Redefining Therapeutic Success with Virtual Reality Exposure Therapy

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ABSTRACT
The success rate for treating phobias with in vivo exposure is high. Unfortunately, few phobics (less than 15–20%) ever seek treatment. Virtual reality (VR) exposure therapy is also proving to be highly effective. The present surveys assessed 162 students high in fear of spiders. In Study 1, when asked to choose between multisession in vivo exposure vs. multisession VR exposure therapy, 81% chose VR. In Study 2, comparing one-session in vivo versus multisession VR exposure therapy, 89% chose VR. Results suggest that VR exposure therapy may prove valuable for increasing the number of phobics who seek treatment.

INTRODUCTION

Phobias are one of the most common mental disorders. It is estimated that about 6% of the general population in the United States suffers from a phobia.1 Among phobias, specific phobias seem to be highly prevalent. According to the most recent large surveys, the ECA and the NCS, about 10–11% of the population in the U.S. experiences a specific phobia.1,2 About 40% of specific phobias fall into the category of bugs (including spiders), mice, snakes, or bats.3 Spider phobics characteristically display a persistent fear of spiders, an immediate anxiety response upon exposure to a spider, and avoidance of spiders. Phobics often recognize that their fear is excessive or unreasonable.4 In fact, for some, fear of the irrational reaction they will have when encountering a spider (losing control, panic attack) is a major source of their anxiety. Spider phobias are twice as common in females than in males and typically begin in childhood.5 Consistent with Rachman’s theory about the acquisition of phobias,6,7 Ost and Hugdahl8 found that the majority of phobics reported acquiring their problem via conditioning, and others reported acquiring their phobias via instruction (e.g., by their parents), or vicariously.

Exposure therapy is a well-established treatment for specific phobias where patients are gradually and systematically exposed to the feared object or situation until their anxiety diminishes. Contrary to their usual avoidance behaviors, such phobics are encouraged during treatment to approach the object or situation they fear. For in vivo exposure (with real spiders), patients might stand across the room from a small spider in a jar, and gradually approach it in stages. When they are eventually

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comfortable picking up the jar, they might progress to a more frightening stimulus such as a larger spider. In vivo exposure has been applied successfully to a wide range of phobias, including fear of spiders,\textsuperscript{9,10} and is typically the most successful and commonly used treatment for specific phobias.\textsuperscript{11–13} Although the experience is likely more intense for the patients, some researchers have had great success treating spider phobics in an accelerated single 3-hour in vivo exposure session, both with individuals and group sessions.\textsuperscript{14} Imagery exposure is another technique sometimes used. Imagery exposure involves simply imagining situations involving spiders. Although it can be very effective,\textsuperscript{15} some patients have trouble imagining spiders, and/or the imagined spiders do not elicit sufficient anxiety to be valuable. In general, for patients motivated enough to seek therapy for their phobia, in vivo exposure therapy is the treatment of choice. It offers high success rates and fear reduction tends to be long term, with low relapse rates (e.g., 75–95% of patients showing clinically significant improvement, measured 1 year after treatment).\textsuperscript{10}

Despite the ease with which specific phobias can be successfully treated, very few specific phobia sufferers (estimated to be less than 15% of all those afflicted) ever seek treatment for their problem.\textsuperscript{1,16} As Chapman\textsuperscript{3} noticed, this finding has been used as an indication of the lesser severity and impairment of specific phobias. However, there is evidence that low percentages of patients who seek treatment have been found for most psychiatric disorders.\textsuperscript{2} On the other hand, when phobia sufferers seek treatment, an important amount of them, about 25%, may refuse exposure therapy\textsuperscript{17,18} because they are too afraid of confronting the feared object or situation. This problem may be particularly true of “one session in vivo therapy” as pioneered by Ost.\textsuperscript{19} Ost estimates that 90% of his spider phobia patients who sought phobia therapy would refuse accelerated “one session” treatment if told in advance what the treatment entailed.

New efforts are needed to increase the number of phobia sufferers who seek and successfully complete treatment. Making treatment less intimidating would be a good start. Recent research has shown that virtual reality (VR) exposure therapy can be an effective medium for the reduction of specific phobias like fear of heights,\textsuperscript{20} fear of flying,\textsuperscript{21,22} spider phobia,\textsuperscript{23,24} and claustrophobia.\textsuperscript{25,26} Virtual reality is designed to give participants the illusion of “being there” inside the computer-generated environment. Position tracking devices allow users to “bring their hands” with them (in the form of a cyberhand) when they go into VR. Movements of their real hand in the real world are mirrored by their cyberhand in VR. Also, what patients see in VR changes as they move their head orientation (e.g., they see a ceiling when they look up). And a technique known as tactile augmentation\textsuperscript{27,28} allows participants to interact with virtual objects that possess physical properties such as solidity and weight (“cyberheft”). VR works as follows. Goggle-sized TV screens are placed close to the user’s eyes in the VR helmet. Each eye is shown a slightly different image of the virtual world. The image shown to the left eye is offset slightly from that seen by the right eye. The human visual system fuses these two images into a single 3D image, helping to give users the illusion that the virtual environment has depth. One of these techniques alone might be convincing. But combined, the synchronized simultaneous converging evidence to the brain that the participant is indeed picking up the virtual object, gives users a uniquely compelling experience of “being there” in the virtual world. In our studies,\textsuperscript{23,24} the place our patients visited was “SpiderWorld,” and the virtual object they picked up was the plump furry body of a virtual Guyana bird-eating tarantula.

VR has a number of advantages over the “in vivo” technique. VR gives the patient and therapist the ability to control the feared object. For example, unlike a real spider, virtual spiders can be placed in various anxiety-provoking positions and orientations and can be touched safely. VR allows the therapist unprecedented control over how frightening the spider appears and allows patients to confront fears that are not easily treated with “in vivo” exposure. For example, “in vivo” exposure of fear of flying can be an expensive project. Hodges\textsuperscript{21} reported difficulty getting to the airport and renting a commercial jet for the purpose of treating patients. Confidentiality can also be a problem.
for "in vivo" applications, such as treating fear of heights in a hotel elevator, where the public can see the patient getting treated. VR also allows possibility of treating "residual fears," given the fact that VR can go beyond what a real situation would allow, making overlearning easier to perform. Patients who were reluctant to start and/or complete an exposure program may be more willing to get involved in VR treatment. Although still relatively expensive, the price of VR systems is dropping quickly and dramatically, as conventional desktop PC systems become powerful enough to handle the computational demands of real time VR.

The purpose of the present study was to assess whether people with high fear of spiders might be more interested in getting treated with VR exposure therapy. In Study 1, we conducted surveys giving people high in fear of spiders a brief explanation of the procedure typically used for multisession in vivo exposure therapy for spider phobia versus multisession VR exposure therapy. We then collected ratings about their willingness to get involved in VR versus in vivo therapy, and asked people to choose between the two types of treatment. Study 2 employed a similar procedure, but compared peoples’ attitudes toward an accelerated 3-hour in vivo single session treatment versus three 1-hour VR sessions suggested by Hoffman et al. The recruitment rate of in vivo therapy leaves much room for improvement. Results of the present study bear on the issue of whether VR exposure treatment might increase patient recruitment for treatment of phobias.

**EXPERIMENT 1**

**Method**

**Participants.** Four hundred and twenty-three University of Washington undergraduate students (61% females and 39% males) participated and received extra credit in their Introductory Psychology course.

**Procedure.** During mass testing at their Introductory Psychology class, participants filled out a reduced version of the Attitude Towards Spiders (fear of spiders) questionnaire to assess which participants were high in fear of spiders. Due to severe time constraints on our access to the students for mass testing, we created a mini-questionnaire composed of 6 questions rated on scales from 1 to 7, where 1 was "does not apply to me" and 7 was "very much applies to me":

1. I now would do anything to avoid a spider.
2. If I came across a spider now, I would leave the room.
3. If I saw a spider now, I would ask someone to kill it.
4. If I saw a spider now, I would be afraid of it.
5. If I saw a spider now, I would feel very panicky.
6. I would feel very nervous if I saw a spider now.

Participants then read a brief explanation about exposure treatment for phobias:

Exposure therapy has proved very successful for treating phobias. Patients start off encountering the feared object from far away, at a distance they are comfortable with. Gradually their anxiety/fear goes down, and they are able to get a little closer (at their own pace). After a few sessions, patients’ fears are typically down to more tolerable levels.

After reading this, participants were asked about their willingness to get involved in two different ways of applying exposure therapy to spider phobia, in vivo exposure or virtual reality exposure:

1. If it was determined that you would benefit from treatment of spider phobia . . . how willing would you be to get involved in a free, anonymous treatment of spider phobia that involved gradual exposure to a real live spider in a real kitchen?
2. If it was determined that you would benefit from treatment of spider phobia . . . how willing would you be to get involved in a free, anonymous treatment of spider phobia that involved gradual exposure to a virtual spider in a virtual kitchen? They answered
by giving a rating between 1 to 7, where 1 was “I would definitely NOT do it” and 7 was “would definitely do it.”

Finally, they chose between the two treatments:

If you had to choose one therapy to go through, which one would you choose:

a. Exposure to a real live spider in a real kitchen; or

b. Exposure to a virtual spider in a virtual kitchen using virtual reality.

Order of presentation was counterbalanced by switching questions 1 and 2 and switching options a and b for approximately half of the participants.

Results

A total score was calculated for each participant by adding all of his or her ratings together. The distribution of the students’ total scores is shown in Fig. 1. Eighty-seven students with fear of spiders scored more than one standard deviation above the sample mean (i.e., participants who scored between 30 and 42 (the highest possible score) were categorized as “high in fear of spiders”). The analyses below are restricted to participants “high in fear of spiders.”

As for rating scales of willingness to participate in in vivo versus VR treatment (on a scale from 1 to 7) we conducted a Wilcoxon signed rank test. Participants were significantly more willing to participate in a VR exposure program (Mean = 5.07, SE = 0.20), than in an in vivo exposure treatment (Mean = 3.62, SE = 0.20, z = 5.82, p < 0.001). We also explored the percentage of participants who refused to go through the two different treatments (i.e., who gave a rating of 1 to question 1 or 2). Seventeen point four percent of the participants said they would definitively not get involved in “in vivo” exposure treatment, whereas only 4.6% said they would definitively not get involved in the virtual exposure treatment. Similarly, 31% said they would definitely do VR exposure therapy, and only 7% said they would definitely do in vivo exposure therapy.

When forced to choose one of the two therapy techniques (question 3), 81% of the “high in fear of spiders” students chose the virtual exposure treatment and only 19% chose the in vivo exposure treatment, a statistically significant preference for VR therapy, as a binomial test showed (p < 0.001).

Discussion

As predicted, most participants with high fear of spiders were more willing to get involved in a VR exposure treatment than an in vivo exposure program for their fear. They preferred VR treatment to in vivo and the proportion of participants who refused VR treatment was lower for VR than in vivo.

EXPERIMENT 2

Study 2 employed a similar procedure, but compared students’ attitudes toward one 3-hour in vivo single session treatment versus three 1-hour VR sessions. Ost argues that single session in vivo treatments are the ideal technique for treating specific phobias. However, for patients who know in advance what the treatment will involve, we predict that VR exposure therapy will be considerably more attractive. One-session exposure therapy is an accelerated in vivo exposure technique. Ost has shown a high success rate for spider phobia pa-
tients. His patients were required to commit to remain in the exposure situation until the anxiety faded away, and never escape from the situation during treatment. Anxiety should be reduced by 50% of its highest value, or completely vanish before patients leave the treatment room. Ost’s patients were not informed about exactly what the treatment was going to involve prior to entering the treatment room. Ost\textsuperscript{19} estimates that 90% of his patients would have refused one-session therapy if told in advance what they were going to be asked to do as the final goal, (eventually let two live spiders crawl on their hand). In Study 2, we predicted that people high in fear of spiders, who were briefly informed of what the therapy sessions involved, would be more willing to undergo three 1-hour VR exposure therapy sessions than one 3-hour in vivo session.

Method

Participants. Three hundred fifty-four University of Washington undergraduate students (65\% females and 35\% males) participated and received course credit.

Procedure. Participants filled out a reduced version of the Attitude Towards Spiders (fear of spiders) questionnaire\textsuperscript{30} during mass testing in their Introductory Psychology class. The reduced version was necessary due to time restrictions (when possible, use of the full questionnaire is encouraged to maximize validity). Our mini-questionnaire consisted of 4 questions rated on scales from 1 to 7, where 1 was “does not apply to me” and 7 was “very much applies to me”:

1. I now would do anything to avoid a spider.
2. If I saw a real spider now, I would be afraid of it.
3. If I saw a real live spider now, I would feel very panicky.
4. I would feel very nervous if I saw a real live spider now.

Note that 28 is the highest possible score for this questionnaire.

After completing the fear of spiders questionnaire, participants read a brief explanation about exposure treatment for phobias, and two exposure therapy techniques. The description of phobia treatment with real spiders is an excerpt from Ost\textsuperscript{10}:

PHOBIA TREATMENT WITH REAL SPIDERS. The number of visits required for completion of treatment for spider phobias varies. Some treatments are more gradual than others. Using “in vivo” (real spider) one-session treatment each patient is given a set of four real spiders of gradually increasing sizes. When the patient can handle the smallest spider with a clearly reduced anxiety it is time to proceed to the next, and so on, until the patients should be able to have two spiders (approximately an inch in size) crawling on their hands before the end of the session.

PHOBIA TREATMENT WITH VIRTUAL SPIDERS. Another new technique is to use virtual spiders instead of real spiders to achieve desensitization over a period of three, one-hour sessions. Patients see a virtual spider in a virtual kitchen and approach as closely as they can using a 3-D mouse to navigate through the virtual world. At any given distance, their anxiety response is expected to gradually diminish due to habituation, and they can progress to move closer to the virtual spider. During the second therapy session, participants pick up a virtual “spider bucket” with their cyberhand. When they let go of the bucket, an animated virtual spider with wiggly legs drifts to the floor of the virtual kitchen accompanied by a brief sound effect from the movie Psycho. Participants pick the bucket up and let out a virtual spider over and over during the second one-hour therapy session. Their anxiety gradually diminishes as they became more used to doing this. During the third one-hour therapy session, patients are encouraged to touch the virtual spider image with their cyberhand. As the patients reach out with their cyberhand to explore the virtual spider, their real hand simultaneously explores a toy spider attached to a stationary Polhemus position sensor. This technique gives patients the illusion of physically touching a furry solid virtual spider.

After reading these descriptions, participants answered the same two questions as in Study 1 about their willingness to get involved in
those two different techniques of applying exposure therapy to spider phobia, in vivo exposure or virtual reality exposure (order of questions counterbalanced), and finally, they chose between the two treatments (order of choice counterbalanced).

Results

The distribution of total fear of spiders scores of all the participants in Study 2 are shown in Fig. 2. The mean (13.70) in the Fear of Spiders questionnaire plus one standard deviation (7.86), defines the cut-off score at 22. Seventy-five participants who scored between 22 and 28 (the highest possible score in Study 2) were categorized as “high” in fear of spiders. The analyses below are restricted to participants “high in fear of spiders.”

We conducted a Wilcoxon signed rank test to analyze whether there were differences in people’s willingness to participate in the two treatments on a scale from 1 to 7, where 1 = “I would definitely not do it” and 7 = “I would definitely do it.” Participants with high fear of spiders were significantly more willing to participate in a VR exposure treatment program (Mean = 4.60, SE = 0.23), than in an in vivo exposure treatment (Mean = 3.21, SE = 0.24, z = 5.20, p < 0.001). Similarly, 34.7% of the participants said they would definitively not get involved in the accelerated, single session in vivo exposure treatment (i.e., they gave a 1 on a scale from 1 to 7), whereas only 8% refused the virtual exposure treatment. And 27% said they definitely would do the VR exposure treatment, whereas only 10.7% said they would definitely do the in vivo exposure.

Regarding the question about what technique they would choose, in vivo exposure or VR exposure, 89.2% of students with high fear of spiders chose VR exposure treatment and 10.8% chose in vivo exposure treatment. A binomial test revealed that the difference between those two proportions was statistically significant (p < 0.001).

Discussion

As predicted, most participants with high fear of spiders were more willing to get involved in a VR exposure treatment than an intensive in vivo exposure program for their fear. They preferred VR treatment to in vivo and the proportion of participants who refused VR treatment was lower for VR than in vivo.

GENERAL DISCUSSION

The purpose of these studies was to collect preliminary data that show the utility of VR programs to overcome some of the limitations of in vivo exposure, the treatment of choice for specific phobias. Research in this field has focused on the design of the best way to treat specific phobia and has been successful in developing exposure treatments that are highly cost-effective, with long-term effectiveness and very low drop-out rates, like the short intensive treatment developed by Ost. However, despite these very good results, we still have to pay attention to other issues related to the low rates of phobic sufferers who seek treatment and the still-high rates of patients who refuse exposure therapy. A change in emphasis is needed in phobia research. New techniques and recruitment programs are needed to increase the percentage of phobics who seek treatment and who get involved in in vivo exposure. When asked in the present study to decide which treatment they would choose for their fear of spiders, most participants with high fear of spiders chose the VR exposure treatment (81% in Study 1 and 89% in Study 2).
On the other hand, when we described the general in vivo exposure treatment, 17.4% of participants with high fear of spiders refused exposure treatment. And, when we described the current treatment of choice for specific phobias, the short intensive program, a larger amount of subjects, larger than the estimated refuse rate (34.7%) refused that treatment. However, the refuse rate for VR exposure was lower than expected from the data from the literature; only 4% in Study 1 and 8% in Study 2 refused VR treatment for their fear of spiders.

VR is a new technology that can recreate “reality” with varying degrees of verisimilitude. VR elicits curiosity and many people want to try it. Also, getting treated with high-tech VR may also reduce the stigma attached to seeking clinical treatment. Results of the present study indicate that VR exposure could offer an attractive alternative for patients unwilling or unable to complete in vivo therapy. VR exposure has potential as a new medium for an old, well-established technique (exposure therapy). A medium that makes exposure less aversive and more attractive to patients is likely to increase the proportion of phobia sufferers who seek treatment. Research in the effectiveness of VR exposure, although still preliminary, is proving successful for treating spider phobia,23,24 fear of heights,20 fear of flying,21,22 claustrophobia,25,26 and even posttraumatic stress disorder31 and body image distortions in eating disorders.32 However, we would like to note that findings from the research on VR exposure are still preliminary. There is still little evidence of effectiveness from controlled studies and about long-term effectiveness. One of the most important issues to study is to compare the efficacy of VR exposure to in vivo exposure. Only if these treatments are equally effective, could VR be an alternative to in vivo exposure.

The data from the present study give us clues about the utility of VR exposure to improve the effectiveness of exposure treatments for phobias. This improvement is related to increasing the amount of phobia sufferers who can benefit from an exposure program, making exposure less aversive and more attractive to the patients. These findings encourage us to continue our work in improving VR treatments and testing their effectiveness in controlled and long-term studies.

ACKNOWLEDGMENTS

The research presented in this paper was funded by Pla de Promocio de la Investigacio, Fundacio Caixa Castello-Bancaixa 1998, the University of Washington Royalties Research Fund, the E.K. and Lillian F. Bishop Foundation, a grant from the Canada Social Sciences and Humanities Research Council, and the Harborview Virtual Reality Funds raised by Ross Chambers.

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