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Virtual Reality Exposure Therapy for Arachnophobia: A Pilot Study

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Abstract: Arachnophobia is a chronic disorder leading to significant avoidance of spider-related situations. This pilot study examines the effectiveness of Virtual Reality Exposure Therapy (VRET) for treating arachnophobia. The study included 25 participants who completed fear questionnaires and avoidance tests before, after and two weeks after the intervention. The intervention consisted of a session of progressive exposure to a novel and gamified virtual environment containing spiders. The results showed a significant reduction in fear and anxiety in relation to the phobic stimulus, suggesting that VRET is a promising approach for treating phobias, in controlled and safe environments.

1 Introduction

Anxiety is an emotional response to uncertain situations that require an appropriate response to deal with. It affects psychophysiological components and can therefore alter the individual's quality of life. Anxiety is considered pathological when it is excessive or disproportionate to the stimulus or when it does not correspond to what is expected in each context and can affect all the individual's occupations Romo-Barrientos et al. (2019).
Anxiety disorders are common globally, affecting around 3.6% of the world's population, with a higher prevalence among women, who are 1.5 times more susceptible Marco et al. (2020).
According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-V-TR), specific phobia is the most prevalent anxiety disorder characterized by extreme fear and anxiety in the presence of a particular stimulus, such as spiders in the case of arachnophobia. Individuals with Arachnophobia tend to avoid situations that cause them suffering and anxiety, namely environments where spiders are possible and probable, and it affects between 3.5% and 6.1% of the population Association (2022).
Exposure therapy, based on the principles of cognitive-behavioral therapy (CBT), is the most effective approach for treating specific phobias, including arachnophobia. CBT aims to modify non-adaptive cognitions and behaviors by challenging dysfunctional thoughts and beliefs through strategies such as cognitive restructuring and exposure Wechsler et al. (2019).
The standard form of exposure therapy involves in vivo approaches that expose the individual to real-world phobic scenarios, keeping their anxiety at controlled levels Wechsler et al. (2019). However, Virtual Reality (VR) offers more assertive environmental control, reducing unpredictability and adverse reactions, making the therapeutic process safer and more personalized Verkuyl et al. (2018).
VR creates immersive three-dimensional scenarios that allow the individual to interact with a virtual environment, recreating Hanifah et al. (2022); Hatta et al. (2022). This immersion allows fears to be reassessed, skills and confidence to be acquired that can be transferred to

everyday life Hatta et al. (2022). Thus, VR makes it possible to assess behavioral, emotional, cognitive, and physiological responses in real-time, which makes the environment more pleasant for the individual to face phobic situations and experiment with new therapeutic strategies Emmelkamp and Meyerbröker (2021).
This type of exposure seems to be very efficient in the controlled and personalized systematic desensitization of the individual about the phobic stimulus and the impulsive responses related to it, enhancing emotional self-regulation and the associated cognitive restructuring Botella et al. (2017); Schweizer et al. (2017). Based on this, this study aims to evaluate the efficacy of a Virtual Reality-based intervention in the treatment of arachnophobia.

2 Materials and Methods

This is a quasi-experimental study without a control group. All participants were assessed before, during, and at the end of the intervention. There was also a follow-up two weeks after the intervention session Ranganathan and Aggarwal (2018).

3 Participants

Participants were selected using a non-probabilistic convenience sampling method. Inclusion criteria required participants to be of legal age and score above 5 on the Spider Phobia Questionnaire-15 (SPQ-15). Exclusion criteria included health conditions that could interfere with the virtual reality experience, and concurrent therapeutic interventions that might influence study outcomes Grill and Haberkamp (2023).

4 Instruments

Sociodemographic questionnaire: Ask sociodemographic information, and the impact of the phobia on their daily living activities.
Fear of Spiders Questionnaire (FSQ): The aim is to assess anxiety and fear of spiders and higher scores correspond to greater fear Lindner et al. (2020a).
Spider Phobia Questionnaire – 15 (SPQ-15): That aims to assess various aspects of arachnophobia's cognitive and behavioral components Zsido (2017).
Behavioral Avoidance Test (BAT): That aims to assess the reaction to the presence of the spider Grill and Haberkamp (2023).
Simulator Sickness Questionnaire (SSQ): Applied to assess the presence of some discomfort during the simulation Carvalho et al. (2011).
Presence Questionnaire (PQ): Applied to evaluate the Virtual Reality experience Vasconcelos-Raposo et al. (2021).

5 Procedures

Subjects' participation in the study was formalized through the completion of an informed consent form Association (2013).
All participants previously completed an online pre-test questionnaire, with the following sections: (1) Sociodemographic data; (2) FSQ; and (3) SPQ-15.
Based on the answers obtained in the questionnaire, the participants were selected. The intervention sessions were scheduled according to the availability of each participant, with a difference of approximately two weeks between the two.

6 Intervention Protocol

The intervention consisted of a session lasting approximately 2 hours, structured as follows Grill and Haberkamp (2023):
1) Psychoeducation on relaxation and breathing techniques;
2) Participant preparation and warm-up;
3) Initial BAT;
4) Psychoeducation on spiders and their role in ecosystems and on spider phobia and its treatment;
5) Progressive exposure to virtual environments for systematic desensitization. 3 activities are carried out at 6 different levels of difficulty.
5.a) Activity 1 consists of looking at the spiders for as long as possible.
5.b) In activity 2, the aim is to protect the spider from spheres. The number of spheres that fall increases.
5.c) Finally, in activity 3, the spider moves, the aim is to always maintain a distance equal to or less than the idealized distance Lindner et al. (2020b).
6) Final BAT;
7) Relaxation and feedback;
8) Filling out the post-test questionnaire.
At the end of the exposure, participants answered an post-test questionnaire, with the following sections: (1) FSQ; and (2) SPQ-15. In addition, a new BAT identical to the initial one was carried out. At the 2-weeks mark, a follow-up session was conducted consisting of a new BAT, identical to the other two. A new post-test questionnaire, the same as the one completed at the end of the exposure, was also completed.

7 Statistical Analysis

Descriptive statistics characterized sociodemographic data, calculating means and standard deviations, as well as absolute and relative frequencies for categorical variables. In the inferential analysis, the assumptions for applying the repeated measures Analysis of Variance (ANOVA), used to identify significant differences between the intervention phases, were checked. If the assumptions were not met, the Friedman test was used Marôco (2021).

8 Results

There were twenty five participants in the sample and, as shown in Table 1, the majority of this group were female (76%) and single (84%).

Table 1- Sample sociodemographic characterization

		Sample n= 25	
		Mean/SD	**Min-Max**
Age (years)		26,68±11,28	18-60
		Frequency	**%**
Sex	Female	19	76
	Male	6	24
Employment Situation	Student	9	36
	Worker	8	32
	Worker-Student	6	24
	Unemployed	2	8
School Grade	Bachelor's degree	12	48
	High School	10	40
	Master's degree	2	8
	Other	1	4
Marital status	Single	21	84
	Married	4	16

Virtual Reality Questionnaires:
The Friedman test was used and PQ was the only variable that showed a significant value at some point, with $p < .001$ (Table 2).

Table 2 - Summary statistical measures for the three moments in Simulator Sickness Questionnaire and Presence Questionnaire

		Mdn(IQR)	Dif(b-a) (z-value)	Dif(m6-m1) (z-value)	p(value)*		Mdn(IQR)	Dif(b-a) (z-value)	Dif(m6-m1) (z-value)	p(value)*
m1	SSQ	8.00(14.50)				PQ	5.43(1.14)			
			-1.00±5.50		.794			0.29±2.24		.028
m2		8.00(12.50)	(-0.26)				5.67(1.31)	(-2.19)		
			0.00±4.00		.476			0.10±0.33		.025
m3		9.00(13.50)	(-0.71)				5.95(1.28)	(-2.25)		
			0.00±4.00		.659			0.00±1.36		.454
m4		9.00(12.00)	(-0.44)				5.90(0.98)	(-0.75)		
			0.00±4.00		.808			0.05±2.38		.354
m5		9.00(15.00)	(-0.24)				6.05(1.10)	(-0.93)		
			0.00±4.00		.553			0.05±2.21		.702
m6		10.00(12.00)	(-0.59)	0.00±8.00			6.00(1.00)	(-0.38)	0.48±1.10	
				(-0.40)	.692				(-3.46)	**<.001**

"a" corresponds to value on the cell of the level above and "b" to the level below. *Bonferroni's method – $\alpha = 0.05/6 = 0.0083$

Spider Fear Questionnaires:
The ANOVA assumptions were assessed and only the FSQ and SPQ data met the requirements. The ANOVA for the FSQ resulted in a p-value of .008 and for the SPQ .013. In the case of BAT, the Friedman test was used, which resulted in a $p < .001$ (Table 3).

Table 3 - Summary statistical measures for the three moments in Fear of Spiders Questionnaire, Spider Phobia Questionnaire and Behavioral Avoidance Test

		Mean/SD	Mdn(IQR)	Dif(PsT-PT)	Dif(FU-PsT)	Dif(FU-PT)	z-value	p(value)*
FSQ	Pre-Test (PT)	59.60±18.94		-7.68±16.17				.026
	Post-Test (PsT)	51.92±18.25			-1.88±13.37			.489
	Follow-up (FU)	50.04±17.64				-9.56 ± 16.41		**.008**
SPQ-15	Pre-Test (PT)	9.40±2.86		-1.00±2.53				.060
	Post-Test (PsT)	8.40±3.04			-0.76±2.62			.160
	Follow-up (FU)	7.64±3.68				1.76±3.38		**.016**
BAT	Pre-Test (PT)		6.00(1.00)	2.00(0.50)			-4.24	**<.001**
	Post-Test (PsT)		8.00(1.00)		0.00(0.00)		-1.63	.102
	Follow-up (FU)		8.00(1.00)			2.00(1.00)	-4.29	**<.001**

* Bonferroni's method – $\alpha = 0.05/3 = 0.0167$

9 Discussion

This study investigated the impact of a virtual reality-based intervention to treat spider phobia. Virtual reality questionnaires, subjective ratings of emotions, scores on different activities and specific questionnaires on fear of spiders were used.

The results of the Simulator Motion Sickness Questionnaire indicated that adverse reactions to VR exposure gradually increased during the session, although they were not statistically significant. Many participants reported general malaise, possibly more related to fear of spiders than to exposure to the virtual environment, explained by sensory conflicts and individual and environmental factors Benson and Stott (2023). The sense of presence in the virtual environment was assessed by the PQ, showing an increase over the course of the study, possibly due to the wide field of vision and real-time interaction Vasconcelos-Raposo et al. (2021).

Emotions were assessed to measure the impact of the intervention on fear, disgust and anxiety in relation to the phobic stimulus, with consistent decreases in fear, disgust and anxiety scores Grill and Haberkamp (2023); Woronko et al. (2023). Participants' performance in three activities was analyzed, showing significant improvements in almost all points, suggesting that repeated practice and gradual exposure helped improve performance Abramowitz et al. (2019). VR can simulate complex environments in a controlled and safe way, allowing the practice of skills needed for everyday life and strengthening confidence in phobia management Emmelkamp and Meyerbröker (2021). Gamification makes therapy more engaging and less intimidating, increasing motivation and adherence to treatment Tertuliano et al. (2023).

The results of the BAT showed a positive evolution in the fear of spiders, with a significant increase in the phase completed by the participants. The Wilcoxon test showed significant differences between pre-test and post-test, and between pre-test and follow-up, suggesting the effectiveness and maintenance of the intervention Association (2022); Grill and Haberkamp (2023).

The specific questionnaires on fear of spiders showed significant changes between pre-test and follow-up, suggesting that the Virtual Reality Exposure Therapy protocol reduced participants' anxiety about exposure to spiders Association (2022); Dunsmoor and Paz (2015).

The results indicate that the VR intervention effectively reduced arachnophobia, evidenced by a decrease in negative emotional responses and improved performance in related activities, corroborating the existing literature on the effectiveness of Virtual Reality Exposure Therapy to treat phobias Demir and Köskün (2023).

However, the study has limitations. The small size and variability of the sample may compromise the robustness of the results. The fidelity of the virtual experience is crucial; unrealistic spiders and technical problems can affect participants' responses. Subjective measures of fear are limited, and the use of objective indicators such as physiological responses is beneficial. The lack of long-term follow-up prevents a full assessment of the durability of the therapeutic effects. Individual factors, such as personal history and intensity of fear, influence responses to VR therapy, as does acceptance and familiarity with the technology.

Recommendations for future research include improving the technology, incorporating more

natural interactions and tactile feedback to increase immersion. More advanced evaluation methods and longitudinal studies are needed to verify the maintenance of therapeutic effects. Comparative studies between VR exposure therapy and other treatment modalities, as well as combining VR with other therapeutic techniques, would be beneficial. More research is needed to gather more robust evidence with larger samples, using different assessment instruments and better control of study variables, as well as follow-up of participants to understand the maintenance of results or the emergence of new changes.

10 Conclusion

The results of this study indicate that exposure therapy using Virtual Reality is a promising approach to treating arachnophobia, showing positive results in reducing anxiety. Although some results were not conclusive, a significant decrease in anxiety in anxiogenic contexts was observed. To strengthen this evidence, future studies should include larger and more diverse samples, better control variables and explore the combination of VR with other therapies, as well as using objective measures, such as physiological indicators, for a more complete evaluation of effectiveness.

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