A Randomized, Controlled Clinical Trial of In Virtuo and In Vivo Exposure for Spider Phobia

Article *in* Cyberpsychology, Behavior, and Social Networking · December 2010

DOI: 10.1089/cyber.2009.0277 · Source: PubMed

5 authors, including:

David Michaliszyn
Université du Québec à Montréal
2 PUBLICATIONS **90** CITATIONS
SEE PROFILE

André Marchand
Université du Québec à Montréal
258 PUBLICATIONS **4,964** CITATIONS
SEE PROFILE

Stéphane Bouchard
Université du Québec en Outaouais
321 PUBLICATIONS **8,194** CITATIONS
SEE PROFILE

CYBERPSYCHOLOGY, BEHAVIOR, AND SOCIAL NETWORKING
Volume 13, Number 6, 2010

DOI: 10.1089/cyber.2009.0277

A Randomized, Controlled Clinical Trial of *In Virtuo* and *In Vivo* Exposure for Spider Phobia

David Michaliszyn, M.Ps.,[1] André Marchand, Ph.D.,[2] Stéphane Bouchard, Ph.D.,[3] Marc-Olivier Martel, B.Sc.,[4] and Joannie Poirier-Bisson, B.Sc.[1]

Abstract

The present study compared the efficacy of virtual reality (VR) *in virtuo* exposure and *in vivo* exposure in the treatment of spider phobia. Two treatment conditions were compared to a waiting-list condition. A 3-month follow-up evaluation was conducted in order to assess the durability of the treatment effects. Participants were randomly assigned to the treatment groups. A total of 16 participants received the *in virtuo* treatment, and 16 received the *in vivo* treatment. The waiting-list condition included 11 participants. Participants received eight 1.5-hour treatment sessions. Efficacy was measured with the Fear of Spiders Questionnaire, the Spider Beliefs Questionnaire (SBQ-F), and a Behavioral Avoidance Test (BAT). In addition, a clinician administered the Structured Interview for DSM-IV to assess DSM-IV's criteria for specific phobia and severity. Clinical and statistically significant improvements were found for both groups. Differences in treatment groups were found on one of five measures of fear: greater improvement on the SBQ-F beliefs subscale was associated with *in vivo* exposure.

Introduction

THE EFFICACY OF *IN VIVO* EXPOSURE in the treatment of specific phobia has been empirically demonstrated, and is currently considered the treatment of choice for this problem.[1] Research in this area has investigated the effectiveness of different methods of exposure, and found that *in vivo* exposure is generally more effective than imaginal exposure[2] for treating specific phobias. Results from some studies that have explored the optimal duration of treatment suggest that one 3-hour treatment session is as effective as shorter, multiple-session treatment.[3,4] However, Rowe and Craske[5] found better results after 1 month with multiple exposure sessions or four sessions a week than with a 1-day 4-hour session. These results suggest that gains can be maximized by spacing out exposure over several days. It is additionally recommended that the client be exposed to varied stimuli, such as different types of spiders. The use of varied stimuli maximizes the maintenance of gains and reduces the possibility that fears will reemerge. Exposure in multiple contexts also protects against relapse.[6] Virtual reality (VR) is a new tool of interest for exposure, offering the possibility of optimal exposure parameters in the treatment of spider phobia. However, it still requires more empirical validation.

The effectiveness of VR exposure therapy (VRET), or *in virtuo* exposure, has gained empirical support. The literature in this area indicates a 25% refusal and drop-out rate (combined) for individuals offered conventional exposure therapy.[7] In the same direction, a survey has found that 76% of respondents would prefer *in virtuo* exposure over traditional exposure therapy, and the refusal rate for *in vivo* exposure (27%) was higher than the refusal rate for *in virtuo* exposure.[7] Further development of *in virtuo* exposure could be an effective treatment for people who consult for phobias. Moreover, this type of treatment could reduce the stigma associated with traditional therapy and the reluctance often associated with exposure.

In virtuo exposure has a number of advantages over conventional therapy, such as: (a) greater control over phobogenic stimuli and thus greater accuracy in inducing anxiety,

[1]Department of Psychology, Université du Québec à Montréal, Montreal, Quebec, Canada.
[2]Department of Psychology, Université du Québec à Montréal, Centre de recherche Fernand-Séguin, Montreal, Quebec, Canada.
[3]Department of Psychology, Université du Québec en Outaouais, Gatineau, Canada.
[4]Department of Psychology, McGill University, Montreal, Quebec, Canada.

and the ability for the therapist to repeat exposure at will; (b) limited unexpected events during exposure; (c) exposure to fears that can be difficult to reproduce *in vivo* (e.g., fear of flying, fear of storms) and reduction of costs (e.g., taking the plane); (d) remaining in the clinician's office during exposure facilitates confidentiality; and (e) decreased maintenance and associated costs required for animals (hygiene, food, etc.) used for exposure.[8]

In addition, research in this area suggests that *in virtuo* exposure can be effective in the treatment of arachnophobia.[9–10] Garcia-Palacios et al.[10] found significant improvement in 23 patients treated with *in virtuo* exposure, in comparison to a waiting-list condition. Using a Stroop task and heart-rate measures, Côté and Bouchard[11] demonstrated therapeutic gains with 28 participants on a cognitive and physiological level using *in virtuo* exposure. Further evidence of the effectiveness of this type of treatment comes from Carlin et al.[9] and Hoffman et al.[12] Both of these studies used "tactile augmentation," which consists of holding an artificial spider (tarantula) while visually perceiving a virtual spider. These studies demonstrated efficacy of tactile augmentation. Hoffman et al.[12] demonstrated that participants in the tactile augmentation condition showed the greatest progress on behavioral measures. This finding is limited by the fact that only 8 of the 36 participants were phobic at a clinical level.

The most important issue in considering the use of *in virtuo* exposure is comparing the efficacy of this form of therapy with that of conventional therapy. This has been addressed and most studies converge toward the finding that *in virtuo* exposure is as effective as *in vivo* exposure for acrophobia (fear of heights) and fear of flying.[13,14] This same conclusion cannot be made yet for arachnophobia, because the existing studies of *in virtuo* exposure for this problem report comparisons of pre–post measures and/or comparisons to a waiting list but do not directly compare a *in virtuo* exposure group to a traditional exposure group. In addition, few studies have included follow-up evaluations to verify treatment durability for arachnophobia.

The first goal of this study is to evaluate the efficacy of *in virtuo* exposure therapy and simultaneously compare it to conventional *in vivo* exposure therapy. The second goal is to measure the maintenance of gains in a 3-month follow-up period.

Method

Participants

Participants were French speakers recruited in the Montreal area by several methods, including: (a) oral presentations and flyers in university courses, (b) advertisements in local newspapers, and (c) individuals who requested treatment for fear of spiders through referrals and acquaintances. The eligibility criteria for participation in the study were:

(a) Fulfillment of DSM-IV[15] diagnostic criteria for Specific Phobia Animal Type (spiders), as evaluated by trained doctoral students. Criteria E and D varied between clinical and subclinical levels, given that people could avoid places where they might come in contact with spiders without necessarily affecting everyday functioning, but still react with irrational fear in the presence of spiders.
(b) A minimum of 1-year duration of the phobia.
(c) An inability to touch a vivarium with a tarantula in it prior to treatment, as evaluated during the Behavioral Avoidance Test (BAT).
(d) A score in the clinical range on both the Fear of Spiders Questionnaire[16] and Spider Beliefs Questionnaire.
(e) No other psychiatric problem in need of immediate treatment (participants were screened for anxiety disorders and depression; participants with comorbid spider phobia and primary anxiety disorder were excluded).
(f) No current alcohol or drug dependence or medication.
(g) No severe physical illness.

Participants were on average 29.1 years old ($SD = 7.99$; range 18–51), with 16.53 years of education ($SD = 2.37$; range 12–22). A total of 64% of the sample were in a romantic relationship and 36% had a child. Further, 64% of participants were currently employed, and only one participant was male. Of the 32 participants included (16 *in virtuo*, 16 *in vivo*), 28 met the full DSM-IV criteria for specific phobia (15 *in virtuo*, 13 *in vivo*). Four participants had a partial diagnosis of specific phobia but scored within the phobic range on the questionnaire measures and on the BAT.

Equipment

The virtual environments (VEs) were generated using a personal computer with a Pentium® 4 3.0 GHz 1.00 GB of RAM cpu, 256MB of graphics memory, and a wide 256-bit memory interface ATI Radeon 9800 XT video card. The environments were displayed on monoscopic I-glasses PC/SVGA A502085® (i-O Display Systems) head-mounted display (HMD) with a resolution of 800×600 pixels. The HMD was draped with a 30 cm×40 cm black cloth to block out ambient light. The HMD was also equipped with an IS-300 Pro® tracker (3 dof) that sensed the movement of the participants' heads. Together, the HMD and tracker provided a view that followed the participants' head movements as they tilted, panned, and swiveled their heads to scan the VE. The participants used a handheld wireless Gyration mouse to control their forward and backward movements in the VE. Ambient sounds were played on the PC's stereo speakers and through the HMD. The arachnophobia environments were modified computer-game environments based on the Max Payne video game and downloaded from the Université du Québec en Outaouais (UQO) Cyberpsychology laboratory Web site (www.uqo.ca/cyberpsy). The computer-graphic artists used the Max Payne platform to customize the environments and populate them with animated spiders of different shapes and sizes.

Measures

Participant evaluation. A battery of questionnaires and a structured clinical interview were systematically administered to participants in order to obtain and document the following information: age, gender, marital status, general health, level of education, presence intensity, duration of arachnophobia, and presence of comorbid disorders. Measures were taken pretreatment, during treatment, posttreatment, and at a 3-month follow-up.

Measures of fear. The Structured Clinical Interview for DSM-IV (SCID-I)[17] was used to confirm the diagnoses of spider phobia (principal diagnosis) and comorbid anxiety disorders (secondary diagnosis), as defined by DSM-IV.[15] The SCID-I has good concurrent validity with clinician judgment ($k = 0.69$) and inter-rater reliability has been reported at 0.77 and 0.92.[18]

The Questionnaire sur la Peur des Araignées (FSQ-F; French translation of the Fear of Spiders Questionnaire)[16] was chosen for a subjective measure of the efficacy of *in virtuo* treatment. This questionnaire is reported to have excellent split-half reliability and internal consistency, and good test–retest consistency. In addition, the FSQ-F's good convergent validity is demonstrated by highly significant correlations with the BAT ($r = 0.65$). Good construct validity is demonstrated by the test's ability to discriminate phobics from non-phobics, as measured by a BAT.[16,19] The FSQ-F is composed of 18 items about fear and avoidance of spiders to be rated on a scale from 1 to 7 (1 = *does not apply to me*; 7 = *very much applies to me*).

The Questionnaire des Croyances à propos des Araignées (SBQ-F) is a French translation of the Spider Beliefs Questionnaire.[20] This instrument is composed of 78 items divided into two subscales (SBQ-F beliefs, SBQ-F behaviors) that respectively address beliefs about spiders and beliefs about own behavior in the presence of spiders. Arntz et al.[20] reported internal consistency of 0.94 for this measure. Test–retest reliability values between 0.59 and 0.84 have been reported.

The BAT is a popular objective measure of clinical progress in overcoming phobias. A large spider (female rosy-haired tarantula, approximately 10 centimeters long including front legs and cephalothorax) was placed in a vivarium without a lid. The cage was placed on a table at the far end of a room and a chair was placed 3 meters from the vivarium. The patient was instructed to enter the room, sit down in the chair, and then get up and walk as close to the cage as possible. Participants were advised that the BAT was an objective measure of their fear of spiders and not part of the therapy. During the test, the experimenter stayed behind the client, in an effort to minimize any potential impact of his presence. When the participants were as near as possible to the spider, the distance in meters between participant and spider was measured. The measure of distance was converted to a behavioral score that ranged from 0 to 11, where 0 = anything less than sitting down on the chair; 1 = 50 centimeters; 2 = 100 centimeters; 3 = 150 centimeters; 4 = 200 centimeters; 5 = 250 centimeters; 6 = 300 centimeters; 7 = staring into the open vivarium for 5 seconds; 8 = touching the vivarium on side farthest from the spider for at least 5 seconds; 9 = touching the vivarium on side closest to the spider for at least 5 seconds; 10 = inserting one hand into the vivarium and putting one finger on the ground on the side farthest from the spider for at least 5 seconds; 11 = placing one hand on the branch in the middle of the vivarium for at least 5 seconds.

An end-state functioning index was developed to assess clinically significant improvement using five measures and their respective cut-off points to rate clinical success. The index included:

(a) BAT (10), SBQ-F beliefs (23.15), SBQ-F behaviors (21.5), FSQ-F (65.3), and SCID-I evaluation of specific phobia. The cut-off score for treatment success on the BAT (scores 0–11) was determined by the sample distribution and set at 10 or higher (inserting one hand in the vivarium and putting one finger on the ground on the side farthest from the spider for at least 5 seconds)
(b) For the SBQ-F beliefs, SBQ-F behaviors, and FSQ-F scales, the established cut-off point for clinically significant change was entry into the non-phobic range. This stricter cut-off point was chosen for its relevance within our data (stricter than 2 *SD* from the phobic sample
(c) An absence of specific phobia diagnosis on the SCID-I was required to meet the criteria of clinical success. Clinical success was awarded 1 point and failure was awarded 0 point.

The scores on these five measures were added together to produce a score out of five.

Control measures. The Inventaire de la Dépression de Beck (IDB),[21] the French translation of the Beck Depression Inventory (BDI),[22] measured the presence and intensity of 21 symptoms of depression. The French version of this questionnaire was validated by Bourque and Baudette,[23] and it was used in this to match the treated participant's language and population. Temporal stability over 4 months was 0.62 and internal coherence varied between 0.90 and 0.92.

The Échelle d'Évaluation du Thérapeute (EET)[24] is a French translation of the Therapist Evaluation Scale.[25] This questionnaire includes 25 items that measure the participant's perception of his or her therapist.

The Questionnaire sur la Perception du Traitement pour Phobies Spécifiques (QPTPS) is a French adaptation for specific phobia of the Questionnaire on Treatment Perception and Credibility.[26] It consists of five questions that measure the participant's perception of treatment credibility. The test–retest reliability is 0.90 ($p < 0.05$).

Virtual-reality questionnaires. The Questionnaire sur l'État de Présence (PQ-F) (French translation of the Presence Questionnaire[27]) was administered following the exposure session. Each of the PQ-F's 19 items are rated on a 7-point scale (1 = *not at all*; 7 = *completely*) that provides a total score and five subscale scores. The five subscales are: *Realism* (similarity between the VE and the equivalent natural environment), *Affordance to Act* (ability to actively explore and manipulate the VE), *Interface Quality* (delays or awkwardness related to the software or apparatus), *Affordance to Examine* (ability to approach virtual objects and to examine them from different angles), and *Self-Evaluation of Performance* (feeling of competence for performing tasks in the VE). The Presence Questionnaire has good reliability (Cronbach's $\alpha = 0.81$).

The Questionnaire sur les Cybermalaises (SSQ-F; French translation of the Simulator Sickness Questionnaire[28]) was also administered after the exposure session. The SSQ-F has a 4-point scale to rate 16 symptoms of simulator sickness, such as nausea, eye fatigue, and vertigo. The SSQ-F produces a total score and three subscale scores: *Nausea*, *Ocular-Motor Problems*, and *Disorientation*. Although the SSQ-F is presently in the validation process, it is already commonly used in VR therapy research.

Protocol

A total of 32 participants with a diagnosis of specific phobia took part in this randomized controlled clinical trial. Participants were randomly assigned to one of three conditions: waiting list, *in virtuo* exposure, or *in vivo* exposure. Participants in the waiting-list group waited for 8 weeks before being reevaluated and randomly assigned to one of the two treatment groups.

Procedure

Treatment

The treatment followed a standardized exposure protocol from the Cyberpsychology Laboratory at UQO. It was administered by five doctoral students in psychology, supervised by a senior psychologist. Treatments were equal in both groups (*in vivo* and *in virtuo*) in terms of number of sessions, exposure time, and techniques in order to allow for valid comparisons. Treatment consisted of psychoeducation about spiders, gradual exposure, and cognitive restructuring. Eight 90-minute treatment sessions were planned. The first session included evaluation, information about treatment, and psychoeducation about phobias and spiders. The next six sessions consisted of gradual exposure tasks and cognitive restructuring. Each exposure session lasted approximately 1.5 hours, with pauses every 20 to 30 minutes to prevent cybersickness in VR and to rest in the *in virtuo* group. The final session focused on relapse prevention. Treatment completion criteria were as follows: for participants in the *in virtuo* group, completing treatment meant going through all three levels of the VR program and confronting a large black-widow spider. In addition, participants had to report low levels of anxiety throughout the program. Participants in the *in vivo* group were considered to have completed treatment when they were able to manipulate two types of live spiders (*Tegenaria domestic* and *Pholcus*) in their hands. Three participants (two *in vivo* and one *in virtuo*) achieved these goals prematurely and therapy ended after seven sessions for them. All other participants received eight sessions. Exposure proceeded according to a list of tasks assigned by the therapist and rated by the participants with a Subjective Units of Distress (SUDs) rating. The tasks were designed to elicit a SUDs rating between 30 and 70 (out of 100).

Results

Significance was set at $p = 0.05$ for this study. Posttreatment analyses included data from the waiting-list group after they were distributed among the *in vivo* and *in virtuo* groups.

Pretreatment tests

Independent t tests revealed no significant differences in demographic and clinical variables between the waiting-list condition and the treatment condition at pretreatment, $p < 0.05$. Further t tests revealed no significant differences in demographic and clinical variables between the *in virtuo* group and the *in vivo* group at pretest ($p < 0.05$).

Pretreatment and posttreatment tests

A one-way between-groups multivariate analysis of variance (2×2 MANOVA) was conducted to compare the waiting-list condition to the combined treatment groups. The dependant variables were FSQ-F, SBQ-F beliefs, and SBQ-F behaviors. No significant differences were found on any clinical variables for the waiting-list group between both pretreatment evaluations, $F(3, 10) = 0.233$, $p < 0.871$, indicating no improvement prior to treatment. A statistically significant difference was found between the waiting-list group at pretest and the treatment group at posttest, $F(3, 44) = 3.65$, $p = 0.02$.

Virtual-reality questionnaire

Scores on the PQ-F showed elevated total presence ($M = 84.21$, $SD = 14.35$). Cybersickness scores on the SSQ-F were slightly higher than the questionnaire norms ($M = 19.41$, $SD = 14.79$), but lower than SSQ-F scores in a phobic sample reported by Robillard et al.[29] We therefore consider our *in virtuo* treatment to have been conducted according to the control standards.

Posttreatment and follow-up tests

Of the 36 participants in this study, 32 completed the posttest evaluation, and 26 were evaluated at a 3-month follow-up. Incomplete evaluations at posttest were explained by psychosocial stressors, and the participants with incomplete evaluations were distributed evenly between the treatment groups. Three participants were switched from the *in virtuo* group to the *in vivo* group due to a lack of reactivity to the virtual spiders. This created an even distribution of participants, with 16 in the *in virtuo* group and 16 in the *in vivo* group. At follow-up, seven non-completers were counted in the *in vivo* condition, and three in the *in virtuo* group. The non-completion in the *in virtuo* condition was explained by cybersickness related to a medical condition and three of the absences in the *in vivo* condition were due to being out of the country. The remaining four participants removed themselves for personal reasons. Independent t tests revealed no significant differences between the missing cases and the completers in age, gender, level of education, and employment status. Significant differences were found with regard to children and civil status. None of the missing participants were married or had children. No significant differences in clinical variables were found between missing participants and completers ($p < 0.05$).

Self-report questionnaires

A repeated-measures MANOVA was conducted on the SBQ-F (beliefs and behaviors subscales) and FSQ-F, revealing a significant time effect, and demonstrating treatment efficacy over time (Table 1). Both *in virtuo* and *in vivo* exposure produced significant improvement at posttest and follow-up.

However, a significant time-by-treatment interaction was found on the SBQ-F beliefs subscale ($p < 0.05$) at follow-up. *In vivo* exposure scores decreased slightly over time, whereas *in virtuo* exposure scores did not change significantly (Table 2). A similar non-significant trend was observed for the SBQ-F behaviors subscale. There were no significant differences between groups for interaction effects or treatment effects on the FSQ-F.

Intent-to-treat analysis

To address attrition in this study, an intent-to-treat analysis (repeated-measures MANOVA) was conducted on the SBQ-F

Table 1. Treatment Outcome and Treatment Interaction for *In Vivo* and *In Virtuo* Exposure for Spider Phobia

	Time effect				*Treatment interaction*			
Measure	F	p	η_p^2	D	F	p	η_p^2	D
FSQ-F	70.12	0.000	0.753	1	0.814	0.445	0.034	0.177
SBQ-F beliefs	39.48	0.000	0.632	1	4.96	0.012	0.177	0.778
SBQ-F behaviors	39.92	0.000	0.634	1	0.309	0.714	0.013	0.094

FSQ-F, Fear of Spiders Questionnaire; SBQ-F beliefs, Spider Beliefs Questionnaire, beliefs subscale; SBQ-F behaviors, Spider Beliefs Questionnaire, behaviors subscale.

(beliefs and behaviors subscales) and FSQ-F. This analysis revealed a significant time effect, demonstrating treatment efficacy over time, $F(6, 28) = 17.12$, $p = 0.00$. Both *in virtuo* and *in vivo* exposure produced significant improvement at posttest and follow-up. There was no significant time-by-treatment interaction for the SBQ-F beliefs subscale, $p < 0.05$.

BAT

The BAT posttreatment scores were asymmetrical and non-transformable. This variable was therefore modified to represent participants' improvement by (a) subtracting pretest scores from posttest scores and (b) subtracting pretest scores from follow-up scores. The new change variable had a normal distribution. A *t* test revealed a significant change at posttest, $M = 6.73$, $SD = 2.96$; $t(31) = 12.86$, $p = 0.00$, and at follow-up, $M = 6.87$, $SD = 3.18$; $t(25) = 11.01$, $p = 0.00$. A two-way between-groups ANOVA was conducted to compare treatment groups on the new change variable. There was no significant difference between *in vivo* and *in virtuo* treatment groups, $F(1, 24) = 2.55$, $p = 0.12$.

SCID-I

The posttreatment and follow-up results on the SCID-I were asymmetrical and non-transformable. This variable was therefore dichotomized, and non-parametric tests were employed for the analysis. Friedman's test revealed a significant difference between pretest and posttest results, as well as between pretest and follow-up measures ($p = 0.00$), thereby demonstrating treatment efficacy. Fisher's exact test was used to compare the treatment outcome on the SCID-I. No significant differences were found between the *in virtuo* and *in vivo* ($p = 0.226$) groups at posttest or at follow-up ($p = 0.238$). It was also observed that, at pretest, the *in vivo* group included 14 participants with a full diagnosis of specific phobia and two participants with a partial diagnosis (criteria D and E subclinical). At posttest, none of the *in vivo* participants still had a diagnosis of specific phobia. The *in virtuo* group included 15 participants with a diagnosis of specific phobia and one participant with a partial diagnosis at pretest. At posttest, only two participants had a remaining partial diagnosis and one participant still had a full diagnosis of specific phobia.

Table 2. Mean and Standard Deviation for Outcome Measures at Pretreatment, Posttreatment, and 3-Month Follow-Up

	In vivo		In virtuo	
Variable	M	SD	M	SD
BAT score				
Pretreatment	3.17	2.55	3.56	2.89
Posttreatment	10.47	1.67	9.25	2.72
Follow-up	9.86	2.15	9.73	2.43
FSQ-F score				
Pretreatment	103.28	13.13	104.61	9.59
Posttreatment	47.88	14.07	54.37	22.46
Follow-up	47.81	32.25	56.67	23.99
SBQ-F beliefs				
Pretreatment	47.73	14.31	41.17	15.58
Posttreatment	16.50	17.83	18.47	20.26
Follow-up	9.71	9.02	16.92	10.81
SBQ-F behaviors				
Pretreatment	45.20	15.45	45.53	18.49
Posttreatment	11.32	17.38	16.39	21.40
Follow-up	9.76	8.29	13.54	15.95
SCID-I diagnosis				
Pretreatment	1.83	0.38	1.94	0.24
Posttreatment	0.00	0.00	0.25	0.58
Follow-up	0.17	0.58	0.33	0.72

BAT, Behavioral Avoidance Test; FSQ-F, Fear of Spiders Questionnaire; SBQ-F beliefs, Spider Beliefs Questionnaire, beliefs subscale; SBQ-F behaviors, Spider Beliefs Questionnaire, behaviors subscale; SCID-I, Structured Clinical Interview for DSM-IV.

End-state functioning index

The posttreatment and follow-up scores on the end-state functioning index were asymmetrical and non-transformable. This variable was therefore dichotomized, and non-parametric tests were employed for the analysis. The Friedman test revealed significant differences in scores over the three time periods ($p = 0.00$), indicating treatment efficacy. Differences between the *in vivo* and *in virtuo* groups were evaluated with a Fisher's exact test. No significant differences were found at posttreatment ($p = 0.76$) or at follow-up ($p = 0.62$).

Discussion

Participants in both *in virtuo* and *in vivo* exposure therapy for spider phobia demonstrated significant improvement on objective and subjective measures of fear after eight 90-minute treatment sessions. No significant differences between the groups were found at posttest or at follow-up on the following measures of fear: FSQ-F, SBQ-F behaviors subscales, and the BAT. At the posttest evaluation, several participants in the *in virtuo* group indicated that they were curious to know how they would react to a spider in their natural environment. At the follow-up period, some had finally encountered a spider and were appreciative of their reaction toward it. Significant differences between groups were also found for the SBQ-F beliefs subscale at follow-up. *In vivo* scores decreased on this measure from posttest to follow-up, whereas *in virtuo* scores were maintained over time. The greater treatment gains in the *in vivo* group may be attributable to the direct contact with spiders and learning about the behaviors and reactions of a live spider.

This randomized controlled study found slight differences between *in vivo* and *in virtuo* treatments for fear of spiders. The effect size between treatment groups at follow-up on the SBQ-F beliefs subscale was 6.9%.

Three participants in the *in virtuo* group displayed no reaction to the virtual spiders and were reassigned to the other group. This possible limitation of VR should be considered in treatment planning. The primary limitations of *in virtuo* exposure published to date have been associated with lack of a sense of presence and cybersickness. Further studies should be required to evaluate levels of presence and cybersickness in participants who react unfavorably to VEs. In addition, future research could explore other variables that may predict treatment success. In the meantime, *in vivo* exposure is recommended when possible. The rate of attrition in the present study was higher in the *in vivo* group than in the *in virtuo* group at follow up. Specifically, at post-test, 2 non completers were counted in both groups, while 7 and 3 non completers were counted at follow up for the *in vivo* group and the *in virtuo* group, respectively. The majority of drop-outs occurred after treatment was completed. Therefore this does not support Garcia-Palacios et al.'s[7] suggestion that *in virtuo* exposure may be less threatening than *in vivo* exposure. The drop-out rate in this study (27%) is therefore attributed to normal attrition.

The strength of this study is the use of randomized distribution and a control group to directly compare *in vivo* and *in virtuo* exposure. Authors of future research on spider phobia may wish to consider the following suggestions for improving study design. First, spider phobia in Quebec is likely to differ from spider phobia in other areas. Spiders in Quebec may bite and cause a local reaction, but they are not deadly or cause for medical concern. To assess functionality in participants in Quebec properly, a BAT task of touching or manipulating a local spider should be considered as an adjunct to the traditional BAT task with a tarantula in both exposure methods. Second, in their study of the use of VR in spider phobia, Garcia Palacios et al.[10] included anxiety measures such as the State–Trait Anxiety Inventory (STAI) in the pre, post, and follow-up evaluations, and included the SUDs during the BAT. This more rigorous evaluation could have been used in the present study to provide more accurate measures of treatment outcome on the BAT. Third, the posttest results on the BAT in the present study demonstrated a ceiling effect. The inclusion of a more complex BAT task, such as manipulating a local spider or touching the live tarantula with a pencil or straw, could prevent the ceiling effect and provide a more accurate measure of participants' improvement. Fourth, although this idea was not explored in this study, *in vivo* exposure following *in virtuo* exposure could consolidate treatment gains Finally, another option would be to include tactile augmentation to the *in virtuo* exposure as did Hoffman et al.,[12] allowing greater presence and improved treatment outcome.

This study did not include physiological measures such as heart rate and skin conductance although they have been demonstrated empirically to be modified by *in virtuo* exposure. Wiederhold and Wiederhold[30] found that arousal in the VR environments varied between individuals on measures of skin resistance and cardiac response, which could affect treatment efficiency. Also, Côté and Bouchard[11] found that *in virtuo* exposure modified cardiac response. In another study, Côté and Bouchard[31] found that changes in perceived self-efficacy and dysfunctional beliefs were the best predictors of change in general outcome and cardiac response. These measures should be included in future researches to measure therapeutic gains.

In conclusion, both *in vivo* and *in virtuo* exposure are efficient methods of treating spider phobia. A slight advantage of *in vivo* exposure over *in virtuo* exposure was found, as revealed by significant and continued gains on the SBQ-F beliefs subscale after posttest in the *in vivo* group. The effectiveness of VR therapy could likely be enhanced considerably by using tactile augmentation[9–12] or complementary *in vivo* exposure. If equivalent efficiency is achieved, *in virtuo* exposure has compelling advantages over *in vivo* exposure and could make it the treatment of choice.

Acknowledgments

This study is the doctoral thesis of David Michaliszyn, Ph.D. (candidate). André Marchand, Ph.D., acted as his thesis advisor. The study was conducted at the Laboratoire de Cyberpsychologie of l'Université du Québec à Montréal (UQAM) where the first author is completing his Ph.D. Special thanks go to Stéphane Bouchard from the Laboratoire de Cyberpsychologie of l'Université du Québec en Outaouais (UQO) (www.uqo.ca/cyberpsy) for his invaluable help during all the stages of this study. Also, we wish to give special thanks to Mélissa Martin and Joannie Poirier-Bisson for their contributions. This study was funded by the Canada Foundation for Innovation.

Disclosure Statement

No competing financial interests exist.

References

1. Emmelkamp PMG, Bowman TKO, Scholing A. (1995) *Anxiety disorders. A practitioner's guide.* Chichester, UK: John Wiley.
2. Emmelkamp PMG. (1982) *Phobic and obsessive–compulsive disorders: Theory, research, and practice*. New York: Plenum Press.
3. Hellstrom K, Öst LG. One session therapist directed exposure vs. two forms of manual directed self exposure in the treatment of spider phobia. Behaviour Research & Therapy 1995; 33:959–65.
4. Öst LG, Ferebee I, Furmark T. One session group therapy of spider phobia: Direct versus indirect treatments. Behaviour Research & Therapy 1997; 35:721–32.
5. Rowe MK, Craske MG. Effects of expanding spaced vs massed exposure schedule on fear reduction and return of fear. Behaviour Research & Therapy, 1998; 36:707–17.
6. Gunther LM, Denniston JC, Miller RR. Conducting exposure treatment in multiple contexts can prevent relapse. Behaviour Research & Therapy 1998; 36:75–91.
7. Garcia-Palacios A, Botella C, Hoffman H, et al. Comparing acceptance and refusal rates of virtual reality exposure vs. in vivo exposure by patients with specific phobias. CyberPsychology & Behavior 2007; 10:722–4.
8. Rothbaum BO, Hodges L, Smith S, et al. A controlled study of virtual reality exposure therapy for the fear of flying. Journal of Consulting & Clinical Psychology 2000; 68:1020–6.
9. Carlin AS, Hoffman HG, Weghorst S. Virtual reality and tactile augmentation in the treatment of spider phobia: A case report. Behaviour Research & Therapy 1997; 35:153–8.
10. Garcia-Palacios A, Hoffman HG, Carlin A, et al. Virtual reality in the treatment of spider phobia: A controlled study. Behaviour Research & Therapy 2002; 40:983–93.
11. Côté S, Bouchard S. Documenting the efficacy of virtual reality exposure with psychophysiological and information processing measures. Applied Psychophysiology & Biofeedback 2005; 30:217–32.
12. Hoffman HG, Garcia-Palacios A, Carlin A, et al. Interfaces that heal: Coupling real and virtual objects to treat spider phobia. International Journal of Human–Computer Interaction 2003; 16:283–300.
13. Emmelkamp PMG, Krijn M, Hulsbosch AM, et al. Virtual reality treatment in acrophobia: A comparison with in vivo exposure. Behaviour Research & Therapy 2002; 40:509–16.
14. Rothbaum BO, Hodges L, Anderson LP, et al. Twelve-month follow-up of virtual reality and standard exposure therapies for the fear of flying. Journal of Consulting & Clinical Psychology 2002; 70:428–32.
15. American Psychiatric Association. (1994) *Diagnostic and statistical manual of mental disorders*. 4th ed. Washington DC: APA.
16. Szymanski J, O'Donoghue W. Fear of Spiders questionnaire. Journal of Behavior Therapy & Experimental Psychiatry 1995; 26:31–4.
17. First MB, Spitzer R, Gibbon M, et al. (1996) *Structured clinical interview for DSM-IV axis-I disorders—Patient version*. New York: Biometrics Research Department, New York State Psychiatric Institute.
18. Summerfeldt LJ, Anthony MM. (2002) Structured and semistructured diagnostic interviews. In Antony MM, Barlow DH, eds. *Handbook of assessment and treatment planning for psychological disorders*. New York: Guilford Press, pp. 3–37.
19. Muris P, Merckelbach H. A comparison of two spider fear questionnaires. Behaviour Research & Therapy 1996; 27: 241–4.
20. Arntz A, Lavy E, Van den Berg G, et al. Negative beliefs of spider phobics: A psychometric evaluation of the Spider Phobia Beliefs Questionnaire. Advances in Behaviour Research & Therapy 1993; 15:257–77.
21. Cottraux J, Bouvard M, Légeron P. (1985) *Méthodes et échelles d'évaluation des comportements*. Paris: Éditions EAP.
22. Beck AT, Rush AJ, Shaw BF, et al. (1979) *Cognitive therapy of depression*. New York: Guilford Press.
23. Bourque P, Beaudette D. Étude psychométrique du questionnaire de dépression de Beck auprès d'un échantillon d'étudiants universitaires francophones. Canadian Journal of Behavioral Science/Revue Canadienne des Sciences du Comportement 1982; 14:211–18.
24. Freeston MH, Dugas MJ, Léger E, et al. (1995) *Échelle d'évaluation du thérapeute*. Québec, Canada: École de psychologie, Université Laval.
25. Williams KE, Chambles LD. The relationship between therapist characteristics and outcome of in vivo exposure treatment for agoraphobia. Behavior Therapy 1990; 21:111–16.
26. Borkoveck TD, Nau SD. Credibility of analogue therapy rationales. Journal of Behavior Therapy & Experimental Psychiatry 1972; 3:257–60.
27. Witmer BG, Singer MJ. Measuring presence in virtual environments: A presence questionnaire. Presence 1998; 7: 225–40.
28. Kennedy RS, Lane NE, Berbaum KS, et al. Simulator sickness questionnaire: An enhanced method for quantifying simulator sickness. International Journal of Aviation Psychology 1993; 3:203–20.
29. Robillard G, Bouchard S, Fournier T, et al. Anxiety and presence during VR immersion: A comparative study of the reactions of phobic and non-phobic participants in therapeutic virtual environments derived from computer games. CyberPsychology & Behavior 2003; 6:467–76.
30. Wiederhold BK, Wiederhold MD. Lessons learned from 600 virtual reality sessions. CyberPsychology & Behavior 2000; 3:393–400.
31. Côté S, Bouchard S. Cognitive mechanisms underlying virtual reality exposure. CyberPsychology & Behavior 2009; 2:121–9.

Address correspondence to:
David Michaliszyn
Department of Psychology
Université du Québec à Montréal
Case Postale 8888
Succursale Centre-Ville
Montréal
Québec H3C 3P8
Canada

E-mail: david.michaliszyn@gmail.com