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Article *in* CyberPsychology & Behavior · September 2003

DOI: 10.1089/109493103322278844 · Source: PubMed

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CYBERPSYCHOLOGY & BEHAVIOR
Volume 6, Number 4, 2003

Three-Year Follow-Up for Virtual Reality Exposure for Fear of Flying

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ABSTRACT

Thirty participants who had been treated for aviophobia with virtual reality graded exposure therapy with physiological monitoring and visual feedback (VRGETpm), virtual reality graded exposure therapy with physiological monitoring only (VRGETno), or imaginal exposure therapy (visualization) with physiological monitoring only (IET) between January 1998 and January 1999 were contacted in January 2002 for a 3-year posttreatment follow-up assessment. Of the participants in the VRGETpm group who had flown successfully by the end of treatment, all had maintained their ability to fly at follow-up. Of the participants in the VRGETno group who had flown successfully by the end of treatment, two were no longer able to fly. Of the participants in the IET group who had flown successfully, all were still able to fly. It appears that the addition of teaching self-control via visual feedback of physiological signals may serve to maintain treatment gains in long-term follow-up.

INTRODUCTION

EXPOSURE THERAPY has long been shown as an effective treatment for reducing symptomatology in those suffering from specific phobias. As has been previously reported,[1,2] long-term follow-up of controlled clinical studies using behavioral techniques are sparse. However, in a more recent study that included a review of the 17 studies that did include long-term follow-up, it was shown that treatment effects may be maintained for up to 10 years after treatment ends.[3] The current study served to make contact with those who had participated in a controlled study between January 1998 and January 1999 on fear of flying treatment.[4–6] We were interested in determining whether treatment relapse had occurred differentially in any of the three treatment groups. Our findings for the VRGETpm (virtual reality graded exposure therapy in combination with physiological feedback) group are consistent with previous reports on the long-term efficacy of *in vivo* exposure therapy for specific phobia treatment, and are the first 3-year follow-up for virtual reality exposure therapy for specific phobia treatment. These results seem to indicate that VRGETpm may be a robust treatment, even at long-term follow-up. With respect to virtual reality exposure therapy (VRET) (without physiological monitoring or feedback) for fear of flying, a 12-month posttreament follow-up was completed by Rothbaum, et al.[6] Results indicated that at 6-month follow-up those in both a VRET group and an *in vivo* group had maintained treatment gains. However, at 12-month follow-up, with 80% of participants completing follow-up self-report questionnaires, 17% of participants reported they had avoided flying, and participants in the VR group reported they were more likely to utilize medication or alcohol to overcome anxiety on flights (73%) than those in the *in vivo* group (30%).

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ORIGINAL STUDY

Method

Participants. The study, performed over a 1-year period, was approved by the Internal Review Board at the California School of Professional Psychology, San Diego. The original sample consisted of thirty participants, comprising three treatment groups: virtual reality graded exposure therapy with physiological monitoring and visual feedback (VRGETpm) (n = 10), virtual reality graded exposure therapy with physiological monitoring only (VRGETno) (n = 10), or imaginal exposure therapy (visualization) with physiological monitoring only (IET) (n = 10). Participants who had a history of heart disease, migraines, seizures, or concurrent diagnosis of severe mental disorders such as psychosis or major depressive disorder were excluded. The mean age of the sample was 39.80 (SD = 9.69), with a range from 24 to 55 years. Seventy-three percent were white collar/professional status workers, 10% were students, 7% were young retirees, 3% were blue-collar workers, and 7% were unemployed. Ninety-three percent were Caucasian and 7% were Hispanic. Further details regarding the sample may be found in the original study report.[3]

Procedure. Detailed procedures for the initial study may be found elsewhere.[3–5] All groups were given eight sessions of treatment: two sessions of breathing retraining and six sessions of exposure to phobic stimuli, either imaginally or via virtual reality. Exposure sessions were each 20 min in duration. The VR, or three-dimensional computer stimuli, was administered via a Liquid Image head-mounted display (HMD) with a Polhemus INSIDETRAK position tracker. The VRGETpm group was allowed to view visual feedback of physiology while learning diaphragmatic breathing as a coping mechanism to use during exposure in VR. The VRGETno and IET groups were taught diaphragmatic breathing with a therapist modeling appropriate behavior, but with no visual feedback of physiological signals given during any of the sessions. The VRGETpm group was progressed through the various parts of the simulated flight based on physiological stabilization as evidenced by the ability to stabilize skin resistance levels. The VRGETno group was progressed based on SUDS (subjective units of distress) on a 0 = no anxiety to 100 = maximum anxiety scale. The IET group members were each progressed based on SUDS levels through an individualized hierarchy of phobic flying scenarios that was decided upon with the therapist during session 2.

Measures

Physiological measures. Physiology for all three groups was measured and recorded during a baseline period and real-time during each exposure session using an I-330 C2 computerized biofeedback systems with PDS Physiological Programming Software. Measurements included electroencephalogram (EEG), or brain wave measurements at two separate locations, CZ and O1; respiration rate, skin resistance, heart rate, and peripheral skin temperature. The two VR groups progressed through several virtual reality scenarios including sitting on the runway with engines off, engines on, taxi to the gate, takeoff, flying at altitude in good weather, flying at altitude during turbulence and thunderstorms, and landing.

Self-report questionnaires. In addition to SUDS levels and physiological measures, a number of self-report questionnaires were used to assess participant progress. Self-report questionnaires were given pre-treatment, after two sessions of breathing retraining, and posttreatment. In addition, all 30 participants were contacted posttreament, three months following the end of their 8-week treatment program and asked if they had been able to fly without medication or alcohol, with medication or alcohol to alleviate anxiety, or if they were unable to fly. Results from this post-treatment follow-up indicated 100% of those in the VRGETpm group able to fly with no medication or alcohol, 80% of those in the VRGETno group, and 10% of those in the IET group.

Results

The significance of this study was that it combined VR with physiological feedback for the first time in a controlled study for fear of flying. Although results for all three groups showed a lessening on self-report fear scores, all members of the VRGETpm group were able to translate the reductions into behavioral change, that is, an ability to fly without medication or alcohol. This did not occur in the other two groups. When questioned about their belief in their ability to fly posttreatment, the VRGETpm group also seemed to have increased self-efficacy compared to individuals in the other two groups. Eighty percent reported they felt they could fly effectively without medication or alcohol, and in actuality 100% flew. In the VRGETno

group, 80% said they could fly without medication or alcohol, and at initial 3-month follow-up, 80% had flown without meds or alcohol. In the IET group, only 10% said they could fly without alcohol or medication, and in fact only 10% did. Although the VRGETno group was more successful than the IET group, there seemed to be an added advantage in providing the coping mechanism of visual feedback of physiological stimuli during breathing retraining, not only in short-term effectiveness but also in long-term maintenance of treatment gains.

THREE-YEAR FOLLOW-UP PROCEDURE

We attempted to reach all of the thirty participants from the original sample for a semi structured telephone interview, based on the procedure used for a 3½-year follow-up on automated treatment for fear of flying done by Denholtz, et al.[1] We were able to contact all individuals in the two VR groups (100%), and 7 individuals (of 10) (70%) in the IET group, including the one individual from the IET group who had been able to fly at 3-month follow-up; for a total of 90% of the original sample. The three participants who did not participate had moved from the San Diego area with no forwarding telephone number or address given to the clinic. We asked all participants if they were currently able to fly, and if so, if they needed medication or alcohol to help alleviate anxiety prior to or during the flight. We also asked if they had continued to fly following treatment, or if there had been flights they avoided. This follow-up occurred in January 2002, just four months after the September 11th, 2001, terrorist attacks. All the participants contacted were willing to participate and appeared to respond honestly, with some responding in great detail via e-mail response. All participant responses were recorded, including attitudes toward flying, ability to generalize treatment gains to other areas of anxiety, and any other comments the participants felt were important to convey to the therapist.

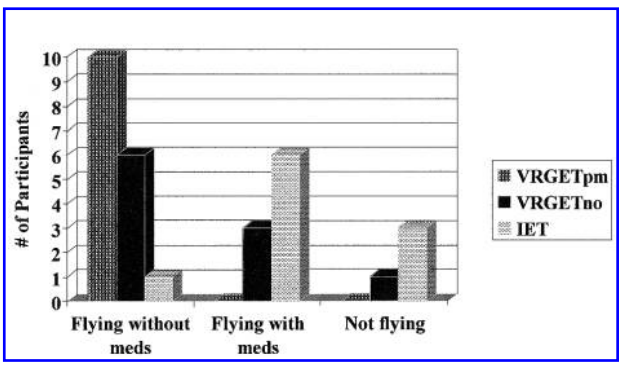

FIG. 1. Three year follow-up data.

Results

Many participants related that the treatment program had changed not only their anxiety and stress related to flying, but that skills learned during treatment had generalized into stress management during everyday life as well as in application to help conquer other phobias not targeted in treatment as well. In particular, one participant reported he used the techniques learned to help overcome his fear of heights *in* vivo without a therapist's assistance. Others have reported this carryover effect as well.[1,8,9]

Of those in the VRGETpm group, all were still able to fly successfully without the use of medication or alcohol to control anxiety (100%). Of those in the VRGETno group, two were no longer able to fly, a 20% recidivism rate. The one participant in the IET group who was able to fly successfully without the use of medication or alcohol at the end of treatment is also still flying successfully without medication or alcohol (Fig. 1). Of those in the VRGETno group, one participant chose to come for additional sessions that were offered to him at the time of the follow-up contact. He was treated with VRGETpm and has since flown successfully once again from California to New York.

Of particular importance, one of those in the VRGETpm group noted that she had flown less than two weeks after the September 11th terrorist attack, when many in the United States were still shaken and unable to fly. She flew from California to Florida for a wedding and stated that over half the invited guests had not attended due to anxiety over traveling. She said she believes the coping mechanisms she had learned as a part of the treatment program had allowed her to deal with the anxiety about flying and had provided a general stress management tool for dealing with the general stress felt after September 11th.

DISCUSSION

The results of our original study, as well as the results of the 3-year follow-up data, seem to indicate that virtual reality is an effective treatment for fear of flying. Additionally, there may be further benefit in the utilization of physiological monitoring and feedback during treatment of those suffer-

ing from phobias. Although current VR treatment methods do work better than imaginal exposure for studies performed to date[4–6]; and VR has been shown to be equally efficacious to *in vivo* exposure,[7,9,10] it seems evident that added benefit comes from visually observing your ability to control physiology during treatment. Not only was the VRGETpm group more successful initially at posttreament and 3-month follow-up, but also treatment gains were maintained successfully at 3-year follow-up. In follow-up studies of those given only VR exposure, without physiological feedback, results are not as favorable.[5–7] Our findings were also consistent with other reports that those who are not treated, or who are initially non-responders to treatment, are unlikely to spontaneously recover from a phobia.[1,2,11,12] None of the participants who were initially non-responders were able to fly when contacted for the 3-year follow-up.

In a recent book, Barlow[13] discusses breathing retraining, and its focus as a recent source of controversy. Its theoretical compatibility with other cognitive and behavioral components has been questioned,[14,15] however, only one study has used a dismantling design to systematically review this component of treatment. In their study, it was speculated that breathing retraining may cause a patient to be at greater risk of relapse, however, it was concluded that because careful patient assessment was not adhered to, the study's generalizability is limited.[15] A clear distinction needs to be made between breathing retraining and breathing retraining done with visual feedback of the patient's physiology. In our study, all patients received breathing retraining, but the group receiving visual feedback reported an added ability to generalize this mechanism of control to real world behavioral changes. Others who use VR in combination with physiological monitoring and feedback also report the added value of visual feedback in patients' progress.[16] Participants reported enjoying the visual feedback provided by the physiological monitoring equipment and felt it motivated them to continue treatment since they could objectively see their improvement over time. As treatment progressed, they also seemed better able to distinguish between physiological arousal and relaxation, even without receiving feedback. This may have, in the real world situation, allowed them to begin using anxiety management techniques (diaphragmatic breathing) to lower anxiety before it reached intolerable levels.

The addition of physiological measures may also be important to help guide the therapist in administering treatment protocols, since all three participant groups reported a lessening of self-report questionnaire scores without subsequent behavioral change. Other studies have also shown that self-report questionnaire scores may not be an accurate indicator of treatment progress.

In addition, as reported by Rachman et al.[17–19] both subjective and objective arousal must be observed during exposure in order for a reduction in fear to then occur. What we observed was synchrony between SUDS levels and physiological arousal in those who were able to fly following treatment. Lang[18] reported that processing of the emotional component, as evidenced by heart rate changes of fear was necessary in order to have effective treatment. So, it would seem that according to Lang, desynchronous participants improved only on a cognitive level (based on SUDS measures) and not on a physiological level, and were therefore less likely to be deemed as "successfully treated" based on the treatment outcome measure of behavioral change.

Rachman[17] reported that synchrony is most likely to occur when the participant is placed in a highly arousing situation, and we found this also. Only 40% of those in the IET group were able to achieve synchrony. It may be concluded that VRGET is more arousing and may allow participants to remain more actively engaged in a situation, similar to *in vivo* exposure, rather than drifting "off task" as we often see with IET patients.

In terms of emotional processing theory,[19] it might be said that the fear structure changed as competing information regarding the feared stimulus was received and as responses to the once feared stimuli were changed. An anecdotal comment from one VR participant was that "VR is in your face—you cannot escape it". This allows for constant exposure to phobic stimuli, unlike those receiving IET who oftentimes cannot hold a mental image or elicit appropriate anxiety when asked to image scenes that in real life do cause fear. Because of the inability to elicit anxiety, or stay on task, a change in the fear structure may not have occurred.

FUTURE RESEARCH

Future studies should emphasize further testing of Rachman's theory on synchrony using heart rate variability, a more sensitive heart rate measure, as well as skin resistance. Consideration should also be given to replicating the current study, using larger sample sizes to compare VRGETno to VRGETpm. In addition, given the portability of some physiological monitoring systems, it might be useful to

add an *in vivo* group receiving physiological monitoring and feedback.[20] In addition, since some of those in the IET group did improve, it might be important to use a longer treatment period, perhaps 10–12 exposure sessions, to determine the exact length of time required for persons in an IET group to improve. This would help us to understand exactly how much more quickly VR might work at alleviating fears to the point that behavioral change occurs.

Additionally, as computer hardware and software advances, it will be important to build environments that allow more flexibility and adaptability for individual patients. Participants in the current study were overall quite impressed with audio and vibratory realness of the simulation, but many commented that they would have preferred less animated visual stimuli. Still, the animation did seem to be enough to elicit anxiety and then as treatment advanced allow desensitization to transpire. Finally, it is important to note that while the technology aspect of virtual reality and simulation treatment allows portrayal of images in a manner that is provocative, interesting, and engaging, it is primarily the skills of the therapist that allow achievement of successful therapeutic results.

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