experiences ("absorption"): a trait related to hypnotic susceptibility. *Journal of Abnormal Psychology, 83,* 268–277.
6. Frischholz, E.J., Spiegel, D., Trentalange, M.J., and Spiegel, H. (1987). The hypnotic induction profile and absorption. *American Journal of Clinical Hypnosis, 30*(2), 87–93.
7. Schwartz, M.S., et al. (1995). *Biofeedback: A practitioner's guide.* New York: Guilford Press.
8. Lang, P.J. (1985). The cognitive psychophysiology of emotion: Fear and anxiety. In A.H. Tuma and J.D. Maser (Eds.). *Anxiety and the anxiety disorders* (pp. 131–170). Hillsdale, NJ: Erlbaum.
9. Foa, E.B., and Kozak, M.J. (1986). Emotional processing of fear: Exposure to corrective information. *Psychological Bulletin, 99,* 20–35.
10. Parent, A. Unpublished questionnaires. Online document, http://www.trytel.com/~aparent.
11. Stark, L.W. (1994). Why virtual reality works: Top-down vision in humans and robots. In ICAT '94 Proceedings: The Fourth International Conference on Artificial Reality and Tele-Existence, Tokyo.
12. Hodges, L.F., Rothbaum, B.O., Alarcon, R., Ready, D., Shahar, F., Graap, K., Pair, J., Hebert, P., Gotz, D., Wills, B., and Baltzell, D. (1999, January 23). Virtual Vietnam: A virtual environment for the treatment of Vietnam War veterans with post-traumatic stress disorder. Virtual Reality and Mental Health Symposium of Medicine Meets Virtual Reality, San Francisco.

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