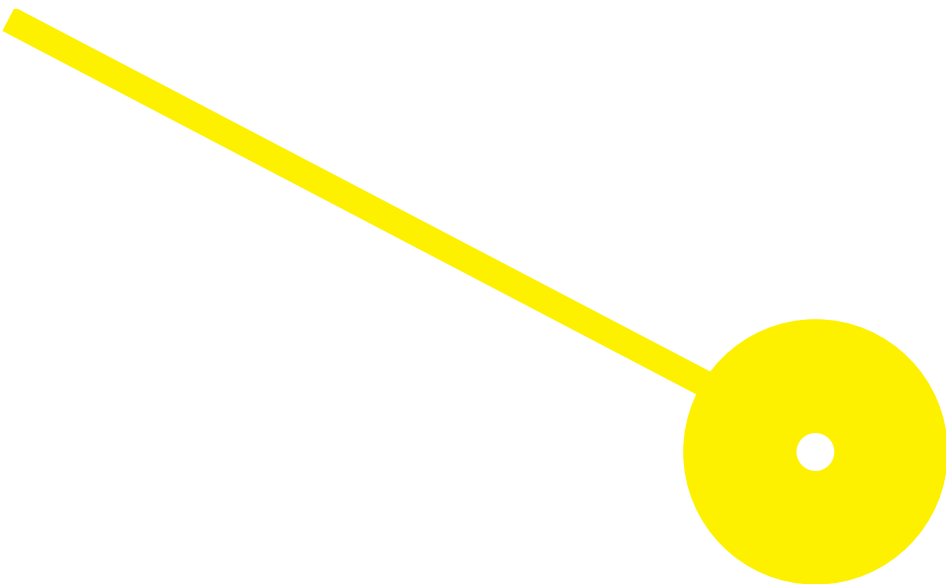




# Efficacy of Virtual Reality Exposure Therapy for Individuals with Arachnophobia: a pilot study

Inês Ferreira Lopes

09/2024



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**Efficacy of Virtual Reality Exposure Therapy for Individuals with Arachnophobia:  
a pilot study**

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Dissertação apresentada para cumprimento dos requisitos necessários à obtenção do grau de Mestre em **Terapia Ocupacional** – Opção em Saúde Mental, pela Escola Superior de Saúde do Instituto Politécnico do Porto.

## **Resumo**

A Aracnofobia é um tipo de fobia específica e é definida como um medo extremo de aranhas afetando entre 3,5% e 6,1% da população. Trata-se de uma perturbação crónica que pode ter impacto na vida das pessoas, uma vez que indivíduos com Aracofobia tendem a evitar situações em que seja provável a existência de aranhas.

Através da Realidade Virtual, enquanto terapia de exposição, é possível obter um controlo mais assertivo do ambiente terapêutico, facilitando a adaptabilidade e a resolução de problemas e oferecendo maiores possibilidades de personalização, flexibilidade e controlo do processo terapêutico.

Este estudo quase experimental sem grupo de controlo teve como objetivo avaliar a eficácia e o impacto de uma intervenção baseada na Realidade Virtual no tratamento da aracnofobia. A amostra era composta por 25 pessoas. O impacto do programa foi medido através da participação num Teste de evitamento comportamental e do preenchimento do Questionário de Medo de Aranhas e do Questionário de Fobia de Aranhas antes e depois da intervenção e passado duas semanas (follow-up).

Os resultados deste estudo sugerem que a terapia de exposição com recurso à Realidade Virtual apresenta resultados positivos e é uma abordagem promissora no tratamento de indivíduos com Fobia de Aranhas. Embora alguns dos resultados não sejam totalmente conclusivos, foram observadas diferenças positivas significativas em todas as avaliações realizadas relativamente a situações ansiogénicas.

**Palavras-chave:** Perturbações de Ansiedade; Aracnofobia; Medo de Aranhas; Terapia de Exposição; Realidade Virtual.

## **Abstract**

Arachnophobia is a type of specific phobia and is defined as an extreme fear of spiders. It affects between 3.5% and 6.1% of the population. It is a chronic disorder that can have an impact on people's lives, as individuals with Arachnophobia tend to avoid situations where spiders are likely to be present.

Through Virtual Reality, as exposure therapy, it is possible to obtain more assertive control of the therapeutic environment, facilitating adaptability and problem-solving and offering greater possibilities for personalization, flexibility, and control of the therapeutic process.

This quasi-experimental study without a control group aimed to assess the effectiveness and impact of an intervention based on Virtual Reality in the treatment of arachnophobia. The sample consisted of 25 people. The impact of the program was measured through participation in a BAT and completion of the Fear of Spiders Questionnaire (FSQ) and the Spider Phobia Questionnaire (SPQ-15) before and after the intervention and after two weeks (follow-up).

The results of this study suggest that exposure therapy using Virtual Reality shows positive results and is a promising approach to treating individuals with spider phobia. Although some of the results are not entirely conclusive, significant positive differences were observed in all the evaluations carried out in relation to anxiogenic situations.

**Keywords:** Anxiety Disorders; Arachnophobia; Fear of Spiders; Exposure Therapy; Virtual Reality.

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## 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 (Romo-Barrientos et al., 2019). In this sense, deregulation of the activity of the autonomic nervous system often presents biomarkers indicative of anxiety, such as high and irregular heart rate and increased variability (Goessl et al., 2017; Tovote et al., 2015). 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 a contemporary global phenomenon with a high prevalence and occur at all ages. They are present in around 3.6% of the world's population and, despite the differences in prevalence between different countries, in all of them, it is higher among women, who are 1.5 times more susceptible (Marco et al., 2020). Anxiety disorders are a group of neuropsychiatric illnesses characterized by feelings of anxiety and fear. Anxiety has no specific trigger that defines its onset and usually corresponds to worry about future events, while fear is a reaction to events in the present (Andreatta et al., 2017; Carnevali et al., 2013; Goessl et al., 2017).

According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-V-TR), one of the anxiety disorders described is specific phobia. This is the most prevalent of these conditions and is characterized by extreme fear and/or anxiety in the presence of a particular situation or object, called a "phobic stimulus", to a degree disproportionate to the actual danger or risk. The phobic stimulus is often avoided, but if this is not possible and exposure occurs, anxiety develops rapidly and can intensify into a panic attack (American Psychiatric Association, 2022). Arachnophobia is a specific type of phobia and is defined, according to the DSM-V-TR, as an extreme fear of spiders (American Psychiatric Association, 2022). 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 (American Psychiatric Association, 2022; Schmitt & Müri, 2009; Vargas-Herrera et al., 2019).

Various therapeutic approaches are used to treat specific phobias, such as arachnophobia. Several studies have shown that the most widely used therapeutic method with the best results is exposure therapy, based on the principles of cognitive-behavioral therapy (CBT), in groups or individually (Apolinário-Hagen et al., 2020; Axelsson & Hedman-Lagerlöf, 2019; Lindner et al., 2017; Morina et al., 2015; Suso-Ribera et al., 2019; Wechsler et al., 2019). CBT aims to modify

non-adaptive cognitions and behaviors by challenging dysfunctional thoughts and beliefs through strategies such as cognitive restructuring and exposure (Apolinário-Hagen et al., 2020; Axelsson & Hedman-Lagerlöf, 2019; 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 (Eaton et al., 2018; Lindner et al., 2017; Linke et al., 2019; Verkuyl et al., 2018; Wechsler et al., 2019). Although promising results have been described in the literature for *in vivo* exposure therapy, some characteristics hinder its use, namely the impossibility of guaranteeing adequate environmental control (Choy et al., 2007; Verkuyl et al., 2018). This is why Virtual Reality (VR) exposure therapy has shown even more promising results, since it allows for more assertive control of the therapeutic environment, reducing the degree of unpredictability and therefore the number of adverse and negative reactions that could occur during the treatment process, facilitating the ability to adapt and solve problems and offering greater possibilities for personalization, flexibility, and control of the therapeutic process (Aldaba et al., 2017; Baus & Bouchard, 2014; Duff et al., 2016; Verkuyl et al., 2018).

Exposure therapy through VR exposes clients to interactive three-dimensional computer-generated scenarios with scenes and objects that seem real, allowing a person to interact with the environment, feeling immersed in it (Emmelkamp & Meyerbröker, 2021; Halldorsson et al., 2021; Hanifah et al., 2022; Hatta et al., 2022; Yeung et al., 2021). In this case, an immersive virtual experience is created in a therapeutic environment, making it possible to recreate real everyday situations (in the case of arachnophobia, environments with the presence of spiders), which cause anxiety in individuals undergoing treatment, in a controlled and safe environment, keeping the individual's anxiety at controlled levels (Duff et al., 2016; Fernández-Álvarez et al., 2020; Lindner et al., 2017; Linke et al., 2019; Verkuyl et al., 2018; Wechsler et al., 2019).

The fact that VR provides the user with a strong sense of immersion, presence, and interaction, allows them to be able to re-evaluate their fears and acquire skills, confidence, knowledge, and mental and physical preparation that are transferred to real everyday life (Emmelkamp & Meyerbröker, 2021; Freeman et al., 2017; Halldorsson et al., 2021; Hatta et al., 2022; Yeung et al., 2021). 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 & Meyerbröker, 2021; Freeman et al., 2017). This allows individuals to engage in simulations of challenging situations, receiving guidance for appropriate responses. These

simulations can be categorized in difficulty and repeated as necessary (Cieřlik et al., 2020; Freeman et al., 2017). When used properly, VR can reproduce therapeutically useful scenarios that are often impossible to recreate in vivo (Cieřlik et al., 2020; Freeman et al., 2017).

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 (Baus & Bouchard, 2014; Botella et al., 2017; Schweizer et al., 2017).

In Occupational Therapy (OT) practice, VR has also been used to induce pleasure and engagement in meaningful activities, as it affects various client factors, motivation, and internal locus of control (Hanifah et al., 2022). OT helps people overcome challenges and barriers in their lives that prevent them from achieving goals, and OT practice has an extensive history dedicated to supporting the mental health demands of the community (Burson et al., 2017; Gunnarsson et al., 2023; Johanson & Bejerholm, 2017). OT focuses its practice on occupational performance and engagement in occupations, which are the results of dynamic interactions between the person, the occupation, and the environment (Gunnarsson et al., 2023; Johanson & Bejerholm, 2017). The interaction between these factors is relevant to people's mental health and quality of life (Gunnarsson et al., 2023; Johanson & Bejerholm, 2017; Kirby et al., 2023).

Building on this foundation, VR offers a promising tool for addressing specific mental health challenges by creating controlled, immersive environments where clients can safely confront and overcome their fears. Given the importance of these dynamic interactions in OT, VR in treating specific phobias, such as arachnophobia, represents an innovative extension of this practice. 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 one month after the intervention session (Andrews & Likis, 2015; Oliveira, 2009; Ranganathan & Aggarwal, 2018).

For this purpose, the hypotheses for this study were determined as follows:

- The Virtual Reality-based intervention reduces the avoidance of phobic situations in individuals who are afraid of spiders;
- The Virtual Reality-based intervention reduces the levels of fear, disgust, and anxiety in individuals who are afraid of spiders.

## 2.1. Participants

Participants were selected using a non-probabilistic convenience sampling method, obtained from the general population by answering a questionnaire posted on social media.

To qualify, participants needed to be available to attend sessions at the Psychosocial Rehabilitation Laboratory (LabRP) twice over two weeks. 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 (e.g., epilepsy, labyrinthitis, sensorimotor disorders, and visual impairments), substance dependence (excluding nicotine), and concurrent therapeutic interventions that might influence study outcomes (Grill & Haberkamp, 2023; Öst et al., 1991).

## 2.2. Instruments

Sociodemographic questionnaire: Sociodemographic information was collected, including gender, age, academic level, place of residence, any conditions contraindicating exposure to virtual reality, and the impact of the phobia on their daily living activities.

Fear of Spiders Questionnaire (FSQ): This is a self-report questionnaire made up of 18 items, answered on a Likert scale from 1 (strongly disagree) to 7 (strongly agree). The aim is to assess anxiety and fear of spiders through cognitive, behavioral, and physiological components. The score ranges from 18 to 126, and higher scores correspond to greater fear (Booth et al., 2016; Granado et al., 2005; Lindner, Miloff, et al., 2020; Szymanski & O'Donohue, 1995).

Spider Phobia Questionnaire – 15 (SPQ-15): It is a self-administered scale comprising 15 dichotomous questions (true/false). That aims to assess various aspects of arachnophobia's cognitive and behavioral components. The score ranges from 0 to 15, with higher scores corresponding to higher levels of phobia (Cowdrey & Walz, 2015; Granado et al., 2005; Olatunji et al., 2009; Zsido, 2017).

Behavioral Avoidance Test (BAT): Conducted in a virtual environment and divided into 8 stages. Higher scores indicate less adverse reactions to the presence of spiders. The BAT ends when all steps have been completed or if the participant does not proceed to the next step. At the

beginning, and end of the BAT, the participant was asked to rate subjective fear, anxiety, and disgust on a scale from 0 to 10 (Grill & Haberkamp, 2023; Öst et al., 1991).

Simulator Sickness Questionnaire (SSQ): Applied to assess the presence of some discomfort during the simulation. It consists of 16 questions evaluated on a 4-point Likert scale from 0 (absent) to 3 (severe). The total is 48 points and higher values indicate worse reactions to VR (Carvalho et al., 2011; Kennedy et al., 1993).

Presence Questionnaire (PQ): Applied to evaluate the Virtual Reality experience and evaluated on a 7-point Likert scale from 1 (not at all) to 7 (completely). It consists of 21 questions and the score ranges from 1 to 7. Higher scores indicate greater immersion (Vasconcelos-Raposo et al., 2016, 2021; Witmer & Singer, 1998).

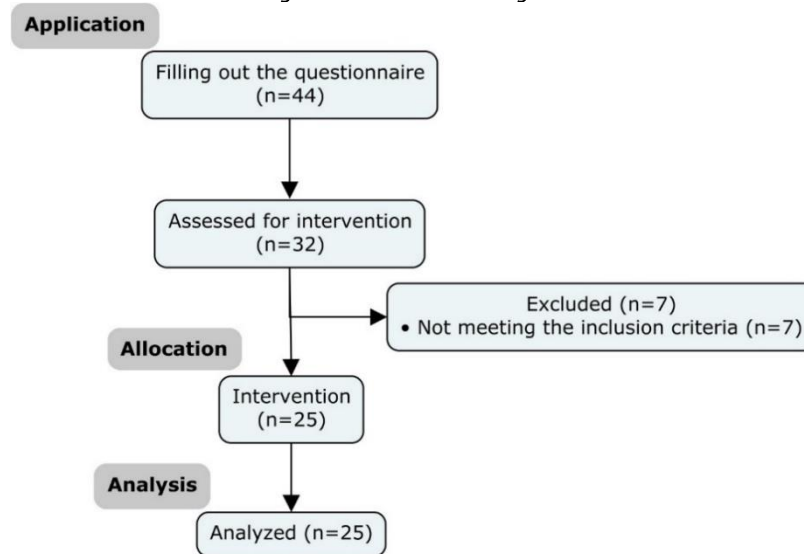
### **2.3. Procedures**

Subjects' participation in the study was formalized through the completion of an informed consent form, in accordance with the Declaration of Helsinki (Braga, 2013; World Medical Association, 2013). This process ensured the privacy and confidentiality of the collected data, as well as the participants' right to access all relevant information needed to make an informed decision about their voluntary participation (Braga, 2013). The study received approval from the Ethics Committee of ESS, Polytechnic University of Porto (CE0015E).

All participants previously completed an online pre-test questionnaire on the Microsoft Forms platform, with the following sections: (1) Sociodemographic data; (2) FSQ; and (3) SPQ-15.

Based on the answers obtained in the questionnaire, the participants who agreed to be contacted for the second phase of the study and who met the previously defined inclusion and exclusion criteria were selected. The intervention sessions were scheduled according to the availability of each participant, with a difference of approximately one month between the two. The Consort Flow Diagram (Figure 1) summarizes the entire participant selection and intervention process. The intervention protocol consisted of two sessions (the first for two hours and the second for twenty minutes).

Figure 1 – Consort Flow Diagram



### 2.3.1. Intervention Protocol

Participants navigated the virtual environment with a joystick, adjusted their field of vision by moving their head and interacted with objects using the controller's trigger button. The controls were explained and after that, the participants were given time to get used to the VR equipment and the controls. The purpose and environment of the BAT were explained and the participants were informed that they could stop at any time. Before starting the BAT, participants rated their levels of fear, anxiety and disgust on a scale from 0 to 10. If they chose not to enter the room, the BAT was rated 0. When they clicked on "BAT", the test began with a spider in a terrarium. The minimum score was 1, depending on the steps completed.

The field of vision was limited to prevent participants from looking away from the terrarium. Interactions could only be started 10 seconds after the previous one, to avoid quick clicks to avoid the spider. At the end of the BAT, participants again rated their levels of fear, anxiety and disgust on a scale of 0 to 10 (Grill & Haberkamp, 2023; Öst et al., 1991; Tardif et al., 2019; Woronko et al., 2023).

The intervention consisted of a session lasting approximately 2 hours, structured as follows:

- 1) Psychoeducation on relaxation and breathing techniques;
- 2) Participant preparation and warm-up (getting used to the virtual space);
- 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 (Resistance). 3 activities are carried out at 6 different levels of difficulty. In all the levels of all the activities, 3 minutes was set as the completion time, with a score counter always visible (Table 1).
- a. Activity 1 consists of looking at the spiders for as long as possible. The longer you stare at the spider, the more points you earn. As long as the spider is in the center of the field of vision, the person wins points, even if they are far away.
  - b. In activity 2, the aim is to protect the spider from spheres. The number of spheres that fall increases. The person increases their points every time they defend the spider and loses when the spider is hit.
  - c. Finally, in activity 3, the spider moves, the aim is to always maintain a distance equal to or less than the idealized distance. The longer you keep the right distance, the more points you get. When you are not at the right distance, you do not get any points (Lindner, Rozental, et al., 2020; Miloff et al., 2016).
- 6) Final BAT;
- 7) Relaxation and feedback;
- 8) Filling out the post-test questionnaire (Table 2).

Table 1 – Organization of activities by level of difficulty

<p>Level 1:</p> <p>Activity 1: 1 spider, non-realistic, size 0.5. For 20 seconds each;</p> <p>Activity 2: 1 spider, non-realistic, size 0.5. Spheres appear every 6-8 seconds and wait 3 seconds before attacking;</p> <p>Activity 3: 1 spider, non-realistic, size 0.5. Desired distance: 2 meters</p>	<p>Level 2:</p> <p>Activity 1: 2 spiders, realistic, size 1. For 20s each;</p> <p>Activity 2: 1 spider, realistic, size 1. Spheres appear every 5-7s and wait 2.5s before attacking;</p> <p>Activity 3: 1 spider, realistic, size 1. Desired distance: 2 meters</p>	<p>Level 3:</p> <p>Activity 1: 3 spiders, realistic, size 1.5. For 20 seconds each;</p> <p>Activity 2: 1 spider, realistic, size 1.5. Spheres appear every 4-6s and wait 2s before attacking;</p> <p>Activity 3: 2 spiders, realistic, size 1.5. Desired distance: 2 meters</p>
<p>Level 4:</p> <p>Activity 1: 4 spiders, realistic, size 1.5. For 10 seconds each;</p> <p>Activity 2: 1 spider, realistic, size 1.5. Spheres appear every 3-5s and wait 1.5s before attacking;</p> <p>Activity 3: 2 spiders, realistic, size 1.5. Desired distance: 1 meter.</p>	<p>Level 5:</p> <p>Activity 1: 5 spiders, realistic, size 2. For 10s each;</p> <p>Activity 2: 1 spider, realistic, size 2. Spheres appear every 2-4s and wait 1s before attacking;</p> <p>Activity 3: 3 spiders, realistic, size 1.5. Desired distance: 1 meter.</p>	<p>Level 6:</p> <p>Activity 1: 6 spiders, realistic, size 2. For 10 seconds each;</p> <p>Activity 2: 1 spider, realistic, size 2.5. Spheres appear every 1-3s and wait 0.5s before attacking;</p> <p>Activity 3: 3 spiders, realistic, size 2. Desired distance: 1 meter.</p>

Table 2 – Moments of evaluation in the intervention

Time	Step	Evaluation
5	Pre-test questionnaire	Sociodemographic data, SPQ-15 e FSQ (PT)
3	Breathing techniques	Fear, anxiety, and disgust on a scale of 0 to 10 pre-intervention (M1)
3	Ambiance	
3	BAT	Fear, anxiety, and disgust on a scale of 0 to 10 (M2)
3	Information	
9	Level 1	Fear, anxiety, and disgust on a scale of 0 to 10 (M3)
3	Pause	SSQ e PQ (m1)
9	Level 2	Fear, anxiety, and disgust on a scale of 0 to 10 (M4)
3	Pause	SSQ e PQ (m2)
9	Level 3	Fear, anxiety, and disgust on a scale of 0 to 10 (M5)
3	Pause	SSQ e PQ (m3)
9	Level 4	Fear, anxiety, and disgust on a scale of 0 to 10 (M6)
3	Pause	SSQ e PQ (m4)
9	Level 5	Fear, anxiety, and disgust on a scale of 0 to 10 (M7)
3	Pause	SSQ e PQ (m5)
9	Level 6	Fear, anxiety, and disgust on a scale of 0 to 10 (M8)
3	Pause	SSQ e PQ (m6)
3	Post-test BAT	Fear, anxiety, and disgust on a scale of 0 to 10 (M9)
3	Breathing techniques	Fear, anxiety, and disgust on a scale of 0 to 10 post-intervention (M10)
3	Post-test questionnaire	SPQ-15 e FSQ (PsT)
3	Follow-up BAT	Fear, anxiety, and disgust on a scale of 0 to 10 (M11)
3	Follow-up questionnaire	SPQ-15 e FSQ (FU)

Thus, this treatment strategy consists of a combination of therapeutic ingredients, including exposure to fear-triggering stimuli, therapeutic instructions, client progress monitoring, performance feedback, and contingent performance improvement.

At the end of the exposure, participants answered an online post-test questionnaire, again on the Microsoft Forms platform, with the following sections: (1) FSQ e; 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 online post-test questionnaire, the same as the one completed at the end of the exposure, again on the Microsoft Forms platform. A new BAT was also carried out, identical to the other two (Garcia-Palacios et al., 2002; Kamphuis & Telch, 2000; Sloan & Telch, 2002).

Immersion and presence in the virtual environment were achieved using virtual reality glasses Meta Quest 2.

Figure 2 – Examples of what the virtual environment looks like



## 2.4. Statistical Analyses

About the procedures for analyzing and processing the empirical information collected, all statistical tests were carried out using IBM SPSS Statistics 29 software. Descriptive statistics were used to characterize the sample's sociodemographic data and, considering the variables used, measures of central tendency, such as the mean, and measures of dispersion, such as the standard deviation, were calculated. For categorical variables, such as the gender of the participants, absolute and relative frequencies were presented, providing a clear view of the distribution of the participants.

For the inferential statistical analysis, the assumptions necessary for the application of Analysis of Variance (ANOVA) were verified. These assumptions were tested using specific tests, such as the Shapiro–Wilk test for normality, the Levene test for homogeneity of variances and the Mauchly test for sphericity. When the assumptions were met, Repeated measures ANOVA was used to check for statistically significant differences between the different phases of the intervention. However, when the ANOVA assumptions were not met, the equivalent non-parametric test, the Friedman test, was used.

In addition, the initial significance level ( $\alpha$ ) of 0.05 was adjusted according to the number of comparisons made to control the risk of type I error when carrying out multiple tests. This correction ensures that the analysis is more robust and appropriate to the characteristics of the sample (Lumley et al., 2002; Marôco, 2021; Pereira & Patrício, 2013; Pestana & Gageiro, 2014).

## 3. Results

There were twenty-five participants in the sample and, as shown in Table 3, the majority of this group were female (76%), single (84%) and had a degree (48%). In addition, 36% of the sample were students.

Table 3 – 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

### 3.1. Virtual Reality Questionnaires

The ANOVA assumptions were tested for the SSQ and PQ variables, but in both cases it could not be used due to the assumptions being violated. It was therefore decided to follow the non-parametric route. PQ was the only variable that showed a significant value at some point, with  $p < .001$ . In the Wilcoxon test, PQ was only significant when comparing the first and last moments (Table 4).

Table 4 - 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)	-1.00±5.50 (-0.26)		.794	PQ	5.43(1.14)	0.29±2.24 (-2.19)		.028
m2		8.00(12.50)	0.00±4.00 (-0.71)		.476		5.67(1.31)	0.10±0.33 (-2.25)		.025
m3		9.00(13.50)	0.00±4.00 (-0.44)		.659		5.95(1.28)	0.00±1.36 (-0.75)		.454
m4		9.00(12.00)	0.00±4.00 (-0.24)		.808		5.90(0.98)	0.05±2.38 (-0.93)		.354
m5		9.00(15.00)	0.00±4.00 (-0.59)	0.00±8.00 (-0.40)	.553		6.05(1.10)	0.05±2.21 (-0.38)	0.48±1.10 (-3.46)	.702
m6		10.00(12.00)			.692		6.00(1.00)			<.001

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

### 3.2. Scores obtained in the different games

The assumptions of ANOVA were tested for the variables of the three activities, but it could not be used for any of them due to violating the assumptions. We therefore opted to follow the non-parametric route. All showed a significant value at some point, with  $p < .001$ . In the Wilcoxon test. Table 5 show the median scores for each activity at each level and the respective Interquartile Range. It also shows the scores for the same activities between the different levels.

Table 5 - Summary statistical measures for the scores of all activities at all levels

Level	Activity 1				Activity 2				Activity 3			
	Mdn(IQR)	Dif(b-a)	Z-value	p(value)*	Mdn(IQR)	Dif(b-a)	Z-value	p(value)*	Mdn(IQR)	Dif(b-a)	Z-value	p(value)*
1	40.00(35.5)				170.00(40.00)				113.00(34.00)			
2	90.00(43.00)	44.00(23.50)	-4.37	<.001	180.00(35.00)	20.00(45.00)	-2.71	.007	115.00(27.00)	2.00(23.50)	-1.51	.132
3	113.00(32.00)	15.00(28.00)	-2.22	.027	220.00(40.00)	40.00(65.00)	-3.23	.001	131.00(17.00)	16.00(23.00)	-2.75	.006
4	93.00(32.50)	-	-	.005	280.00(45.00)	60.00(70.00)	4.05	<.001	139.00(43.00)	13.00(36.00)	-1.76	.078
5	104.00(33.00)	14.00(30.50)	2.84	.597	360.00(100.00)	90.00(90.00)	3.62	<.001	147.00(26.00)	11.00(43.50)	-1.30	.193
6	100.00(29.00)	1.00(28.00)	0.53	.397	520.00(145.00)	200.00(105.00)	-4.15	<.001	149.00(44.00)	0.00(38.50)	-0.14	.886

\*a\* corresponds to value on the cell of the level above and \*b\* to the level below. \*Bonferroni's method -  $\alpha = 0.05/5 = 0.01$

### 3.3. Subjective Evaluation of Emotions

The assumptions of ANOVA were tested for the evaluation of the three emotions: fear, disgust and anxiety. However, only the fear and disgust variables met the assumptions necessary for the use of parametric tests. The analyses for these two emotions revealed significant differences, with p-values <.001 in both cases. The emotion of anxiety, on the other hand, did not meet the assumptions for ANOVA, and was therefore assessed using non-parametric tests. In the Friedman test, anxiety also showed a p <.001, indicating a significant difference at some point (Table 6).

Table 6 – Summary statistical measures for all moments in subjective evaluation of fear, anxiety and disgust

	Disgust			Fear			Anxiety			
	Mean/SD	Dif(b-a)	p(value)*	Mean/SD	Dif(b-a)	p(value)*	Mdn(IQR)	Dif(b-a)	Z-value	p(value)*
<b>M1</b>	6.44±2.52	-1.32±2.11	.005	5.16±2.43	-1.46±1.91	< .001	7.00(4.00)	-2.00 (4.00)	-3.00	.003
<b>M2</b>	4.98±2.80	0.26±1.74	.462	3.84±2.47	-0.40±1.95	.315	5.00(4.25)	0.00 (2.50)	-1.14	.255
<b>M3</b>	4.58±2.86	0.26±1.09	.245	4.10±2.45	0.34±1.05	.118	5.00(4.25)	0.00 (1.25)	-1.23	.219
<b>M4</b>	4.92±2.82	0.06±1.20	.806	4.36±2.49	0.22±1.39	.437	5.50(3.75)	0.00 (1.50)	-0.12	.902
<b>M5</b>	5.14±3.22	-0.38±1.23	.135	4.42±2.79	0.06±0.86	.730	6.00(3.25)	-0.50 (1.00)	-2.07	.039
<b>M6</b>	5.20±2.95	-0.28±1.22	.261	4.04±2.72	-0.30±1.42	.302	4.50(4.25)	-0.50 (2.00)	-2.81	.005
<b>M7</b>	4.90±2.77	-1.60±1.24	.525	3.76±2.62	-0.02±1.73	.955	4.50(5.75)	0.00 (1.00)	-0.02	.982
<b>M8</b>	4.88±3.41	0.66±1.73	.069	3.60±2.90	0.24±1.93	.574	4.00(5.50)	0.50 (2.00)	-1.84	.065
<b>M9</b>	5.12±3.24	-1.40±1.60	.665	4.26±2.90	0.40±2.06	.342	5.00(4.25)	0.00 (2.50)	-0.28	.779
<b>M10</b>	5.52±2.49	-1.60±1.78	.001	4.40±2.50	-1.52±2.02	< .001	5.00(4.00)	-2.00 (0.50)	-2.52	.012
<b>M11</b>	4.00±3.01			2.80±2.27			4.00(4.50)			
		<b>Dif</b>			<b>Dif</b>			<b>Dif</b>		
<b>MA</b>		-2.44±2.83	.026		-2.36 ± 2.52	<.001		-3.00(4.50)	-3.52	<.001
<b>MB</b>		-0.92±1.94	<.001		-0.76 ± 2.17	.092		-1.00(4.00)	-2.52	.012

\*"a" corresponds to value on the cell of the level above and "b" to the level below. \*Bonferroni's method –  $\alpha = 0.05/12 = 0.00417$  "MA" corresponds to Dif(M11-M1);

"MB" corresponds to Dif(M10-M1)

### 3.4. 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, indicating significant differences between the moments, which led to post-hoc analyses being carried out to identify the origin of these differences. In the case of BAT, as the ANOVA assumptions were not met, the Friedman test was used, which resulted in a p <.001. Based on this result, the Wilcoxon test was applied to investigate the differences between the specific moments (Table 7).

Table 7 – 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 –  $\alpha = 0.05/3 = 0.0167$

#### 4. Discussion

This study investigated the impact of a virtual reality-based intervention to treat spider phobia. The analysis included virtual reality questionnaires, subjective assessments of emotions, scores on different activities, and specific questionnaires on fear of spiders.

The results obtained through the Simulator Sickness Questionnaire indicated that adverse reactions to exposure to Virtual Reality gradually increased throughout the intervention session, though these changes were not statistically significant. Many participants reported similar reactions in the first and last assessments, as reflected in the score obtained in "Dif(m6-m1)". Notably, the highest scores were related to generalized malaise, which could be linked to the fear of spiders rather than just the virtual environment exposure (Albakri et al., 2022; Carvalho et al., 2011; Distefano et al., 2020; Kennedy et al., 1993; Rzeźniczek et al., 2020; Tovote et al., 2015; Weech et al., 2019).

Several factors can explain the increase in the SSQ score. One of the main ones is sensory conflict, occurring when there is a discrepancy between what the vision and the body perceive, resulting in nausea and discomfort (Aldaba et al., 2017; Benson & Stott, 2023; Kim et al., 2018; Park & Lee, 2020; Rueda & Lara, 2020). For instance, the likelihood of cybersickness increases when the user is virtually moving but physically stationary, as in the VR experience (LaViola, 2000; Ramaseri Chandra et al., 2022). While higher quality VR equipment tends to provide a smoother, more realistic immersive experience that can reduce cybersickness, it may paradoxically intensify adverse reactions due to increased presence and immersion. This can exacerbate sensory conflicts, leading to more acute symptoms (Weech et al., 2019, 2020). Additionally, prolonged exposure, especially in fast-moving VR experie (Alamirah et al., 2022; Hale & Stanney, 2017)lamirah et al., 2022; Hale & Stanney, 2017). Individual characteristics also matter; participants using VR for the first time may be more susceptible, as many did in this study. Those prone to motion sickness or in less favorable health conditions (e.g., fatigue or dehydration) are at a higher risk of experiencing these symptoms (Oh & Son, 2022; Rebenitsch

& Owen, 2016). Environmental factors, such as bright lights, cramped spaces, or high temperatures, can further contribute to discomfort, aggravating cybersickness (Aldaba et al., 2017; Golding, 2006; Kim et al., 2018; Park & Lee, 2020; Rueda & Lara, 2020).

The presence of participants in the virtual environment was assessed using the PQ, which measures the subjective sensation of being physically present in a computer-generated environment – a crucial element in exposure-based therapies (Rueda & Lara, 2020). The sense of presence increased throughout the study, significantly rising between the first and last moments. This could be due to the wide field of vision and the user's ability to interact naturally and in real-time with the virtual environment, where their actions generated immediate and coherent responses. The involvement of multiple senses and the alignment of stimuli also likely reinforced the sense of presence (Park & Lee, 2020; Rueda & Lara, 2020; Vasconcelos-Raposo et al., 2016, 2021; Witmer & Singer, 1998).

Emotions were assessed to measure the intervention's impact on the participants' fear, disgust, and anxiety towards the phobic stimulus. The results showed a consistent decrease in fear and disgust from the beginning to the end of the intervention. Anxiety scores also decreased, with the most notable differences occurring between the first and last moments. The significant impact of these emotions suggests that repeated exposure to virtual spiders may have desensitized the participants, reducing their adverse emotional responses (Grill & Haberkamp, 2023; Lindner, Miloff, et al., 2020; Miloff et al., 2016; Öst et al., 1991; Tardif et al., 2019; Woronko et al., 2023).

The participants' performance in the three activities over six levels was also analyzed. Activity 1 showed score improvements at almost every time point, with significant changes at two points. In Activity 2, participants demonstrated consistent progress across levels, with significant differences at almost every point. The last activity showed a trend towards improvement, although only one comparison reached statistical significance after Bonferroni adjustment. These findings support the idea that repeated practice and gradual exposure helped participants improve their performance, likely reflecting reduced aversion or fear that initially hindered their performance (Abramowitz et al., 2019; Craske et al., 2014; Hofmann et al., 2012; Öst et al., 1991; Sars & van Minnen, 2015; Stöber, 1993).

OT focuses on enabling individuals to overcome obstacles that impede their daily functioning, often through structured, goal-orientated interventions. Integrating the principles of OT, VR interventions not only facilitate the desensitization of phobias, but also improve functional outcomes by immersing participants in purposeful, self-centered activities (Gunnarsson et al.,

2023; Johanson & Bejerholm, 2017; Kirby et al., 2023). VR can simulate complex real-world environments in a controlled and safe space, allowing individuals to practice and perfect the skills needed for everyday life. This therapeutic approach strengthens the participant's confidence and skills in managing their phobia (Cieslik et al., 2020; Emmelkamp & Meyerbröker, 2021; Freeman et al., 2017).

Incorporating VR into OT can provide a unique advantage by creating realistic simulations of daily activities that participants may find difficult in the real world. For example, VR environments can be customized to replicate specific scenarios that trigger phobias, such as encounters with spiders, allowing for controlled exposure and gradual desensitization (Donnelly et al., 2021; Maier et al., 2019; Sardi et al., 2017; Waller et al., 2022).

Furthermore, the application of gamification in this framework amplifies the effectiveness of therapy. By integrating elements such as rewards, progressive challenges and real-time feedback, gamification transforms the therapeutic process into an engaging and motivating experience. By incorporating game-like features, VR-based therapy becomes more interactive and less intimidating, which can significantly increase participant motivation and treatment adherence. The inclusion of gamification elements may have contributed to maintaining engagement and motivation, even with increased exposure. Through progressive challenges and immediate feedback, gamification probably made the exposure process less aversive and more engaging, encouraging persistence. This playful aspect may have facilitated gradual desensitization, promoting continuous performance improvement (Deterding et al., 2011; Lumsden et al., 2016; Tertuliano et al., 2023).

The results of the BAT also indicated a positive evolution concerning the fear of spiders reported by the participants, with a significant increase in the step they could complete. The Wilcoxon test showed significant differences between the pre-test and post-test and between the pre-test and follow-up, suggesting that the intervention was effective and maintained its effectiveness over time. This adds to the evidence that this Virtual Reality Exposure Therapy protocol positively impacted reducing participants' fear of spiders (American Psychiatric Association, 2022; Dunsmoor & Paz, 2015; Grill & Haberkamp, 2023; Öst et al., 1991).

The results obtained in the specific spider fear questionnaires (FSQ and SPQ-15) showed significant changes only between the pre-test and follow-up, although the average score decreased at all times. This reduction suggests that the Virtual Reality Exposure Therapy protocol had a positive effect on reducing the participants' level of anxiety in relation to

exposure to spiders (American Psychiatric Association, 2022; Dunsmoor & Paz, 2015; Granado et al., 2005). The specific spider fear questionnaires (FSQ and SPQ-15) showed significant changes only between the pre-test and follow-up, despite a decrease in average scores at all times. This reduction suggests that the Virtual Reality Exposure Therapy protocol effectively reduced participants' anxiety regarding spider exposure (American Psychiatric Association, 2022; Dunsmoor & Paz, 2015). The significant difference between pre-test and follow-up in the FSQ aligns with the perception that the FSQ is effective in capturing subtle and progressive changes in fear levels. The SPQ-15 showed a significant difference only between pre-test and follow-up.

These results highlight the importance of using instruments that accurately and sensitively capture changes in fear levels over time. According to studies, while the SPQ-15 is useful, the FSQ seems more suitable for monitoring participants' progress throughout an intervention like Virtual Reality Exposure Therapy, particularly in studies aiming to detect gradual and sustained changes in behavior and cognition (Booth et al., 2016; Cowdrey & Walz, 2015; Granado et al., 2005; Lindner, Miloff, et al., 2020; Olatunji et al., 2009; Szymanski & O'Donohue, 1995; Zsido, 2017).

Overall, the study's findings suggest that the virtual reality intervention effectively reduced spider phobia, as evidenced by the significant reduction in negative emotional responses and improved performance in related activities. These results align with the literature that supports Virtual Reality Exposure Therapy as a positive treatment method for phobias (Botella et al., 2017; Carl et al., 2019; Demir & Köskün, 2023; Freitas et al., 2021; Oprüş et al., 2012; Parsons & Rizzo, 2008).

Finally, this study has some limitations. One of these limitations is the small size and variability of the sample, which may limit the robustness and statistical validity of the results, reducing the ability to detect significant effects. The fidelity of the virtual experience is another factor; if the spiders are not realistic enough, the participants' responses may not reflect the same intensity as they would in a real-life scenario. Immersion is also crucial; technical issues or discomfort, such as motion sickness, can affect the validity of the experience. The subjective nature of fear measures poses another limitation, as self-reports are prone to bias. Complementing these with objective indicators, such as physiological responses, would be valuable. The lack of long-term follow-up also prevents a proper assessment of the durability of the therapeutic effects observed.

Individual factors, such as the participants' personal history, fear intensity, and other psychological conditions, can influence responses to VR-based exposure therapy. Participants' acceptance and familiarity with VR technology also affect their engagement and response to treatment. Given that many participants were new to VR, they might have been more focused on the VR experience than the stimuli presented. Future studies should consider improving technology, incorporating more natural interactions, and adding tactile feedback to enhance immersion. More advanced assessment methods, such as physiological measurements, and conducting longitudinal studies, would help verify the maintenance of therapeutic effects over time. Comparative studies between VR exposure therapy and other treatment modalities, as well as exploring the combination of VR with other therapeutic techniques, would also be beneficial.

Further research is needed to gather more robust evidence with larger samples, using different assessment instruments, better control over study variables, and participant follow-up to understand if results are maintained or if new changes occur.

## **5. Conclusion**

The results of this study contribute to demonstrating that exposure therapy using Virtual Reality shows positive results and is a promising approach in the treatment of individuals with spider phobia. Although some results were not entirely conclusive, it was possible to observe significant positive differences in reducing anxiety in anxiogenic contexts. These findings suggest that Virtual Reality can be an effective tool for addressing and mitigating the symptoms of specific phobias, providing a controlled and safe environment for therapeutic exposure.

However, to strengthen the evidence in this area, it is essential that future studies are carried out with larger and more diverse samples, as well as greater control of the variables under study. Further research should also explore the combination of Virtual Reality with other therapeutic modalities and include objective measures, such as physiological indicators, to obtain a more comprehensive assessment of the effectiveness of this approach.

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