

# *Virtual Reality Applications for Exposure*

**Stéphane Bouchard and Sophie Côté**

*University of Ottawa*

**David C. S. Richard**

*Rollins College*

## WHAT IS IN VIRTUO EXPOSURE?

By definition, virtual reality (VR) is “an application that lets users navigate and interact with a three-dimensional, computer-generated (and computer-maintained) environment in real time” (Pratt, Zyda, & Kelleher, 1995, p. 17). The key concept that differentiates VR from the use of other audiovisual media to deliver exposure is interactivity. Even if anxiety-provoking stimuli are presented on slides, videotape, computer screen, or even IMAX theater, those exposure methods should not be considered as VR. The mediated experience becomes an alternate reality when participants can explore the surroundings (e.g., look under a closet, open a door, or walk out of a room), and the displayed images are changing accordingly. The selected technology can immerse the patient to different degrees in the virtual environments, from a simple presentation on a computer screen to the use of head-mounted displays and motion trackers, and even to a full-size 10 × 10 × 10-foot room with stereoscopic images projected on walls, floor, and ceiling. Although it could be considered as VR by Pratt, et al.’s (1995) definition, the simple use of a computer screen is probably not immersive enough to provide an optimal exposure tool. The room-size system, often referred to by the trade name of CAVE (C-Automated Virtual Environment™, Fakespace Technology), is an attractive medium to deliver virtual stimuli. But it costs more than \$250,000 and the space requirements are significant deterrents for most clinical researchers and psychologists. The solution that has attracted most researchers is the use of smaller

head-mounted displays (HMD, see Figure 16.1) and motion trackers. From a therapeutic perspective, performing in virtuo exposure (Tissau & Harrouet, 2003) could be attractive for a number of reasons. Before addressing the advantages of VR, however, let's insist on what VR is not pretending to be. In virtuo exposure is not proposed as more effective than in vivo exposure. It is proposed as an alternative medium to deliver exposure, and as potentially more practical and effective than imaginal exposure or presentation of films and slides. [AU1]

In virtuo exposure offers a standardized, controlled, replicable environment that can be used to induce emotions for therapeutic purposes. Whenever such a situation is required, VR should be considered (see Wiederhold & Wiederhold, 2005, for examples). However, the advantages of in virtuo exposure may not apply to all exposure situations.

For practical research issues such as sample characteristics, development of innovative treatment protocols, three-dimensional design, and computer programming restrictions, or the necessity to use reliable behavior avoidance/approach measures, most studies published so far have focused on specific phobias. Hence, applications



FIGURE 16.1 Head-mounted display. (Images courtesy of the Cyberpsychology Lab.)

to more complex anxiety disorders are currently under development and validation. Nevertheless, it is possible to create a list of the advantages (Table 16.1) of current VR programs that are used to provide exposure. A reasonable question involves whether computerized and virtual reality approaches for the treatment of phobias

TABLE 16.1 Advantages of in virtuo exposure relative to in vivo exposure in the treatment of selected disorders

	Specific phobia: spiders	Specific phobia: heights	Specific phobia: enclosed space	Specific phobia: public speaking	Specific phobia: flying	Specific phobia: driving	Specific phobia: snakes	Specific phobia: thunder	Post-traumatic stress disorder	Social anxiety disorder	Panic disorder with agoraphobia	Substance abuse (for cue exposure)	Eating disorders (for body image)	Stuttering (for social performance)	Anger management
Increased treatment standardization	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Treatment is more attractive to patients	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Increased control over the pace of exposure	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
More stimuli readily available than in vivo	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
No more need to conduct imaginal exposure		✓			✓		✓	✓	✓			✓	✓		
Better protection of confidentiality		✓		✓	✓	✓		✓		✓		✓		✓	
Increased patient's safety during exposure		✓			✓	✓									
No more need to care for animals (stimuli)	✓							✓							
More attention devoted to avoidance behaviors		✓				✓									
Reduced costs					✓	✓									

The absence of a check mark indicates that either the situation does not apply (e.g., there is usually no need to conduct imaginal exposure for claustrophobia) or that VR does not offer any significant advantage over in vivo (e.g., it is rarely a problem to create a simple hierarchy of enclosed situations to treat claustrophobia).

and related anxiety disorders are acceptable to clients. Little research has been conducted on treatment acceptance specifically (i.e., Davis, 1993), but in the published literature, results appear to suggest openness, especially among younger generations, [AU2] to using VR technology. In one clinical study, Botella, et al. (submitted) treated 24 adults suffering from panic disorder with agoraphobia either with exposure in vivo or in virtuo and assessed treatment satisfaction. In both conditions, all ratings were above 9 out of 10 for how logical the treatment appeared, how satisfied the patients were, to what extent the patients would recommend the treatment, how useful the treatment was for their problem, and how the exposure strategy used seemed useful. Other studies have confirmed that in virtuo exposure seems more attractive to patients. For example, Garcia-Pallacios, Hoffman, Kwong See, Tsai, and Botella (2001) surveyed undergraduate students with high levels of spider fear. When students were asked whether they would prefer a multisession in vivo or a multisession in virtuo intervention, 81% chose virtual therapy. When asked whether they would prefer one session in vivo treatment or a multisession in virtuo intervention, 89% still chose VR. When this research team conducted the same survey with 102 diagnosed phobic patients, 70% of them chose in virtuo exposure (Garcia-Palacios, Botella, Hoffman, Villa, & Fabregat, 2004). When asked whether they would refuse to go into therapy if one form of exposure or the other was used, 23.5% refused in vivo exposure, compared to 3% in the case of in virtuo exposure. Considering these results in the light of treatment satisfaction, one obvious limitation to these studies was the speculative nature of what the virtual intervention entailed. Asking individuals which treatment modality they would prefer, in the absence of actually experiencing both treatments, provides no evidence about treatment satisfaction and about which treatment they actually preferred. Nevertheless, it tells a lot about which treatment would be chosen if a choice was made available. These results clearly show that VR is more attractive, or enticing, than traditional in vivo exposure. This issue is especially important in the case of children and adolescents, for whom getting psychological treatments is not always based on a strong intrinsic motivation. In the case of adults, it could represent a substantial advantage when seeking in vivo treatment is considered too frightening.

The clinician's control over the virtual environment often allows for smoother and better hierarchical exposure sessions, such as flight conditions and turbulences in a virtual flight or intensity of commuting traffic in a virtual driving exposure session. It also allows for standardized and behaviorally relevant analogue observation techniques. Whereas analogue observation methods have historically involved exposing individuals to functionally relevant challenging situations in a controlled environment such as a clinic, virtual analogue observation refers to assessment of the individual in a virtual environment that closely approximates the feared naturalistic setting. Assessing behavioral responses in virtual environments (Renaud, Bouchard, & Proulx, 2002) is a new and rapidly evolving form of analogue observation.

In cases such as social anxiety, where performance in front of other people is necessary, or acrophobia, where therapists have to accompany the patient to

exposure situations outside the office, VR provides a better protection against breached confidentiality. Patient security can also be increased with exposure when they might actually fall (acrophobia) or have an accident (driving phobia). And in other instances, the controlled situation allows the therapist to pay more attention to the actual behavior of the patient than to personal safety concerns (i.e., the therapist paying attention to upcoming cars and patient's driving skills at the expense of patient's avoidance and safety-seeking behaviors).

Because of the standardized nature of the stimuli presented to the participants, virtual environments also provide the opportunity for measuring treatment processes more reliably in terms of both subjective and physiological responses. For example, some researchers have examined changes in event-related potentials as a function of exposure to a virtual environment (see Mager, Bullinger, Mueller-Spahn, Kuntze, & Sturmer, 2001). Others have studied the relative contribution of [AU3] changes in self-efficacy, beliefs, and information processing to treatment outcome (Côté & Bouchard, submitted), and some have looked at the benefits of including [AU4] NMDA partial agonist (d-cycloserine) medication to facilitate exposure (Ressler, Rothbaum, Tannenbaum, Anderson, Graap, Zimand, et al., 2004). Methodologically, all these experimental studies benefited from treatments in which exposure stimuli were highly standardized.

## CAN VR INDUCE ANXIETY?

VR's potential to elicit genuine fear reaction when people are exposed to virtual phobogenic stimuli is a prerequisite for using VR in exposure-based therapies. VR's capacity to produce anxiety reactions reliably has been repeatedly documented. For example, Robillard, Bouchard, Fournier, and Renaud (2003) immersed 13 control participants paired with 13 phobic individuals in the same VR environments. Their results confirmed that immersions in phobogenic virtual environments can elicit subjective fear reactions in nonphobic participants, and that these reactions were significantly more intense among phobic participants. Using motion tracking devices, Renaud, et al. (2002) have shown that exposure to phobogenic virtual stimuli leads to objective behavioral avoidance patterns that are significantly more pronounced in phobics than in nonphobics. Using physiological measures, Moore, Wiederhold, Wiederhold, and Riva (2002) have illustrated that immersing nonphobics into potentially phobogenic virtual situations such as elevators and grocery stores with virtual people could lead to significant changes in heart rate and skin conductance. Meehan (2001) and Zimmons (2004) have assessed nonphobic participants' reactions under a variety of conditions while immersed in a virtual height environment and confirmed that VR can produce strong and significant changes in heart rate, skin conductance, and skin temperature when participants are exposed to phobogenic situations.

People's reactions to virtual stimuli also apply to virtual humans. For example, James, Lin, Steed, Swapp, and Slater (2003) have immersed nonphobics in various

virtual social environments and observed an increase in anxiety when participants had to interact with virtual humans who appeared disinterested to their presence. Later on, the same research team (Slater, Pertaub, Barker, & Clark, 2004) compared the impact of giving a speech in an empty seminar room or to a virtual audience on phobics and nonphobics. The level of anxiety, measured subjectively and physiologically, was low among nonphobics in both conditions, but it was significantly higher among phobics in the empty room condition and even higher when the phobics delivered their speeches to the virtual humans. Pursuing their research on virtual people, Pertaub, Slater, and Barker (2002) compared the reaction of 43 people suffering from fear of public speaking when they delivered two speeches to an audience of virtual humans that were programmed to respond neutrally (no reaction), positively (leaning forward, eyes wide open, etc.), or negatively (leaning back, discussing among themselves, etc.) to the speeches. Delivering a speech to the negative audience was significantly more anxiety inducing and rated as less satisfying than delivering a speech to a neutral audience. Of interest, all these studies used virtual environments and virtual people that were not perfectly realistic. Taken together, these results illustrate that VR can be used to expose people to virtual stimuli. All these studies have also found significant correlations between the anxiety reaction and the feeling of presence (the illusion of being *in* the virtual environment), which might give us clues to explain why VR can elicit emotions.

It is not clear, however, whether physiological responses to virtual environments show a consistent pattern across individuals. Wiederhold and Wiederhold (2000) found that participants do not show consistent changes in peripheral skin temperature or heart rate when being exposed to virtual environments. Similarly, Jang, Kim, Nam, Wiederhold, Wiederhold, and Kim (2002) exposed 11 nonphobic individuals for 15 minutes to virtual environments depicting a flying or driving scenario. Heart rate variability analyses showed no significant differences between the interactive driving condition and the passively explored flying environment. Within environments, however, baseline and exposure heart rates were significantly different in the driving, but not the flying, virtual environment. Consistent with habituation, participants initially showed an increased skin conductance in the driving environment that dissipated after 7 minutes.

Although this chapter focuses on anxiety disorders, it is important to mention studies that were made on exposure for substance abuse (smoking and crack/cocaine). [AU5] Bordnick, Graap, Coop, Brook, and Ferrer (in press) and Lee, et al. (2003) [AU6] found that a virtual environment depicting venues and objects known to be associated with cigarette craving elicited higher self-reported craving than did pictures of the same objects, and Graap (2004) reported the same finding with crack and cocaine cues. VR is also used for other disorders, such as eating disorders and body [AU7] image dysphoria (Riva, Bacchetta, Barufi, & Molinari, 2002), or anger management (Rizzo, Neumann, Pintaric, & Norden, 2001).

## EFFICACY OF INVIRTUO EXPOSURE

In preparing this chapter, we counted about 21 individual case studies, three studies using a multiple baseline across subjects design, three uncontrolled group studies or open clinical trials, six controlled group design studies that included a passive control condition (wait list, placebo, or no treatment), and nine studies comparing virtual treatment to an alternative active treatment control condition (usually in vivo, relaxation, or cognitive). The longest follow-up assessments were 12 months (e.g., Bullinger, 2005; Rothbaum, Hodges, Anderson, Price, & Smith, 2002) and 3 years (Wiederhold & Wiederhold, 2003). The two largest sample sizes in a controlled design were 73 (Rothbaum, et al., in press) and 213 (Bullinger, 1995). Given the rate of publications in this area—the majority of the VR treatment outcome literature has been published in the last 6 or 7 years—the rapid evolution of relevant technology, and the number of outcome studies under way and presented in scientific conferences, we fully expect this review to be outdated by the time it is published. Based on that, and given the fact that many thorough comprehensive reviews are being published (e.g., Côté & Bouchard, submitted; Miyahira, 2005; Wiederhold & Wiederhold, 2005), the following pages describe and comment on selected studies rather than pretending to be comprehensive and detailed for each study.

## FEAR OF FLYING

The most common therapeutic application of virtual technology has been in the treatment of flight phobia. There are several reasons for this development. First, virtual environments simulating flight cabins and virtual flights are less difficult to develop and achieve an interesting degree of realism. Second, virtual exposure is attractive because of the cost-efficiency and logistical ease relative to in vivo exposure. Third, fear of flying is a pervasive problem associated with significant economic impact. Estimates are that up to a quarter of the flight population experiences anxiety when flying, and 20% of those with flight phobia use sedatives or alcohol to cope with flying (Greist & Greist, 1981).

Indices of treatment efficacy came initially from individual case studies, with controlled group designs published in the last 4 or 5 years. The case studies vary widely in terms of their quality and reliance on quantitative measures to infer clinical change. For example, Klein (1998, 1999) reported five case studies in separate publications. In each case, clinical change was measured either in Subjective Units of Distress scales (SUDs) scores or other forms of self-report. Similarly, other researchers (e.g., North, North, & Coble, 1997; Kahan, 2000) relied almost exclusively on anecdotal report to infer clinical change. Although some researchers report whether a client completed a post-treatment flight (e.g., Kahan, 2000; Rothbaum, Hodges, Watson, Kessler, & Opdyke, 1996), some criticisms have been raised about using post-treatment flight as an outcome measure. For example, Öst,

Brandber, and Alm (1997) have noted that it could be a questionable measure of clinical change given that most clients are not afforded the opportunity to complete a pretreatment flight. Also, many flight phobic individuals can fly despite their anxiety. Therefore a pretreatment flight must be offered at pretreatment (to exclude participants who can actually fly) and the post-treatment flight should be carefully designed to avoid methodological problems (such as patients' sense of security gained by flying accompanied by a therapist). Fortunately, some of the randomized control design studies described here did offer flight tickets for free, excluded participants who agreed to fly at pretreatment, and took methodological precautions.

Relative to other anxiety disorders, the published literature on the application of virtual reality in the treatment of fear of flying is the most developed from a research design standpoint. Controlled group designs have been published by a number of independent research groups. In every case, the virtual reality intervention has yielded treatment effects comparable to in vivo exposure or other appropriate comparison interventions.

The most often cited controlled group design was reported by Rothbaum, Hodges, Smith, Lee, and Price (2000) in which 49 participants were randomly assigned to in virtuo exposure, in vivo exposure to an airplane at the airport, or a wait-list control group. Participants in the exposure conditions first completed four sessions of anxiety management training before in virtuo or in vivo exposure. Results showed that the exposure groups were largely equivalent in treatment effects and superior to the wait-list control group. Treatment effect sizes ranged from .21 to .70 on subjective questionnaires and the in virtuo and in vivo groups were 3.5 times more likely than the wait-list control group to take a post-treatment flight. There were no group differences in treatment satisfaction ratings between the exposure groups and treatment gains were maintained at the 6-month follow-up period.

[AU10] Later, Rothbaum, et al. (2002) reported results from a 12-month follow-up evaluation of the aforementioned study. In all, 80% of participants from the initial study responded. No significant differences were found between the two treatment groups at follow-up evaluation on any of the outcome measures. Treatment effects relative to the wait-list group, however, were maintained at 12 months. There were no differences between treatment groups in the number of group members flying since the end of treatment, but there were some signs of greater alcohol and drug use in the in virtuo group to quell in-flight anxiety.

In a replication and extension of their previous study, Rothbaum, et al. (in press) reported on the results from an independent sample of 75 participants (25 completers per condition out of 83 initially enrolled). Analyses included an intent-to-treat approach, as well as traditional completer analyses. With a new and larger sample than in their previous publications, they demonstrated once more that (1) both traditional exposure and in virtuo exposure were superior to the waiting list and (2) the differences between the two active treatments were far from being

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significant. Once participants in the waiting list were reassigned to the experimental conditions and treated, the comparisons between the treatment involving in virtuo and in vivo exposure were conducted with 42 and 40 patients in each condition, respectively. The reported effect sizes for the difference between both conditions at the 12-month follow-up evaluation in terms of treatment efficacy ranged between eta-squares of .016 and .001. This corresponds from small to trivial [AU11] effect sizes according to Cohen's (1988) criteria. More important, the gains did not [AU12] deteriorate at follow-up evaluation. For example, 71% and 76% of the participants in the in virtuo and in vivo conditions, respectively, did not meet the diagnostic criteria for specific aviophobia at the 6-month follow-up period. And in this study, there was no evidence of differences in anxiety during the post-treatment flight, as self-rated anxiety was rather low and similar in both treatment conditions.

Results by Rothbaum, et al. (2000; 2002; in press) appear to echo those from Au: Any update? other researchers. For example, Maltby, Kirsch, Mayers, and Allen (2002) published a study in which 45 participants were assigned to either a five-session in virtuo intervention or an attention-group placebo condition. Results showed large pre-post differences in measures of subjective flight anxiety, with 77% of the treatment group reporting a meaningful decline in flight anxiety compared to only 22% for the control group; however, group differences disappeared or were attenuated at the 6-month follow-up period. Although 65% of the in virtuo exposure group had been able to complete a post-treatment flight, 57% of the control group completed it as well. Mean SUDs ratings of in-flight anxiety did not differ between groups. These follow-up results are difficult to interpret, although the methodological issues raised by Öst, et al. (1997) might provide some tentative answers. Because the post-treatment flight was conducted using a small aircraft and accompanied by a therapist (albeit not the one treating the patient), some participants in the control condition might have felt confident enough to try the graduation flight. This successful behavioral experiment at post-treatment could also have a positive impact on their fear, explaining why statistical differences on questionnaires completed at post-treatment disappear at follow-up evaluation.

Another controlled study was reported by Mühlberger, Wiedemann, and Pauli (2003). In their dismantling study, they examined the treatment effects of motion simulation by randomly assigning 45 flight phobics to one of four treatment conditions: cognitive treatment and in virtuo exposure with motion simulation, cognitive treatment and in virtuo exposure without motion simulation, cognitive treatment alone, or wait-list control. The 3-hour therapy session consisted of identifying and analyzing catastrophic cognitions and discussing concepts related to anxiety and exposure, and then performing four consecutive flights in VR (each flight included take off, quiet flight, turbulences, and landing). Results showed that the VR groups differed significantly from the cognitive-only and wait-list control groups on most self-report measures of anxiety after treatment and at the 6-month follow-up evaluation; however, there were no significant group differences in rates of flying between the three groups receiving treatment at post-treatment and at

the 6-month follow-up period. Although somewhat surprising, the efficacy of the cognitive therapy control condition might be explained by results from Hunt, [AU13] Fenton, Goldbert, and Tran (submitted) who showed that cognitive restructuring alone could be effective in the treatment of specific phobias. The results of the VR immersion were consistent with an earlier study by Mühlberger, Hermann, Wiedemann, Ellgring, and Pauli (2001), who found greater reduction in subjective and physiological measures of anxiety for a group of flight phobics completing a virtual intervention than for participants completing a relaxation training session. In the latter study, however, the difference between the two conditions remained significant at the 3-month follow-up period.

In an interesting study, Wiederhold, Jang, Gevirtz, Kim, Kim, and Wiederhold (2002) compared imaginal exposure to in virtuo exposure and in virtuo exposure plus physiological feedback. Physiological feedback was presented verbally by the therapist about participants' skin resistance levels while they were immersed in the virtual environment. Feedback was also displayed on a computer monitor at pre- and post-VR immersion for heart rate, skin conductance, and respiration rate. All 30 participants received two sessions of anxiety management skills training, plus six sessions of exposure. At post-treatment, only 10% of the participants accepted to fly (alone, without medication), 80% of the participants in the in virtuo exposure only condition flew, compared to 100% for the participants in the in virtuo exposure plus physiological feedback. Statistical differences from pretreatment to post-treatment and between conditions on questionnaires mirrored these results. At the 3-year follow-up evaluation (Wiederhold & Wiederhold, 2003), the number of participants who were still flying on their own was 10% in the imaginal exposure condition, 60% in the exposure in virtuo condition, and 100% in the exposure in virtuo plus physiological feedback condition. The fact that the physiological feedback improved treatment efficacy is interesting and may contribute to our understanding of the treatment mechanism of in virtuo exposure. First, taking physiological measures allows the therapist to see if patients' physiology is in concordance with their subjective report of anxiety. According to Wiederhold and Wiederhold (2000), obtaining such information can help the therapist, notably when participants are reporting high levels of anxiety that are not accompanied with physiological arousal. These cases may represent patients that are more difficult to treat or have issues related to secondary gains. Second, it is possible that by observing improvements objectively in their ability to face their fear, participants could increase their perceived self-efficacy (Bandura, 1986) to cope with their phobia, a variable that was found to be a significant predictor of treatment outcome, at least for arachnophobia (Côté & Bouchard, 2005).

In sum, VR interventions for flight phobia have been studied empirically more than any other anxiety disorder. Results from individual case studies and uncontrolled group designs are uniformly favorable. With regard to randomized controlled trials, there are strong evidences for treatment efficacy from the

Rothbaum group (with a replication study, large sample sizes and comparisons with the *in vivo* gold-standard form of exposure, and waiting list conditions, as well as 12-month follow-up evaluations) and from the Wiederhold's group (with a comparison with imaginal exposure and a 3-year follow-up evaluation). The results from Mühlberger, et al. (2003) and Maltby, et al. (2002) are encouraging at post-treatment, but follow-up data are less impressive. These results, and the methodological differences between the studies, have to be weighed against the very favorable ones from of the 3-year follow-up period by Wiederhold and Wiederhold (2003) and both 12-month follow-up evaluations of Rothbaum, et al. (2002; *in press*). There is no evidence to suggest that virtual treatments are more efficacious than *in vivo* exposure, as is the case for all other anxiety disorders. As mentioned earlier in this chapter, however, researchers in the field of VR never claimed that *in virtuo* exposure was meant to be more efficacious.

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## SPIDER PHOBIA

Although a significant proportion of the literature surrounding virtual treatments has focused on flight phobia, researchers have creatively applied the technology to other anxiety disorders as well. Despite the smaller literature bases, results have been emphasizing that virtual environments may be useful. Evidence for the efficacy of virtual treatments for spider phobia comes from two case studies, two uncontrolled studies, and one controlled group design. Carlin, Hoffman, and Weghorst (1997) provided a 37-year-old female 12 weekly 1-hour sessions of VR exposure therapy. By the end of treatment, SUDs ratings decreased over time to the virtual spider. In addition, the authors reported the elimination of compulsive, avoidance-related rituals. At the end of treatment, the patient was able to hold a live tarantula in her hands and control her anxiety.

In a study with children using a multiple baseline across subjects design, St.-Jacques, Bouchard, and Renaud (2004) treated nine children (8 to 16 years old) with eight sessions of *in virtuo* exposure. Questionnaire data were collected at pretreatment and post-treatment, as well as at a 6-month follow-up period. Weekly self-monitoring was completed during baseline (lasting from 3 to 5 weeks) and during the treatment phase. Self-monitored fear of spiders was reduced after the introduction of treatment in all subjects, and the statistical analyses conducted on each questionnaire revealed a significant reduction from pretreatment to post-treatment and no relapse at follow-up evaluation.

In a pilot study, Bouchard, Côté, Robillard, St.-Jacques, and Renaud (submitted) assessed the efficacy of five sessions of *in virtuo* exposure using a virtual environment created by extensively modifying three-dimensional game software. This preliminary study was conducted with a small sample ( $N = 8$ ) and had no control group. Statistical analyses revealed significant improvement between prerésults and postrésults on the behavioral avoidance test, the Spider Beliefs Questionnaire, the

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Fear of Spider Questionnaire, and a measure of perceived self-efficacy. Results were maintained after 6 months.

[AU15] To document the impact of virtual reality exposure on cardiac response and automatic processing of threatening stimuli, and later on study treatment processes, Côté and Bouchard (in press) treated 28 adults suffering from arachnophobia with in virtuo exposure. The treatment was manualized and lasted five sessions. This study used classical paper and pencil tests, but also a behavioral avoidance test, a pictorial emotional Stroop task with spider and control color-filtered images, and a physiological measure of anxiety (interbeat intervals) while participants were performing the behavioral avoidance test. As expected from other studies' results, repeated measures ANOVAs revealed that in virtuo exposure had a significant impact on questionnaire data, as well as on the behavioral avoidance test. What is more original is that the authors also found significant improvement on the pictorial Stroop task, showing that information processing of spider-related stimuli changed after treatment. Analyses of heart rate data also confirmed that improvement could be observed on psychophysiological parameters while patients were facing a live tarantula. In a subsequent article (Côté & Bouchard, 2005), researchers used these data to compare the predictive power of three possible explanations for treatment efficacy: changes in beliefs toward spiders, changes in information processing, and changes in self-efficacy. All three variables changed significantly and were significantly correlated with patients' improvement in symptomatology and performance on the behavior avoidance test. However, the hierarchical regression analyses revealed that increased perceived self-efficacy was the best predictor of treatment outcome, over and above the variance explained by the other process variables.

[AU16] In the only controlled study, Garcia-Palacios, Hoffman, Carlin, Furness III, and Botella (2002) assigned 23 participants to a VR or wait-list control condition. Treatment duration was flexible and averaged four 1-hour sessions. Of interest, this is the only study in which the tactile sensations were used in therapy. During the last therapy session, participants in the in virtuo exposure condition were invited to "touch" the virtual spider with their virtual hand, while at the same time their physical hand was actually touching a furry toy spider. By the end of treatment, 83% of the patients in the VR group showed clinically significant improvement, but none of the wait-list group members achieved clinically significant improvement. All subjective measures (completed by the patients, the therapists, and an independent assessor), as well as the behavioral avoidance test, showed significant reductions in anxiety and avoidance favoring the VR group.

Studies in the application of VR to arachnophobia do not have the methodological strength of those about aviophobia. There is clearly a need for a study comparing in virtuo to two control conditions, the gold-standard (in vivo), as well as an inactive control one (wait list, placebo, etc.) and a long-term follow-up period. Some studies, however, are providing new information on in virtuo exposure, such as documenting the impact of the treatment with information processing measures

using tactile stimulation to enhance the virtual experience, or shedding some light on the treatment mechanism of phobias.

## FEAR OF PUBLIC SPEAKING AND SOCIAL ANXIETY

The first series of outcome studies on fear of public speaking were conducted by North, North, and Coble (1998). They assigned 16 participants diagnosed with specific phobia of public speaking to an in virtuo exposure treatment or a no-treatment control condition (they were immersed in a trivial VR scene and were advised by the experimenters to manage their fear and expose themselves on their own, without any systematic treatment program). The treatment was delivered over five brief 10- to 20-minute therapy sessions. The six participants out of eight who completed the in virtuo exposure treatment showed significant improvement at post-treatment, and no significant changes were noticed in the control condition.

Harris, Kemmerling, and North (2002) assigned 14 students to either an in virtuo exposure treatment or a wait-list control group. The VR treatment involved four 12- to 15-minute sessions of speaking in public in a virtual environment. There were no between-group differences in state-trait anxiety or SUDs ratings, but the VR group reported significant increases in public speaking confidence over time relative to the control group. In addition, the VR group showed significant decreases in heart rate (and resting heart rate) over time while giving a speech to the simulated audience.

Three studies have been conducted with people suffering from social phobia. Anderson, Rothbaum, and Hodges (2003) reported two cases (a 46-year-old female and a 50-year-old female) of social phobics in which the patients were provided an anxiety management program, cognitive restructuring, and in virtuo exposure to an audience while giving a speech. In both cases, pre-post reductions in SUDs ratings across all virtual stimuli conditions were observed and decreases in trait anxiety were noted. In addition, both women were able to give a speech to a small audience at the end of treatment and rated their own performance as acceptable. Only the 46-year-old client completed the follow-up measures, and results suggested that treatment gains were maintained. In a pilot study, Riquier, Herbelin, and Chevalley (2005; Herbelin, Ponder, & Thalmann, 2005) developed highly realistic and complex virtual people and immersed three social phobics (ages between 14 and 23) in an uncontrolled case study. Participants, who were invited to give speeches in front of a small and a large audience for five therapy sessions, reported significant clinical improvements at post-treatment.

Klinger, et al. (2004) completed a group trial comparing 12 sessions of tradi- [AU17] tional group cognitive-behavioral therapy (CBT) and in vivo exposure to individual CBT and in virtuo exposure. Participants in the in virtuo exposure condition received minimal cognitive therapy training as therapy sessions were mostly devoted

to exposure in the virtual environments. Four virtual situations were created to tackle different aspects of social phobia: assertiveness anxiety (being assertive to virtual people who are criticizing the patient), performance anxiety (giving a talk to a group of virtual people in a meeting room), intimacy anxiety (discussing with a virtual friend and unknown virtual people in an apartment), and observation anxiety (engaging in conversations with a virtual friend and a virtual waiter while being looked at by virtual people in the surroundings). Results on a clinician's rating scales as well as clients' ( $N = 36$ ) self-report questionnaires (quality of life, social anxiety felt in different contexts, etc.) showed a significant improvement in both conditions, with no condition being superior to the other. On the Liebowitz scale, a well-known measure of social anxiety disorder symptomatology, the effect size of the difference between CBT with in vivo and in virtuo was so small that a sample of more than 300 participants would have been required to detect a statistically significant difference (and would then have suggested that VR therapy was more effective than group-CBT). On some other measures, such as performance anxiety or fear of scrutiny and intimacy, the differences were so trivial that a sample of more than 3000 participants would have been required to reach statistical significance. Despite its innovative features, some limitations of this study warrant further replication, notably the lack of a no-treatment control condition and long-term follow-up evaluation.

Although preliminary results are suggestive, research surrounding the virtual treatment of public speaking and social anxiety is still in its infancy. More studies with larger sample sizes and relevant comparison treatments are needed, but current results are promising. The application of VR to more complex anxiety disorders such as social anxiety, compared to specific phobias, is especially valuable. Although treatments protocols become more complex and are not limited to in virtuo exposure only, the applications of VR are also becoming more attractive to therapists who are dealing with difficult patients and social exposure sessions.

## FEAR OF HEIGHTS

Virtual reality technology has also been applied to assist the treatment of fear of heights. With regard to case studies (Choi, Jang, Ku, Shin, & Kim, 2001; Bouchard, St.-Jacques, Robillard, Côté, & Renaud, 2003), results suggest that in virtuo exposure to heights situations was effective in reducing symptoms of acrophobia over five or six sessions. Both studies found reductions in subjectively reported anxiety, and the 61-year-old man in Choi, et al.'s study (2001) also showed physiological evidence consistent with habituation over time to the virtual stimulus. In a pioneering [AU18] work, Lamson (1997) reported the treatment of 32 cases of acrophobia. After a single therapy session of in virtuo exposure and 60 additional minutes of discussions with their therapists, post-treatment results showed that 90% of the participants were considered much improved, with no more avoidance were considered to

have reached their treatment goals. At a 3-month follow-up evaluation, 90% of the [AU19] participants were able to use a glass elevator and ride to the 15th floor.

The first published controlled study of any virtual treatment was Rothbaum, Hodges, Kooper, Opdyke, Williford, and North's (1995) study with 20 students suffering from a fear of heights. Participants were assigned to either a 7-week in virtuo treatment protocol or a wait-list condition. Results showed that measures of anxiety, distress, and avoidance all declined for the VR group but not the wait-list control group. Mean ratings of discomfort significantly decreased across sessions for the VR group as well, suggesting habituation to the virtual stimulus. Although 7 of the 10 VR participants were able to complete an in vivo exposure to a heights situation, three were not. No data were presented regarding wait-list controls on the behavior avoidance test.

After a presentation of their preliminary results (Emmelkamp, Bruynzeel, Drost, & van der Mast, 2001), Emmelkamp, Krijn, Hulsbosch, de Vries, Schuemie, and van der Mast (2002) reported results of an outcome study in which 33 adults suffering from chronic acrophobia (mean duration of 31.5 years) were randomly assigned to either three 1-hour sessions of in vivo exposure (exposure in a mall, a fire escape, and a rooftop) or to three 1-hour exposure sessions to the same locations reproduced in VR. In addition to a 6-month follow-up evaluation, an interesting asset of this study is the use of a gold-standard control condition (in vivo exposure) where the virtual environments were replicas of the physical environments that were used in therapy. They found significant within-group differences in both conditions on all subjective and objective measures of anxiety from pretreatment to post-treatment, and stability of the results from post-treatment to follow-up periods. They did not find any significant differences in treatment efficacy between both conditions. The effect sizes of the differences suggest that any potential one would be marginal, if not trivial.

In the study with the largest sample so far, Bullinger (2005) recruited 213 adults who were randomly assigned to in virtuo exposure (74 using HMD technology and 40 using a highly immersive system similar to a CAVE), in vivo exposure ( $n = 52$ ), [AU20] and a wait-list control ( $n = 47$ ). Participants received three sessions of exposure and completed questionnaires and physiological measures (heart rate, salivary cortisol, etc.). At 6 months, participants performed a behavioral avoidance test in which they were invited to climb to the top of the bell tower of the Münster of Basel and look down. As was the case in the Emmelkamp, et al. (2002) study, the virtual environment was a replica of the physical environment used for in vivo exposure. Results showed that in virtuo exposure was as effective as in vivo exposure, which were all superior to the waiting list. As discussed later in this chapter, there was no significant difference between the two different technologies that were used to immerse the patients (HMD vs. CAVE).

The three controlled studies in this area again suggest that virtual interventions are efficacious in the treatment of fear of heights, with no differences between virtual and in vivo exposure. The studies published so far documented comparisons

[AU21] of in virtuo with either in vivo or passive wait-list control conditions. The exceptionally large sample in Bullinger's (1995) study, as well as the comparison with two control conditions, should reassure those who worry about the power of VR outcome studies. With the evidences collected to date on different phobias, including acrophobia, it is doubtful that VR will be shown to be more or less effective than in vivo exposure.

## POST-TRAUMATIC STRESS SYMPTOMS AND POST-TRAUMATIC STRESS DISORDER

Another innovative use of virtual technology applied to complex anxiety disorders has been the creation of virtual environments that are relevant to individuals suffering from post-traumatic stress symptoms or post-traumatic stress disorder (PTSD). Three studies, two case studies (Difede & Hoffman, 2002; Hodges, Rothbaum, Alarcon, Ready, Shahar, Graap, et al., 1999) and one uncontrolled group study (Rothbaum, et al., 2001), have been published detailing such efforts.

In the Difede and Hoffman study, a 26-year-old female who survived the World Trade Center attacks was treated with in virtuo exposure after imaginal exposure had been ineffective. Six graded 1-hour VR sessions were completed with scenes detailing virtual planes crashing into the World Trade Center, people jumping to their deaths, and the towers collapsing. SUDs ratings decreased over the six sessions with a corresponding 83% reduction in depression symptoms and a 90% reduction in PTSD symptoms. By the end of treatment, the patient no longer met diagnostic criteria for PTSD or major depression. A larger outcome study from the same group is currently under way (Difede, Hoffman, Cukor, Patt, & Giosan, 2005) and preliminary results showed a marked improvement in the seven patients treated [AU22] with in virtuo exposure (change in Clinician-Administered PTSD Scale/CAPS scores of an average of 28 points) and few changes in the 14 participants assigned to the waiting list (average change of five points on the CAPS). Results are therefore preliminary but encouraging.

Rothbaum and her colleagues, on the other hand, have focused on the treatment of PTSD in the chronic and difficult population of Vietnam veterans. Rothbaum, Hodges, Alarcon, Ready, Shahar, et al. (1999) reported the case of a Vietnam helicopter pilot who they exposed to a virtual helicopter and jungle combat scenes over fourteen 90-minute sessions. In addition to in virtuo exposure, imaginal exposure was also used. The authors reported a 22-point reduction in the CAPS by the end of treatment. However, arousal scores changed by only two points at 6-month follow-up evaluation. Also, trait anxiety scores did not show much change at follow-up evaluation. In a more recent open clinical trial, Rothbaum, et al. (2001) reported the results of eight Vietnam veterans who completed the same virtual scenes over ten 90-minute sessions. Similar to the individual case reported earlier, CAPS ratings were out of the clinical range at 6



months with a reduction in intrusion symptoms on the Impact of Events Scale at 6-month follow-up evaluation.

To sum up, the validation of VR applications for PTSD is still in development. A few interesting case studies have been reported. More control studies are needed to document the efficacy of in virtuo exposure better, with the exclusion of concomitant psychological and behavioral interventions. In the addition of the current clinical trial by Difede, et al. (2005) for the World Trade Center attacks, other trials are in preparation for war-related traumas such as the Middle-East (see Kaplan, 2005) and other war zones (Gamito, Pacheo, Ribeiro, Pablo, & Saraiva, 2005), or for stress inoculation training for noncombatants (see Kaplan, 2005).

## DRIVING PHOBIA

Researchers are only beginning to document the efficacy of VR for the fear of driving. Although in vivo stimuli are easily accessible to conduct exposure, in virtuo exposure provides a safer context to conduct treatment either for patients who are suffering from driving phobia, have been in a motor vehicle accident, or who are suffering from PTSD resulting from a motor vehicle accident. Only a few case studies have been conducted so far. Wiederhold, Wiederhold, Jang, and Kim (2000) mention three females in their forties who were successfully treated with an exposure-based protocol in which in virtuo was used early in the hierarchy. The treatment also involved in vivo exposure between sessions and during some therapy sessions.

Walsh, Lewis, Kim, O'Sullivan, and Wiederhold (2003) presented the results [AU23] from seven patients treated with in virtuo exposure and a mix of VR environments designed for the fear of driving or adapted from three-dimensional racing games. Improvement was statistically significant on all questionnaire data.

[AU25] In two related articles, Wald (2004) and Wald and Taylor (2001; 2003) [AU24] reported a client treated with three sessions of driving simulations in VR. They also describe a single case study with multiple baseline across subjects design in which five women received eight sessions of in virtuo exposure. Questionnaire data were collected at pretreatment and post-treatment and at 1-, 3- and 12-month follow-up evaluations. Statistical analyses applied to the daily self-monitoring data revealed a modest but significant improvement in fear for four of five patients. However, these improvements did not lead to a significant increase in driving frequency. Three of the five patients did not meet the diagnostic criteria for specific phobia, the other two having benefited from the treatment only moderately.

Overall, these results suggest that in virtuo exposure shows some promise for the treatment of driving phobia. The field is now ready for larger studies using classical group designs. Worthy of note is the use of off-the-shelf three-dimensional games, compared to more expensive VR systems.

## PANIC DISORDER WITH AGORAPHOBIA

The treatment of more complex anxiety disorders like panic disorder with agoraphobia involves many therapeutic strategies such as cognitive restructuring and interoceptive exposure. Only one study reports on the sole use of VR to treat agoraphobia and it was conducted with a non-clinical sample (North, et al., 1997). Other investigations used VR to conduct exposure to agoraphobic cues (e.g., subway, mall, elevators), and in some cases interoceptive cues (e.g., hyperventilating, hearing others hyperventilate, tunnel vision), in combination with other CBT techniques.

For example, Vincelli, Anolli, Bouchard, Widerhold, Zurloni, and Riva (2003) reported preliminary results from 12 adults enrolled in an ongoing clinical trial. The treatment lasted eight sessions and participants were randomly assigned to either traditional CBT with in vivo exposure, CBT with in virtuo exposure, or a waiting list. Nonparametric statistical analyses revealed that both treatments were superior to the waiting list on every measure, including the Fear Questionnaire. Naturally, results from the completed trial must be awaited before reaching any firm conclusion.

[AU26] In a larger study by Botella, et al. (submitted), 36 people diagnosed with panic disorder with agoraphobia were assigned to traditional CBT with in vivo exposure, CBT with in virtuo exposure, or a waiting list. Although follow-up data are still being analyzed, post-treatment data showed significant improvements in fear, catastrophic beliefs, and anxiety sensitivity in both treatment conditions, and not in the wait-list control condition. These findings were also observed on measures of agoraphobic avoidance, which should be particularly sensitive to the difference between the two active treatments. The effect sizes for the difference among both treatments were small, suggesting that both forms of treatment were equally efficacious.

Based on the currently available data, it is still too early to state that using VR is an effective alternative for the treatment of panic disorder with agoraphobia. The sample size of the study by Vincelli, et al. (2003) is too small and follow-up data [AU27] from Botella, et al. (submitted) have to be analyzed; however, these two studies will be completed in the next year or so. If the promising results hold, there should soon be strong evidence to support the use of in virtuo exposure for panic disorder with agoraphobia. In addition, a larger study with 90 participants using a design similar to the other two is in progress in France (Cottraux, Berthoz, Jouvent, Pull, Zaoui, Pelissolo, et al., 2005). A total of 46 patients have been enrolled so far and results are to be analyzed in 2006.

## CLAUSTROPHOBIA

Six studies have reported the use of virtual technology in the treatment of claustrophobia. All but one of the reports are case studies (Bouchard, St.-Jacques,

Côté, Robillard, & Renaud, 2003; Botella, Baños, Perpiñá, Villa, Alcañiz, & Rey, 1998; Botella, Villa, Baños, Perpiñá, & García-Palacios, 1999; Bullinger, Roessler, [AU28] & Mueller-Spahn, 1998; Wiederhold & Wiederhold, 2000). In each case, individuals completing VR treatment sessions that exposed them to scenes designed to evoke sensations associated with claustrophobia (e.g., tunnels, locked rooms, elevators, sliding walls allowing small rooms to “shrink”) were able to complete relevant behavioral avoidance tests. In the only multiple baselines study, Botella, Baños, Villa, Perpiñá and García-Palacios (2000) had four participants complete eight 35-minute virtual reality exposure sessions. Each participant reported decreased fear of enclosed spaces at termination and follow-up evaluation. Also, all participants were able to complete a behavioral avoidance test.

As with other fears, initial results across these studies suggest that VR interventions may be efficacious in the treatment of claustrophobia. However, there has been no randomized group controlled study to date.

## SUMMARY OF OUTCOME STUDIES

Based on the available literature, what can we conclude about the efficacy of VR when used for exposure purposes? Obviously, there exists a research community that is highly stimulated by the applications of in virtuo exposure. Researchers followed a natural progression in the design of their studies, with single case and uncontrolled studies being conducted first, followed by more rigorous randomized control trial, and ultimately leading to studies assessing treatment processes and dismantling therapeutic ingredients. No study has reported that in virtuo exposure was not effective at all, and only three studies reported weak effects compared to the control condition (Maltby, et al., 2002; Mühlberger, et al., 2003; Wald & Taylor, 2003). No study has shown that VR is more effective than real-life situations, but none was conducted with that aim in mind. It is in fact other assets of VR that may make the treatment more effective, rather than more efficacious.

One might argue that each of the studies published so far can be criticized on at least one ground (small sample size, lack of long-term follow-up data, poor treatment standardization, reliance on subjective measures only, etc.), and thus that it is impossible to conclude that in virtuo exposure is efficacious. But such a conclusion would not be fair. For each study's weakness, there are two or more studies that are not suffering from such weakness and lead to the same conclusion. For example, some studies have long follow-up periods (e.g., Wiederhold & Wiederhold, 2003); others are using a combination of self-report, behavioral, and physiological measures (e.g., Côté & Bouchard, in press); others have very large sample size (Bullinger, 2005); some compare VR with a gold-standard in vivo control condition (e.g., Emmelkamp, et al., 2002) or to basic waiting-list control (e.g., Rothbaum et al., 2000); and some target more complex anxiety disorders (e.g., Klinger, et al., 2004). There is even a replication study with very strong methodological assets [AU29]

Au: Any update?

(Rothbaum, et al., in press) and a comparison with imaginal exposure (Wiederhold, et al., 2002). Overall, the number of converging evidences and replications using different methodologies and populations all point out that VR offers an attractive alternative to in vivo exposure.

## ISSUES IN VR TREATMENT

### **Presence and Pictorial Realism of the VR Environments**

It is intriguing that VR may work given the fact that virtual reality does not perfectly replicate physical reality. Advocates of VR interventions contend that virtual environments create a superior sense of presence relative to imaginal exposure and, as a result, are more likely to activate the underlying neural network associated with fear processing (see Rothbaum, et al., 1996; Foa & Kozak, 1986). The sense of presence is often defined as the subjective impression of being *there* in the virtual environment (Sadowski & Staney, 2002). Presence is also thought to be related to the suspension of disbeliefs (Wiederhold & Wiederhold, 2005), or when the user fails to perceive the existence of a medium in his interactions with the environment (the illusion of nonmediation; Lombard & Ditton, 1997). Presence may occur when a person interacting with a virtual environment reports a greater degree of interactivity with the virtual environment than with their physical environment (Wiederhold & Wiederhold, 2000). Several variables have been found to influence presence (Sadowski & Staney, 2002), such as: ease of interaction, user-initiated control, minimal pictorial realism, length of immersion in the virtual environment, social interactions in the virtual environment, subjective factors from the user, and hardware/software factors.

According to Wiederhold and Wiederhold (1999; 2005), the quality of presence that is felt in the virtual environment may be related to treatment outcome. This hypothesis is appealing, especially as some people do not seem to react emotionally to virtual environments (e.g., Walshe, et al., 2003). To relate presence and patient's emotional involvement in VR therapies, Wiederhold and Wiederhold (1999) affirmed that individuals receiving VR treatment should be classified into four functional groups. The first subgroup exhibits high subjective and objective arousal to the virtual environment. Such individuals are described as "highly phobic" and "capable of becoming highly immersed in the VR environment" (Wiederhold & Wiederhold, 1999, p. 163). The second subgroup of individuals evidence a high level of physiological arousal, but a low level of subjective arousal. These individuals may show significant decreases, for example, in autonomic arousal, but not reporting any change in subjective discomfort (or may deny becoming anxious when exposed to virtual stimuli despite measurable increase in physiological arousal). A third subgroup evidences high levels of subjective arousal, but objective indices of physiological arousal are nominal. Wiederhold and Wiederhold suggest this may occur in situations where

the individual may have something to gain by inaccurately reporting his or her level of anxiety (e.g., secondary gain issues, if litigation is pending, and so forth). A fourth group, and one not often seen in treatment, includes individuals who are not able to immerse themselves in the virtual world. These participants do not report feeling present in the virtual environment and do not benefit from in virtual exposure, unless the therapist can help these participants moving into the first subgroup.

A common misconception about VR relates to the level of pictorial realism. Many virtual environments that are used in the studies described earlier look cartoonish, and none of the virtual environments represent an excellent replica of the physical reality. However, judgments about the perceived realism of the VR environments differ significantly between phobics and nonphobics. The Robillard, et al. (2003) study is a nice example where the comparison between phobics and nonphobics revealed significant differences, and large effect sizes on measures of anxiety, presence, and sense of realism. Taking the realism to a minimum, Herbelin, Riquier, Vexo, and Thalmann (2002) asked 10 nonphobics to deliver a speech in a virtual room filled with images of just and only eyes staring at them. Even in this unrealistic condition, participants reported significant increases in anxiety and heart rate. Zimmons (2004) immersed 42 nonphobics in a virtual height simulation (throwing balls down a pit) and, in an attempt to assess whether the texture or the lighting quality of the image played a role in the experience felt in VR, used a simple black and white grid representation of the virtual pit as a control condition. Of interest, there was a statistically significant increase in anxiety (heart rate) even in the black and white environment. These are only a few examples reminding us that emotions are not logical and that anxiety can be triggered by the simple perception of a threat, even if the stimuli are virtual, cartoonish, and not really dangerous.

The relationship between presence and the level of anxiety felt in the VR environment may be more complex than it appears at first glance. As mentioned earlier, there is a strong relationship between anxiety and presence. For example, Robillard, et al. (2003) reported a significant correlation ( $r = .74, p < .001$ ) between anxiety and presence. To document the direction of the causal relationship between anxiety and presence, two studies were conducted by Bouchard and his colleagues. In a first study conducted with snake phobics, participants were told that the virtual environments were either infested or not infested with snakes (Bouchard, St.-Jacques, Robillard, & Renaud, 2004). Because the VR environments were exactly the same, changing the instructions allowed the researchers to manipulate experimentally the level of anxiety and assess its impact on presence. Using a counter-balanced design, they found that inducing anxiety lead to a significant increase in presence. To test the inverse relationship, Michaud, Bouchard, Dumoulin, and Zhong (2004) asked acrophobics to do a feared task (i.e., riding a glass elevator up to a selected floor, crawling outside the building while looking down to the streets, walking on wooden scaffolds toward a building across the street, etc.) while immersed in VR with conditions that were favorable or unfavorable to presence (lights turned on in the laboratory, surrounding physical environment visible in the participant's field

of view, etc.). The level of anxiety was higher in the immersions conducted when presence was higher, and vice versa. Taken together, these two studies suggest that there is a reciprocal determinism between anxiety and presence; increasing anxiety leads to more presence, and more presence leads to increase in anxiety. What remains to be tested is whether this relationship is linear or if it holds only if a minimal level of presence is reached.

What is the relationship between presence and treatment outcome? Many researchers in the VR research community assume that degree of presence in the virtual environment is related to treatment outcome. Garcia-Palacios, Quero, Botella, and Baños (2005) treated 45 phobics with in vitro exposure to perform a regression analysis and document the relationship between change in fear/avoidance and presence. Their analysis was not significant, as measures of presence, dissociation, and emotional involvement did not correlate significantly with treatment outcome. In their study on treatment mechanism with arachnophobics, Côté and Bouchard (2005) also failed to find any predictive power of presence on treatment outcome. These results echoed findings from Krinj, Emmelkamp, Biemond, de Wilde de Ligny, Schuemie, and van der Mast (2004), and Bullinger (2005), who compared the efficacy of a highly immersive CAVE-like system and the less immersive but more affordable HMD technology. Both research teams reported more presence and more anxiety in the CAVE system, but no difference in treatment outcome. Another known attempt to assess realism and treatment outcome is from Mühlberger, Wiedemann, and Pauli (2005), who reanalyzed their previous data in comparing participants who went in the virtual flight while airplane motion was either simulated ( $n = 12$ ) or not simulated ( $n = 13$ ). The motion mirrored the VR flight, with speed acceleration and deceleration as well as turbulence. They, too, found that motion induced statistically stronger anxiety, but had no effect in terms of treatment outcome.

These data do not mean that Wiederhold and Wiederhold's (2005) hypothesis, that "the efficacy of VR is related to the *quality* of presence" (p. 77, italics added) is erroneous. Patients in the fourth subgroup of the Wiederhold's classification did not become present and did not feel any anxiety in VR. It is quite possible that future research will show that a minimal level of presence is necessary to trigger the anxiety reaction. Once this threshold is passed, becoming more present may be interesting but may have limited impact on treatment outcome. Thus it may be more a matter of quality than quantity.

### **Cybersickness: Virtual Reality-Induced Symptoms**

It has been reported in the literature that immersions in virtual reality can induce unpleasant side effects, such as nausea, dizziness, and headache (Lawson, Graeber, Mead, & Muth, 2002). The term *cybersickness* is also often used to describe symptoms similar to motion sickness (McCauley & Sharkey, 1992), although some side

effects are irrelevant to motion sickness and are easier to control. In a review chapter on the topic, Lawson, et al. (2002) concluded that about 5% of people immersed in a virtual environment might experience significant side effects. The scientific studies on the side effects of VR immersions are often difficult to generalize to clinical populations, because most studies were conducted on nonclinical samples (e.g., fighter pilots, astronauts, soldiers) performing tasks that significantly differ from treatment protocols (e.g., flight simulations for fighter pilots) and using old and heavy equipment compared to what is currently used during therapy. In a study with 23 children and 35 adults selected from the community and immersed in VR environments used in therapy, St.-Jacques and Bouchard (2005) found that the VR immersions could induce minor side effects in some people, but no side effects lasted according to participants when they were interviewed 24 hours after the immersion.

Some VR-induced symptoms and effects could be directly related to the equipment used. For example, heavy HMD may cause neck strain or headache if the strapping band is too tight around the forehead. Also, as staring at TV monitors for a long time can induce eye strain, looking into an HMD for a long time can cause the same phenomenon. Adapting stereoscopic displays in the HMD to interpupillary distance is also necessary, although very few VR environments used for in vitro exposure involved a stereoscopic HMD. Nevertheless, problems caused by the equipment become less and less frequent given the fast pace of technological advances. For example, most affordable commercial HMDs can now offer a  $800 \times 600$  resolution and weigh less than 7 ounces, which is not problematic for adults and most children. The problem of eye accommodation occurring over long immersions is also easily solved by taking small pauses once every 20 or 30 minutes of immersion, which is also useful to allow time for therapist and patient discussion.

Another potential source of side effects is caused by conflict between sensory information. For example, think of an acrophobic who is immersed in VR with an HMD. When he turns his head around, he can contemplate the scenery. If he looks down, he can see the depth of the cliff, and by pressing a mouse button with a finger, he can walk forward towards the edge of the cliff. When that user “walks” in the virtual environment, his visual perceptual system signals movement, while part of the vestibular and the proprioceptive systems do not detect forward motion. When the user turns his head around, the vestibular system also detects this motion immediately, but there may be a small lag in time while the computer processes the information and displays the corresponding visual stimuli in the HMD. These incongruities between the sensory systems (vision, proprioception, and inner ear otolith/semicircular canal systems) could cause symptoms of nausea, vertigo, dizziness, etc. These symptoms of cybersickness are related to motion sickness; however, they are usually transient, neither severe nor dangerous, and often disappear during the immersion in VR. Because some people are more sensitive to motion sickness than others, it is recommended to pay attention to VR side effects during

the exposure session (Stanney, 2002). It is important, however, not to confound VR side effects with anxiety symptoms, or other naturally occurring side effects, such as vertigo induced by looking down a cliff during exposure.

One last set of VR-induced side effects relates to the task the user has to perform in the virtual environment. In regrouping factors related to VR side effects, Stanney, Mourant, and Kennedy (1998) found that many side effects could be explained by task characteristics, such as the speed of movements, the degree of control the user can have on the immersion, images shown in peripheral visual field, etc. These task characteristics may explain why very few patients mention symptoms of cybersickness during therapy, compared to immersions for leisure or training purposes.

Wiederhold and Wiederhold (1999) have also reported unexpected reactions from patients in response to the virtual environment, just as it would happen during *in vivo* exposure. They discuss the case of a flight phobic who had a panic attack during VR therapy. What makes this case especially interesting is that the panic attack occurred in the third VR session and after unsuccessful imaginal exposure therapy. Also, the case illustrates the importance of using both subjective and objective indices of anxiety. The authors report that the only indication a panic attack was occurring was the sudden and unexpected change in heart rate. In the same report, Wiederhold and Wiederhold (1999) also report the case of a motor vehicle accident survivor who experienced a flashback during VR treatment. As with the prior case, imaginal exposure had not been successful. Executing a left turn in the VR environment elicited the flashback and necessitated cessation of the session. Subsequently, the individual reported cessation of nightmares and treatment was ultimately successful.

To sum up, in some cases, immersion in VR can induce a few side effects. Some of these side effects could be related to the equipment or the tasks the client has to perform during the *in virtuo* exposure. These symptoms are usually easy to prevent. Other symptoms are related to motion sickness and may occur in people who are sensitive to motion sickness, or if they are intoxicated or suffering from inner-ear problems. Questionnaires can be used to assess these symptoms, and clinical studies report few, if any, side effects. Finally, these symptoms have to be different from sensations induced by the exposure itself.

### Cost Issues

A frequent objection to the use of virtual reality exposure programs is the cost involved and whether the technology warrants such an investment. VR headsets and peripheral devices can easily run into thousands of dollars. Whether such an expense is cost-effective will ultimately depend on the incremental treatment utility of VR interventions. In other words, given the nontrivial costs associated with the technology, the results of VR interventions cannot simply be as effective as *in vivo* exposure. Given the impressive success rates of this traditional and less expen-



sive form of exposure, the incremental gains that VR interventions can possibly post will, mathematically, be minimal at best. As such, a demonstration of equivalence, although useful from a research perspective and eloquent of impressive and creative use of an emergent technology, does not necessarily imply widespread clinician acceptance.

In a similar vein, claims of cost-effectiveness are almost always made relative to in vivo exposure techniques. Although in vivo exposure for some behavioral disorders can be logistically untenable and cost prohibitive (e.g., fear of flying), this does not necessarily mean that VR therapy is cost-effective, as other forms of exposure (e.g., imaginal exposure) have been shown empirically to successfully treat a variety of anxiety disorders and phobias. Thus, the term *cost-effective* must always be considered relative to an alternative therapeutic criterion. If the criterion is itself cost prohibitive, VR interventions will, of course, gain the appearance of being a cost-effective alternative.

On a more positive note, costs are likely to decrease significantly. For example, a decent HMD could have cost almost \$6,000 seven years ago and \$1,000 by January 2005. Today, units are probably substantially less as new and very powerful products are now being sold for half that amount. In addition, once the initial hardware is purchased, it becomes easier and less costly to invest in new software and applications. Nevertheless, despite these improvements, VR still involves costs. As listed in Table 16.1, the incremental gains of VR therapy include its attractiveness for patients and the increased control over the stimuli for therapists. In some cases, the increase in safety, confidentiality, stimuli, variety, and treatment standardization are worth the investment.

## CASE HISTORY

Josée, a 38-year-old administrative assistant and mother of three, cannot always travel where she wants. She suffers from spider phobia. Because of her fear, she limits her trips to locations that are as close as possible to the sea or water spots, in hope she will not be taken by surprise by spiders. But what she fears can be found anywhere, as she realized during a vacation in Florida. While standing on a large veranda in a museum looking at some animals, her boyfriend told her suddenly to look to her left. Approximately 15 meters from where she stood, she saw a large web with two big spiders (approximately 15 cm in diameter). She immediately felt panicky, disgusted, and had the urge to go back inside the museum. She subsequently refused to return to the veranda for the remainder of the visit.

Spider phobia, also called arachnophobia, is a relatively common disorder among the population, although most people typically do not seek professional help to get rid of their fear. Accordingly, Josée has never sought treatment until she read about a research program in a local newspaper, called the clinic, and scheduled an intake evaluation.

At the time of the intake, Josée reported having always been scared of spiders, and she could not identify any particular event that would have caused her phobia. She reported that, whenever she saw a spider, she felt a sudden rush of anxiety and had to run away. She would then ask someone else to kill the spider for her. She reported avoiding certain places because of her fear and usually remained vigilant, checking for spiders around her. She even avoided pictures of spiders and conceded that she had to fold the research project ad in the newspaper to hide the spider picture so that she could call for an appointment. She acknowledged that her fear of spiders was unjustified.

### **Clinical Case Conceptualization**

The etiology of her anxiety cannot be detailed precisely, as she could not remember any traumatic event that might have initiated her fear of spiders; however, she could remember many past events that illustrated the level of her fear. For example, she remembered being on a swing at the age of 7 when she observed two spiders crawling across clothes. She reported being so frightened that she jumped immediately off the swing. She hypothesized that this event remained salient in her memory because she did not see the spiders after jumping off the swing, and was therefore not afforded the opportunity of knowing she was safe. She also mentioned being the victim of many practical jokes by her brothers with plastic spiders and reported feeling uncomfortable around her siblings at family reunions as a result.

Consistent with a functional analysis of any anxiety disorder, it is fruitful to focus on those mechanisms that maintain a phobia (Antony & Swinson, 2000; Barlow, 2002). The information gathered at the intake suggested that through a series of episodes involving unfortunate experiences with spiders or practical jokes, Josée started avoiding spiders. Avoidance behavior exacerbated her fear in two ways: (1) by preventing her from confronting her fears and correcting the associations she had developed between spiders and threat or disgust (Thorpe & Salkovskis, 1997), and (2) by accumulating evidence that she cannot cope with spiders because of her fearfulness (Bandura, 1986). As Josée put it, when she saw a spider, she felt a strong rush of anxiety that quickly rose to maximal distress levels. As a result, she was constantly vigilant, and if she saw a spider she would immediately ask someone to kill it. Thus, flight behavior was reinforced and she accumulated evidence that she was ineffectual at dealing with spiders. With time, she also developed many dysfunctional beliefs about spiders and about herself when confronted with spiders, such as “if I saw a spider now, it would try to jump on me,” or “if I saw a spider now, I would panic.”

### **Treatment Selection**

VR was selected because it offers many opportunities for clinical psychologists who want to use standardized or specific stimuli to conduct exposure to feared stimuli.

In virtual exposure gives the therapist total control over the situation. For example, in the treatment of the fear of spiders, the therapist can control the number, speed, and aggressiveness of spiders, providing a multilevel hierarchy. For example, in some virtual environments, clients can begin their hierarchy while immersed in VR and look at pictures, then move to rooms with very small spiders that stay perfectly still or move very slowly, and then go to other locations filled with spiders that have different sizes and behaviors. Such a degree of control over the stimuli would be difficult to achieve with traditional in vivo exposure. In virtual exposure also allows clients to be exposed to the exact same situation over and over again, or even to go far beyond what they could try during in vivo sessions (e.g., standing next to a giant tarantula or being surrounded and followed by dozens of spiders). In the case of in virtual treatment for arachnophobia, protecting the spiders' safety can be useful, especially if it is difficult to find spiders and keep them alive (e.g., during winter). Panicking clients could drop the spider, which could be fatal for a tarantula. Finally, in virtual exposure is more enticing for patients than in vivo, as Garcia-Palacios, et al. (2001) have demonstrated.

### Assessment

It is to be noted that Josée was participating in a study on cognitive mechanisms underlying the treatment mechanism of in virtual exposure (Côté & Bouchard, 2005), which explains why so many questionnaires were used. Although such a quantity of measures is not necessary outside a research context, objective measures can greatly help a client following his progress over time. Also note that results from the emotional Stroop task are not presented for the sake of simplicity.

The diagnosis was based on the Structured Clinical Interview for DSM-IV (SCID; First, Spitzer, Gibbon, & Williams, 1996). At pretreatment, the *Immersive Tendencies Questionnaire* (Witmer & Singer, 1998) was also administered. It measured individual's susceptibility to feel present in VR.

Two weeks before treatment and every week during treatment (immediately after the session), Josée was asked to rate, on a scale of 0-100, the intensity of her fear, her avoidance behavior, and her perceived self-efficacy toward spiders. At pretreatment, midtreatment, and post-treatment, Josée's spider phobia was assessed with the *Spider Beliefs Questionnaire* (Arntz, Lavy, van der Berg, & van Rijsoort, 1993), the *Fear of Spiders Questionnaire* (Szymanski & O'Donoghue, 1995) and the *Perceived Self-efficacy Towards Spiders*. The latter was constructed and validated specifically for Côté and Bouchard's (in preparation) study to measure patients' perception about their ability to perform efficiently in certain tasks involving spiders and/or to remain calm while doing so. [AU30]

In a *Behavioral Avoidance Test (BAT)*, a live tarantula was placed in a transparent Plexiglas cage, with the lid closed, on a sliding motorized platform that the client controlled by holding a switch button (see McGlynn, Rose, & Lazarte, 1994). She sat on a chair, at the end of the motorized platform, and had to let the therapist lift

the cardboard box (Step 1) and let her remove the box's lid (Step 2). After looking at the spider for 1 minute, she had to move the platform closer (each 25 cm forward constituted Steps 3 to 9). Once the platform was the closest possible to her (23 cm to the chest), she had to bend forward and place her face above the opening of the box and look at the spider for 1 minute (Step 10). She was instructed to go through the steps until her anxiety was too uncomfortable and then she could stop.

After each in virtuo exposure session, she had to fill the *Presence Questionnaire* (Witmer & Singer, 1998) and the *Simulator Sickness Questionnaire* (Kennedy, Lane, Berbaum, & Lilienthal, 1993).

## Treatment

Josée's treatment consisted of 11 weekly 60-minute sessions. There was a 5 minute pause in the middle of each in virtuo exposure session to reduce the risks of cybersickness. No homework was given, as this treatment was part of an experimental study and in vivo homework would have contaminated the results. After each in virtuo session, Josée had to wait in the waiting room for 15 minutes before she left to ensure that she did not feel any cybersickness symptoms. Treatment was administered by a Ph.D. candidate (S.C.) using a computer working with Windows 2000 (Pentium III, 4.2GHz, 1 Go of RAM, equipped with a nVidia™ GeForce4 Ti 4200 128MB [AU31] graphics card), an Intertrax<sup>2</sup> motion tracker from Intersense™ (USB model, 3dof, update rate 256Hz), an I-Glass SVGA head mounted display by IO-Display™ (resolution 800 × 600, 26 degrees FoV diagonal) and a wireless mouse by Gyration™. The VR environments were created by adapting a 3D game (Max Payne™; see Figure 16.2). The evolution of Josée's progress during treatment is detailed next.

### Session 2

After the intake session, Josée was provided the clinical case conceptualization regarding the factors that likely caused and maintained her phobia and the justification for an in virtuo treatment approach. Josée listened carefully to this information and demonstrated her understanding by illustrating with examples from her own experience. She was instructed in ways to reduce cybersickness symptoms (turn her body completely when in motion in virtuo, not moving too fast, etc.), and how to use the equipment. She then practiced these skills in virtuo in a spider-free environment. Within a few minutes of entering the virtual world, she was able to move reasonably well through the virtual space (an apartment) and use objects found there.

### Session 3

To maintain a meaningful level of presence during her exposure sessions, instructions were always given as if the exposure was taking place in physical reality. For



FIGURE 16.2 Illustration of a person immersed in virtual reality and images of the VR environment used to treat arachnophobia.

example, the therapist would instruct Josée to “walk forward” instead of asking her to “press the left button.” In this way, Josée quickly incorporated the equipment in her natural movements and its manipulations became automatic within the first exposure session. The intensity of the exposure was monitored with Josée’s subjective evaluation of her anxiety level on a scale of 0–100.

Josée chose to begin the exposure with only framed pictures of spiders that were hung on the walls of the virtual apartment, which was the lowest level possible of the in virtual hierarchy. She gradually approached 3 virtual cm from the pictures, and afterward, she exposed herself to a “live” virtual spider staying still on a stove. She mentioned that she was very surprised to be able to come close to this spider and said she was happy to see progress so soon in therapy. Indeed, she reported that her anxiety lowered more quickly at the end of the session.

### *Sessions 4–6*

Josée rapidly understood and integrated the exposure principles, so only minimal instructions were given throughout the session. Indeed, without any suggestion

from the therapist, she would take initiative and approach spiders once her anxiety had decreased to manageable levels (i.e., to approximately 40%). We also encouraged her to turn her back on the spiders because losing track of their physical location triggered anxiety. The last phobogenic stimuli used in a previous session were systematically revisited to assess whether they still triggered anxiety. If they did, exposure was continued until her anxiety diminished. Generally, Josée still felt anxious with those previously seen stimuli, but she could approach them much faster and closer (e.g., in 3 minutes instead of 25) before her anxiety reached high levels.

During exposure, Josée mentioned that she had the same reactions she usually felt in the presence of a spider (itchiness, worrying hands, feeling hot, etc.). This suggested a strong feeling of presence. She generally reported few cybersickness symptoms, but was sometimes uncomfortable with the weight of the HMD or the time lag between her physical moves and the corresponding motions in VR. She usually ignored these elements after a few minutes, however, especially when her anxiety was high.

Although reporting between 9 and 11 anxiety curves per sessions, Josée's evolution through the hierarchy was surprisingly slow. After session five, she was still confronting the same relatively easy situations (small spiders, staying still), as opposed to the worse scenarios available in the virtual environment (being surrounded by spiders of different sizes and behaviors). At session six, she reported a dream about a colleague opening an envelope and many plastic spiders falling on her pillow, which woke her up. She then had to turn the lights on and reassure herself that she was safe. During this session, she could move to the next level, but spent all the session exposing herself to the same two spiders: tarantulas that moved toward her or unexpectedly on the side and then stayed still. She reported feeling more anxious that particular week, for work-related reasons, and cried during the session when the spiders moved and surprised her, which made her anxiety peak at 100%. She mentioned that she often felt sad and vulnerable when she exposed herself, because she had remembrances of her brothers' practical jokes. Nevertheless, she could go through with the exposure and ended the session standing between the two spiders, each at less than a virtual foot from her, and let her anxiety decrease at 40%. She mentioned that she saw progress at home, as she could watch a TV program with many tarantulas, a thing she could not have done before.

### *Sessions 7–10*

Josée's progress, although still moderately slow, was accelerated during those sessions. Indeed, Josée began to see the positive impacts of therapy at home. She reported being able to watch a movie scene involving a lot of giant spiders and remain calm. She also reported that, seeing a spider walking on her husband's foot, she kept talking normally and did not react. She said that before treatment, she

would have felt a rush of anxiety and would have shaken her clothes and hair to make sure there was no spider on her.

What seemed to particularly help Josée going through the hierarchy was an awareness of her tendency to anticipate negative reactions from either herself or the spiders during exposure. For example, she would often say: “I am ok now, but if that one moves, I will jump out the window!” She acknowledged the steps she had successfully negotiated, but never her capacity to go further, as if she doubted future success. The therapist pointed out that when she was anticipating failure and helped impede these cognitions by encouraging her to think in the present tense (as if she was doing an observation experiment) or by walking in the virtual world toward the object of her fear. Both strategies were successful and did not intensify Josée’s self-reported anxiety. At the conclusion of therapy, Josée acknowledged that the tendency to anticipate failure mediated her anxiety.

### Final Session

During the last session, Josée completed the final VR exposure scenario: crossing a room filled with spiders and going into a bedroom with a particularly huge and aggressive spider. She was able to remain calm as she successfully approached the spider to a distance of 1 virtual foot. Information was then provided concerning relapse prevention. With the therapist, Josée developed a graded hierarchy so that she could conduct exposure sessions at home. The graded in vivo hierarchy involved approaching a medium-size domestic spider in a plastic bowl, then touching the bowl with her hand, touching the spider with a pencil, placing her hand in the bottom of the bowl, and touching the spider with a finger. The last step involved killing spiders with a tissue. As a final recommendation, Josée was suggested that she should always consider herself as “the designated person to kill spiders,” wherever she is, so life can naturally provide her endless possibilities in practicing her skills and maintaining her gains.

### Results

As previously mentioned, measures were taken before the intake and after each session, as detailed in Figure 16.3.

Josée’s rating of her fear and avoidance were high at the beginning of the therapy before plateauing and then slowing as she progressed and was able to control her anticipation during the exposure exercises. Her perceived self-efficacy rating also followed the same pattern: a rapid increase that corresponded with progress in therapy and at home.

Standardized questionnaires were administered after sessions 1 (pretreatment), 7 (midtreatment), and 11 (post-treatment). Scores on the *BAT* and the *Perceived*

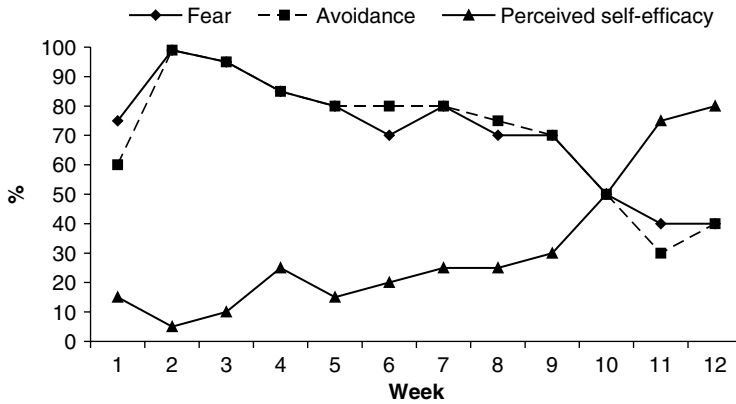


FIGURE 16.3 Weekly measures of fear, avoidance, and perceived self-efficacy during VR treatment.

*Self-Efficacy Towards Spiders Questionnaire* are reported in Figure 16.2, and scores of the *Fear of Spiders Questionnaire* (FSQ) and the *Spiders Beliefs Questionnaire* (SBQ) (both the beliefs toward the spiders and the beliefs toward self-scales) are reported in Figure 16.4.

As therapy progressed, Josée was able to interact further with the live spider in the *BAT*. Indeed, even if her *BAT* score was only 1 at midtreatment, she could let the therapist remove the cardboard box over the Plexiglas cage and look at the spider for 1 minute, something she had refused to do at the pretreatment. After therapy, Josée was able to let the therapist remove the lid over the Plexiglas cage and move it 70 cm closer to her chin. Although not part of the *BAT* procedures,

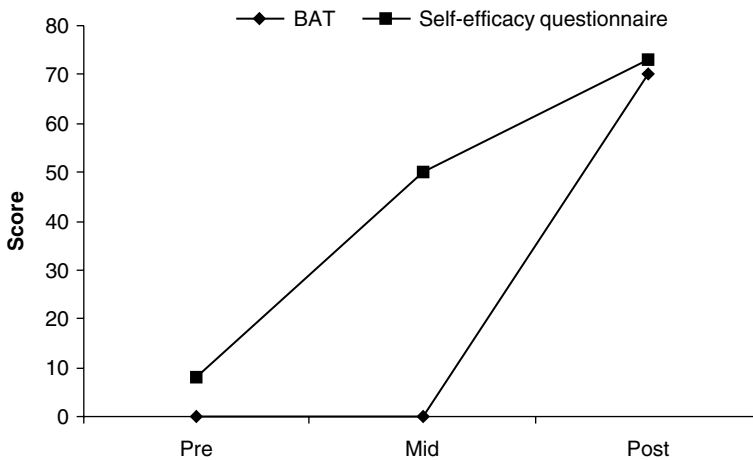


FIGURE 16.4 Behavioral avoidance test (in steps) and self-efficacy (in %).



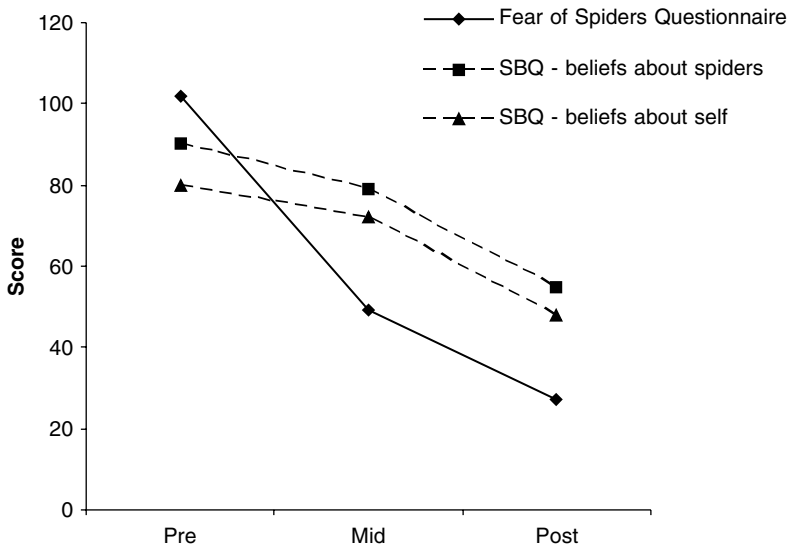


FIGURE 16.5 Fear of Spiders and Spider Beliefs Questionnaire.

she could also stand 2 feet from the cage with the lid closed. For Josée, this was a clinically significant change, even though it was not scored in the standard BAT protocol. In the same fashion, her perceived self-efficacy score gradually increased as treatment progressed. Josée's beliefs toward spiders and fear of spiders as measured by the SBQ and the FSQ also gradually decreased throughout treatment to reach nonclinical levels after treatment (Figure 16.5).

### Case Discussion

At the end of treatment, Josée wrote a note about her experience with VR therapy. She wrote that, although feeling a lot of skepticism, apprehension, and anxiety before treatment, she considered herself to have been more successful than she originally anticipated. She mentioned that in virtual exposure allowed her to interact with spiders and gain mastery. She also learned that she frequently anticipated negative outcomes and that she could impede negative self-statements. She concluded by saying that the treatment had significantly increased the quality of her life.

### CONCLUSION

Over the last 2 decades, the exponential growth and use of computer technology have precipitated dramatic changes in business practices in both the public

and private sector. A survey conducted in the 1990s suggested that at that time, clinical psychologists had readily accepted computer technology for purposes of office management and assistance in completing mundane tasks (e.g., generating assessment reports), but that computer applications to deliver therapeutic protocols were slow to catch on. McMinn, Buchanan, Ellens, and Ryan (1999) surveyed 420 psychologists and found modest rates of computer use for treatment intervention purposes. In fact, when comparing their results to survey results reported by Farrell (1989), they concluded that clinical psychologists have not accepted the computer as an adjunctive therapy tool despite large advances in technology and development of computer software for that purpose. Although respondents to the questionnaire generally viewed computerized test reporting and test scoring assistance as ethical, respondents were critical of computer-delivered adjunctive therapies. A total of 60% considered using a computer in lieu of traditional, face-to-face therapy to be unethical. Although only 12.8% considered virtual treatments for anxiety disorders to be unethical, 45.5% were not sure. At best, results suggested that computer applications resulting from the latest wave of technology (i.e., applications designed to deliver treatments rather than helping the clinicians perform clerical tasks) were considered by clinicians to be ethically questionable. Although McMinn and colleagues ultimately concluded that computer technology was having a “minimal impact” (p. 172) on clinical practice, they remained optimistic for the future. In a more recent Delphi poll on the future of psychotherapy, 62 experts in the field of psychotherapy listed the changes they considered the most likely to occur in the next 10 years (Norcross, Hedges, & Prochaska, 2002). The panel concluded that VR therapy will flourish, ranking the use of VR as the therapeutic intervention third most likely to increase the greatest in the next 10 years (after homework assignments and relapse prevention). In line with the prediction in the Norcross, et al. (2002) survey, there has been an important increase of studies using virtual reality in the treatment of mental disorders.

Despite the advantages mentioned earlier in this chapter, and the fact that more than 40 empirical articles have been published on the efficacy of in virtuo exposure, results from the survey reported by McMinn and colleagues (1999) raise the question of different trajectories between clinicians and researchers. Specifically, juxtaposing McMinn’s results against those presented by Richard and Lauterbach (2003) leads to some interesting conclusions. In a review of computer applications in behavioral assessment, Richard and Lauterbach entered key word terms into the PsycInfo database and counted publications and dissertations related to computerized behavioral assessment applications over the last 40 years. Not surprisingly, the number of publications has increased exponentially over time at a rate much greater than other assessment instruments (e.g., MMPI, Rorschach, WAIS). The interest in virtual treatments has also spawned a number of relevant organizations, journals, and businesses. Scientific journals such as *Cyberpsychology and Behavior* and *Presence* publish frequent studies about VR applications, and VR publications have popped up in established American Psychological Association

journals (e.g., *Journal of Consulting and Clinical Psychology*). Taken in conjunction [AU32] with McMinn's study, these results suggest that increased interest in computer applications by researchers has not yet been met with a corresponding enthusiasm by clinicians. Informal discussions with mental health professionals also support this impression. We suspect several reasons to explain this slow transfer from the research labs to the clinics: (1) the vast majority of clinicians have little to no experience with computerized or virtual treatment procedures, (2) graduate training does not emphasize adjunctive computerized interventions, (3) some clinicians remain concerned about the effect computer programs will have on therapist-client rapport and treatment outcome, (4) the costs associated with a devoted computer or virtual reality system remain high, and (5) the incremental usefulness of treatment using computer and VR programs has not yet been demonstrated convincingly.

Important information must be provided to counter the last three issues. The consideration that there is no significant advantage of using VR to conduct exposure is partly based on the impression that in vivo stimuli can always be used instead of in virtuo ones, or that imaginal exposure is as effective as in vivo. The population used in the early outcome studies certainly contributed to this impression, with studies on acrophobia, arachnophobia, or claustrophobia using stimuli that are easily available in vivo. The interest to use VR may seem low for therapists who receive few people consulting for specific phobias and where the available VR environments depict situations where in vivo stimuli are easily accessible. In early studies, sample selection was often based on methodological and practical considerations. Researchers initially began to validate in virtuo exposure for disorders for which behavioral avoidance tests could be devised (rather than relying solely on subjective measures), for which in vivo exposure could be used as a gold-standard control condition, and for which treatment was more simple and straightforward to adapt (compared to more complex anxiety disorders). As illustrated in Table 16.1 and previous sections of this chapter, VR environments are currently available for more complex disorders and for situations where in vivo stimuli are more difficult to find. Applications where in vivo stimuli are less available are now being tested (e.g., fear of thunderstorms), as well as for more complex anxiety disorders (e.g., post-traumatic stress disorder, panic disorder with agoraphobia, social anxiety disorder). New and original applications are also being tested for in virtuo exposure in the treatment of mental disorders other than anxiety, such as substance abuse, eating disorders, stuttering, or anger management. In addition, the availability of in vivo exposure stimuli is certainly not the only issue to consider. In some cases, therapists may be interested in VR for treatment attractiveness, increased standardization, and control over the stimuli or confidentiality.

As for the cost issue, there has been a significant reduction in the price of the required hardware and software. With the increase in demands from mental health professionals and developments in computer science, the price of VR was prohibitive years ago, is still currently high, and will soon be affordable.

Finally, although no study has measured the direct impact of using VR on therapist–client rapport, it must be pointed out that using VR should not hinder the therapeutic alliance, as the computer does not replace the therapist; it is merely a tool to deliver potent and emotionally relevant stimuli, just as television does when therapists use videotaped stimuli. A potentially more threatening technology for the therapeutic alliance and bond is the use of videoconference to deliver the treatment, and even in the case where the patient and the therapist never meet face to face, the therapeutic bond remains very strong (Allard & Bouchard, 2005; Bouchard, Paquin, Payeur, Allard, Rivard, Fournier, et al., 2004).

To conclude, although more studies are warranted, the bulk of evidence from converging results from outcome studies point to the fact that in virtuo exposure is effective. Results were replicated over and over with different methodologies: (1) sample sizes varied from single case studies to more than 200 patients; (2) follow-up time sometimes extended as far as 3 years post-treatment; (3) a wide variety of measures have been used, from questionnaire to behavioral, physiological, and information processing ones; (4) a number of control groups have been used, from waiting-list to imaginal and in vivo exposure; and (5) a variety of populations have been tested, including complex cases. The difference in treatment efficacy between in vivo and in virtuo exposure seems minimal. VR presents some assets that justify, in some circumstances, considering in virtuo exposure. It generally offers the advantage of treatment standardization, increasingly realistic environments, and control of aversive stimuli. From an exposure therapy standpoint, VR treatments are convenient for both therapists and clients, as the therapy protocols can be completed in an office rather than outdoors or in public settings. VR software also allows clinicians considerable control over environmental parameters, thereby maximizing salient environmental features that trigger fears in the client. What remains to be seen is whether the advantages of VR will be sufficient to offset the burden imposed by costs.

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- [AU1] Is it Tissau or Tisseau? See reference list.
- [AU2] If Botella et al hasn't been accepted, please list as unpublished.
- [AU3] Stumer or Stoermer? See reference list.
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- [AU5] Is this Coop or Copp? See reference list.
- [AU6] Is Lee et al. 2003 the same as Lee et al. 2004? If so, clarify correct date and list 6 authors and then et al.
- [AU7] Barufi or Baruffi? See reference list.
- [AU8] Is 1995 the correct date? If so, please add this to reference list; if not please change to 2005.
- [AU9] If not accepted, please change to unpublished.
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- [AU12] Is this 1988 or 1998? See reference list.
- [AU13] If this work has not been accepted, please list as unpublished.
- [AU14] If Bouchard et al has not been accepted for publication please list as unpublished.
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- [AU23] Walsh or Walshe? See reference list.
- [AU24] You cite 3 articles here not 2, although Wald and Taylor 2001 isn't in the Bibliography; please clarify.
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- [AU41] Please list journal, volume and page for Richard and Lauterbach.
- [AU42] Can you update Rothbarum et al in press?
- [AU43] This last paragraph would typically be set as a footnote—ok to change? Also, should address and email for Dr. Bouchard be left in or deleted?
- [AU44] change to "considering" ok?