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Virtual Reality's Potential to Reduce Public Speaking Anxiety: A Pilot Study

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Resumo

A glossofobia é um problema que muitas pessoas enfrentam quando se trata de falar em público, devido a preocupações subjacentes de ansiedade social que afetam as suas capacidades em várias áreas, como a académica e a profissional. Neste projeto de investigação, estamos a explorar os benefícios da utilização da tecnologia de realidade virtual (RV) como meio de ajudar as pessoas a lidar com os medos de falar em público e a aliviá-los. Durante seis simulações de Realidade Virtual envolvendo 30 participantes, acompanhámos as suas reações, incluindo a frequência cardíaca (FC) e a atividade electrodérmica (EDA), ao mesmo tempo que avaliámos os seus níveis de ansiedade utilizando a Escala de Ansiedade de Falar em Público (PSAS) e a Escala de Autoavaliação de Falar em Público (PSSAS). Os resultados mostraram uma diminuição da frequência cardíaca e um aumento da autoconfiança, tal como indicado pela PSSAS, o que significa que os participantes se adaptaram gradualmente à pressão de falar. Com a EDA a aumentar consistentemente ao longo do tempo, indicando que a tensão se mantinha apesar dos progressos físicos, enfatizando a importância de incorporar estratégias adicionais para o controlo emocional. Estas descobertas sugerem a integração da RV nos métodos terapêuticos, juntamente com técnicas orientadas pela neurociência, como o neurofeedback, para desenvolver abordagens de tratamento holísticas e personalizadas. Além disso, a utilização de conteúdos personalizados, tais como diapositivos personalizados do PowerPoint de um indivíduo, em conjunto com cenários, pode aumentar a eficácia da realidade virtual na abordagem dos desafios da ansiedade de falar em público.

Palavras-chave: Realidade virtual; ansiedade; falar em público.

Abstract

Glossophobia is an issue that many people face when it comes to speaking in public due to underlying social anxiety concerns impacting their abilities in various areas, such as academics and professional settings. In this research project we are exploring the benefits of using virtual reality (VR) technology to help individuals cope with and alleviate public speaking fears. During six reality (VR) simulations involving 30 participants we tracked their reactions, including heart rate (HR) and electrodermal activity (EDA) while also evaluating their anxiety levels using the Public Speaking Anxiety Scale (PSAS) and the Public Speaking Self-Assessment Scale (PSSAS). The findings showed a decrease in heart rate and an enhancement in self-confidence as indicated by PSSAS signifying the participants gradual adjustment to speaking pressure. With EDA consistently increasing over time indicating that tension lingered despite physical progress emphasizing the importance of incorporating further strategies for emotional control. These discoveries suggest integrating VR into therapy methods alongside neuroscience driven techniques like neurofeedback to develop holistic and tailored treatment approaches. Additionally, utilizing personalized content such as an individual's custom PowerPoint slides in conjunction with scenarios may augment the efficacy of virtual reality in addressing the challenges of public speaking anxiety.

Keywords: Virtual reality; anxiety; public speaking.

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1. Introduction

Public speaking anxiety, also termed glossophobia, is a type of social anxiety that affects many individuals and threatens their performance in academic, professional, and social situations (Miranda et al., 2020). An estimated 13% of people will experience social anxiety disorder at some point in their lives, which can hinder both career and personal growth (Barnhill, 2023). According to Miranda et al. (2020), extreme dread, insecurity, sweating, elevated heart rate, and shortness of breath are cognitive and physiological symptoms of glossophobia that impede public speaking performance. Given the increasing demand for communication skills across various life spheres, public speaking anxiety presents a significant challenge.

The treatment of public speaking anxiety has primarily focused on behavioral interventions, with Cognitive Behavioral Therapy (CBT) being one of the most common approaches. CBT employs systematic desensitization to gradually expose individuals to feared situations and cognitive restructuring to correct dysfunctional thought patterns (Knapp & Beck, 2008). In the era of digital technologies, new therapeutic tools are emerging alongside traditional treatments, with Virtual Reality (VR) presenting a promising strategy for addressing social anxiety disorder. This innovative tool allows individuals to be systematically exposed to anxiety-inducing situations, such as public speaking, under controlled conditions, mitigating the risks associated with real-world exposure (Franck, 2024). VR enables individuals to develop communication skills and gradually build tolerance to stage fright, which is essential for effective public speaking.

This study aims to test the following hypotheses regarding the impact of a VR program on reducing public speaking anxiety: first, it is hypothesized that participants exposed to the VR program will demonstrate significant anxiety reduction, as measured by physiological markers (e.g., heart rate and electrodermal activity) and psychometric scales (PSAS and PSSAS). Additionally, participants are expected to report increased self-efficacy and confidence in public speaking following the VR intervention. Moreover, it is hypothesized that those who undergo the VR intervention will experience greater reductions in anxiety compared to traditional methods.

2. Literature Review

Recent studies suggest that virtual exposure can trigger physiological responses, such as increased heart rate and sweating, similar to those experienced in real-life emotional situations, which goes beyond what typical imagination can achieve. These technological advancements have been studied in both clinical and educational settings, including Occupational Therapy, which focuses on enhancing functionality and promoting independence in daily living activities. VR has emerged as a promising tool for treating social phobias, including glossophobia, particularly among occupational therapists (Maples-Keller et al., 2017).

Combining VR with other therapeutic approaches, such as relaxation and mindfulness techniques, creates complex interventions aimed at not only reducing anxiety symptoms but also improving cognitive skills essential for communicative performance, like thought organization, eye contact, and self-confidence. This integration of fear exposure with practical activity development allows traditional Occupational Therapy to offer a more comprehensive treatment option, addressing the limitations of current VR effects. Such practices enable individuals to learn and adapt skills for real contexts, demonstrating notable advancements in communication capabilities and self-esteem.

Despite the promising applications of VR, research investigating its feasibility in the general population and among at-risk groups (e.g., experienced professionals, subclinical individuals with moderate social anxiety, and minority group members) remains scarce (Turner & Casey, 2014). This highlights a critical gap in knowledge regarding the broader applicability of VR interventions for public speaking anxiety.

3. Methods

3.1. Type of study

This pilot study is characterized as a quantitative investigation with a quasi-experimental design. The quantitative approach allows measurable variables to be analysed to verify and explain relationships or influences between them (Fortin & Salgueiro, 2003). The classification as quasi-experimental is justified by the manipulation of the intervention, without a random allocation of participants (Almeida & Freire, 2008).

3.2. Participants

The study's sample consists of students in higher education. Participation is open to all students, regardless of their institution, and they may withdraw at any time. The study is also completely anonymous. Convenience sampling, a non-probabilistic method, is used to select participants based on their interest and availability.

The study's inclusion criteria included higher education students who were at least eighteen years old, who spoke Portuguese fluently, and who admitted to feeling anxiety or terror when speaking in front of an audience. Exclusion criteria included students with serious mental health issues that could interfere with their participation, those with significant previous experience in virtual reality (to avoid familiarity bias), individuals with medical conditions that contraindicated exposure to virtual reality, pregnant women, and participants with uncorrected visual acuity.

This study was approved by the Ethics Committee under process number (CE0060E), and informed consent was obtained and signed by all participants.

The process of participant randomization is described in the flowchart prepared according to the CONSORT guidelines (Schulz et al., 2010), presented in Figure 1.

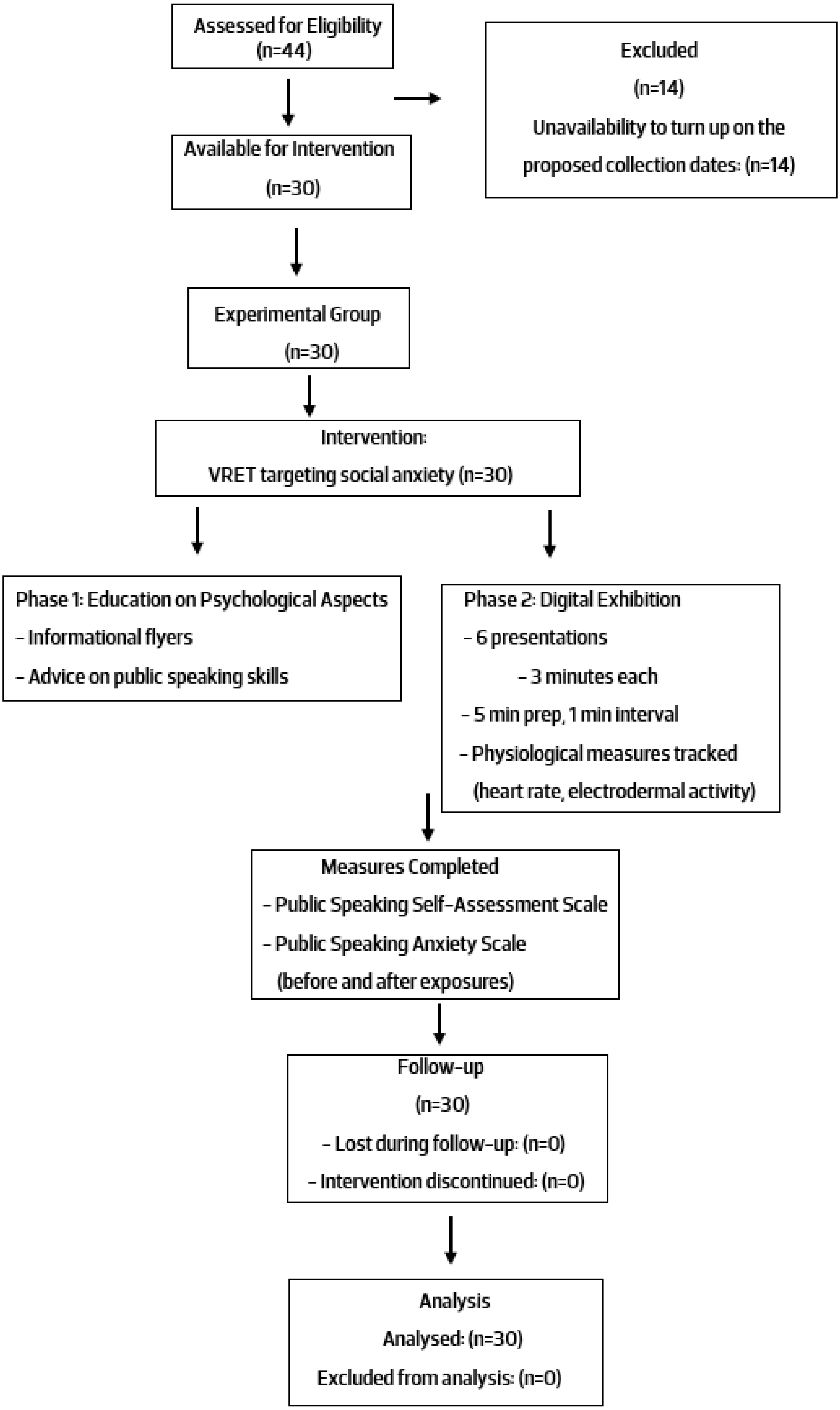

Figure 1. CONSORT diagram of study design.

3.3. Instruments

The study measured the participants' emotional and physiological reactions in simulated public speaking scenarios using a variety of tools and questionnaires. The Biosignalsplux was one of the primary pieces of equipment; it had an 8-channel wireless hub card and two dedicated sensors: an EDA sensor for skin electrodermal activity measurement and an ECG sensor for heart rate monitoring. EDA is a measure of sympathetic nervous system activity that is closely correlated with stress levels and emotional state, particularly in anxiety-inducing circumstances (Dawson et al., 2016). As one of the primary markers of physiological activity in stressful circumstances, heart rate fluctuation was observed by the ECG sensor while the individuals' heart rates were being tracked.

A set of virtual reality glasses, which produced an immersive and regulated environment, was another crucial piece of equipment used. With the use of this technology, a public presentation scenario could be simulated, giving participants a realistic experience that allowed them to experience emotions comparable to those they would have in a true public speaking setting in a safe and controlled environment.

To complement the physiological data, several questionnaires were administered to the participants. The sociodemographic questionnaire collected personal and contextual information divided into five main categories: general data, such as age and gender; academic data, such as level of education and academic background; mental health information, addressing possible disorders and psychological well-being; previous experience with virtual reality, asking if the participants had used this technology before, which could influence their reactions; and other considerations that might be relevant to the study.

The Public Speaking Self-Assessment Scale (PSSAS), developed by (Hofmann & DiBartolo, 2000), assesses how individuals perceive their public speaking abilities. It consists of 10 items where participants rate their agreement with statements about their performance on a Likert scale from 0 ('disagree') to 5 ('totally agree'). The scale measures both confidence and perceived success during speeches by incorporating both positive and negative perceptions. The Portuguese version of this instrument achieved a Cronbach's α of 0.90 (Osório et al., 2008).

Finally, the Public Speaking Anxiety Scale (PSAS), developed by Bartholomay and Houlihan (2016), was employed to measure the participants' anxiety levels before, during, and after the public speech. This psychometric scale, which consists of 16 items, explores the emotions and actions linked to anxiety in each of the three stages. It uses a Likert scale that goes from 'strongly disagree' to 'strongly agree'. With this scale, it was feasible to measure the emotional impact of the simulation more precisely and connect this information to the physiological responses recorded by the Biosignalsplux sensors. The Portuguese version of this instrument obtained a Cronbach’s α index of 0.97 (Soares et al., 2020).

3.4. Data analysis procedure

Students interested in participating in the study signed up by completing a sociodemographic form sent to their institutional email. After registration, participants received a standardized protocol for Virtual Reality Exposure Therapy (VRET) targeting social anxiety, based on the guidelines provided by Lindner et al. (2019).

The procedure was split into two phases:

• Education on psychological aspects: Participants were sent two informational flyers via email providing advice on enhancing their public speaking skills. This resource offered useful advice and knowledge to get them ready for the online showcase.

• Digital exhibition: The event took place in a virtual reality environment, as shown in different perspectives on the right (figure 2) and left (figure 3), with attendees delivering six back-to-back 3-minute presentations while standing. Participants would select a subject and then be given 5 minutes to ready their speech at the beginning of each session. There was a one-minute interval between the speeches. While giving their speeches, participants utilized a cardio band to track heart rate and a galvanic response sensor to observe electrodermal activity, enabling the analysis of these physiological measures.

Participants filled out the Public Speaking Self-Assessment Scale and the Public Speaking Anxiety Scale both before and after six exposures. Upon finishing the registration form, the students notified the school of their willingness to participate in the in-person session. The session’s date was later communicated by e-mail.

Figure 2. Participant's view to the right in the virtual environment.

Figure 3. Participant's view to the left in the virtual environment.

4. Statistical analysis

The data were initially subjected to statistical analysis before being displayed in tables. IBM SPSS Statistics software, version 29, was used to analyse the data using both descriptive and inferential statistics (Marôco, 2018).

Different parameters were utilized in the descriptive analysis to assess the distribution of variables, such as frequency, percentage, mean, and standard deviation. Non-parametric tests were used for inferential analysis due to the inability to meet the normal distribution assumption, as confirmed by the Kolmogorov-Smirnov test, which is necessary for parametric tests.

The Wilcoxon test was used to compare the number of participants regarding electrodermal activity (EDA) and heart rate (HR) between the first and subsequent virtual reality presentations, as well as to compare the values of the Scales before and after the six presentations. This non-parametric test is suitable for comparing the median of the studied population with a theoretical value (Marôco, 2018).

To compare the EDA and HR values across the six public speaking presentations using virtual reality, the Friedman test was applied. This non-parametric test is appropriate for comparing two or more populations based on paired samples where the dependent variable is at least ordinal (Marôco, 2018).

5. Results

5.1. Sociodemographic and academic analysis

The study sample consisted of 30 participants, 60% women. The average age of the participants was 24.4 years, with a standard deviation of 9.2 years. In terms of academic background, 53.3% were first-year students. Of the participants, 73.3% were studying for a bachelor's degree, while 26.7% were studying for a master's degree (Table 1).

Table 1. Sociodemographic characterization of participants.

		Min/Max	Mean/SD
Age		19-56	24.4 (9.2)
		n	%
Gender	Male	12	40.00
	Female	18	60.00
Marital status	Single	28	93.30
	Married	2	6.70
Academic degree	Bachelor	22	73.30
	Master	8	26.70

(Min=minimum; Max=maximum; SD=standard deviation; n=total; %=percentage)

5.2. Analysing the experience of public speaking, anxiety and virtual reality

The distribution of anxiety, prior public speaking experience, and virtual reality technology use is displayed in table 2. This analysis draws attention to the prevalence of specific replies, emphasizing the respondents' generally good health, lack of experience speaking in front of an audience, and infrequent use of virtual reality technology.

Most of the participants mentioned they lacked prior experience in addressing an audience, with 36.7% saying 'No' and the same percentage indicating 'Neutral', while only 26.7% claimed to have some experience. Regarding their health, 80% are in good health, while anxiety is the most prevalent issue among the remaining 20%. Regarding the diagnosis of anxiety disorders or related diseases, six participants declared having a mental ailment, mentioning anxiety disorders in particular. In addition, 23.3% of individuals use medication. Moreover, 93.3% of individuals hardly ever use virtual reality devices, and a similar proportion have never used VR therapy.

Table 2. Frequency of public speaking experience, anxiety and virtual reality.

		n	%
Have you had or do you have experience speaking to an audience?			
	No	11	36.70
	Yes	8	26.70
	Neutral	11	36.70
Do you have any health problems?			
	No	24	80.00
	Yes	6	20.00
Do you have a history of anxiety diagnosis or related disorders?			
	No	18	60.00
	Yes	12	40.00
Do you currently take any medication?			
	No	23	76.70
	Yes	7	23.30
How often do you use virtual reality technologies?			
	Rarely	28	93.30
	Occasionally	2	6.70
Have you had any previous experience with Virtual Reality Therapies?			
	No	28	93.30
	Yes	2	6.70

5.3. Electrodermal Activity (EDA)

The mean EDA values of the participants in six distinct virtual reality public presentations are displayed in Table 3. The mean EDA values are shown to be increasing gradually over the course of the presentations, peaking at 0.000058 S in the first and rising to 0.000067 S in the sixth. This increase raises the possibility that as the presentations go on, the participants' emotional or stress response will get stronger. There was a statistically significant difference across the various moments (p=.001).

Table 4 complements this analysis by comparing the number of participants who had their EDA increased, decreased, or maintained throughout the presentations, always taking the first presentation as a reference. In all comparisons, most participants showed an increase in EDA, with the percentage varying between 63% and 77% of participants. The p-values from the Wilcoxon test indicate statistical significance in the differences observed between the first and remaining presentations, with p-values ranging from 0.054 (between presentations 1 and 2) to 0.001 (between presentations 1 and 6).

By connecting the two tables, we can determine that the participants' EDA steadily rises during the presentations, as shown by the rise in average EDA values and the increasing number of participants displaying this trend. This pattern indicates that, as the presentations progress, the participants may be facing a higher level of stress or excitement, which is consistently shown in both statistical analyses displayed in the tables.

Table 3. Comparison of EDA values between the six public presentations through virtual reality.

Electrodermal Activity (EDA)				
	N	Mean (S)	SD(S)	p
EDA_Presentation1	30	0.0000058	0.0000034	
EDA_Presentation2	30	0.0000060	0.0000031	
EDA_Presentation3	30	0.0000063	0.0000031	
EDA_Presentation4	30	0.0000065	0.0000030	
EDA_Presentation5	30	0.0000066	0.0000029	
EDA_Presentation6	30	0.0000067	0.0000032	0.001

(p=Friedman test; S=Siemens)

Table 4. Comparison of the number of participants in relation to the EDA values, between presentation 1 and each of the presentations in virtual reality.

Electrodermal Activity (EDA)									
	Decreased		Increased		Maintained		Total		*p*
Presentation1_Presentation2	11	37%	19	63%	0	0%	30	100%	0.054
Presentation1_Presentation3	10	33%	20	67%	0	0%	30	100%	0.027
Presentation1_Presentation4	8	27%	22	73%	0	0%	30	100%	0.006
Presentation1_Presentation5	8	27%	22	73%	0	0%	30	100%	0.008
Presentation1_Presentation6	7	23%	23	77%	0	0%	30	100%	0.001

(p=Wilcoxon test)

5.4. Heart Rate (HR)

The average HR of participants across six virtual reality public presentations are summarized in Table 5. The data shows a steady decline from 90.27 bpm in the first presentation to 84.57 bpm in the sixth, suggesting a reduction in stress or anxiety through physiological adaptation. Friedman's test confirmed statistical significance with a p-value of 0.001.

Table 6 compares the changes in HR relative to the first presentation, showing that 73% to 80% of participants experienced a decrease in HR over time. The Wilcoxon test further validated these differences with statistically significant p-values ranging from 0.014 (between presentations 1 and 2) to 0.002 (between presentations 1 and 3, and 1 and 6).

Overall, Table 5 and 6 highlight a consistent reduction in HR, indicating participants' increased comfort or reduced anxiety during repeated public presentations.

Table 5. Comparison of HR values between the six public presentations using virtual reality.

Heart Rate (HR)				
	N	Mean (bpm)	SD (bpm)	p
HR_Presentation1	30	90.27	12.42	
HR_Presentation2	30	87.34	10.59	
HR_Presentation3	30	85.86	11.13	
HR_Presentation4	30	84.84	9.10	
HR_Presentation5	30	85.04	10.35	
HR_Presentation6	30	84.57	8.77	0.001

(p=Friedman test; bpm=beats per minute)

Table 6. Comparison of the number of participants in relation to HR values, between presentation 1 and each of the public presentations through virtual reality.

Heart Rate (HR)									
	Decreased		Increased		Maintained		Total		*p*
Presentation1_Presentation2	23	77%	7	23%	0	0%	30	100%	0.014
Presentation1_Presentation3	24	80%	6	20%	0	0%	30	100%	0.003
Presentation1_Presentation4	22	73%	8	27%	0	0%	30	100%	0.002
Presentation1_Presentation5	22	73%	8	27%	0	0%	30	100%	0.005
Presentation1_Presentation6	23	77%	7	23%	0	0%	30	100%	0.002

(p=Wilcoxon test)

5.5. Public Speaking Anxiety Scale (PSAS)

PSAS scores were assessed before and after six virtual reality presentations, showing a reduction in mean scores from 3.18 to 2.66, indicating decreased public speaking anxiety. The standard deviation also decreased slightly (from 0.66 to 0.57), reflecting less data variability. Additionally, the P25 and P75 percentiles dropped, further supporting reduced anxiety levels. 72% of participants reported lower anxiety, 21% reported increased anxiety, and 10% noted no change. The Wilcoxon test yielded a statistically significant p-value of 0.004 (Table 7). Overall, repeated practice in virtual reality appears to significantly reduce public speaking anxiety and improve participants' comfort.

Table 7. Comparison of the number of participants in relation to the values of the PSAS, between the moment before and the moment after the six public presentations using virtual reality.

PUBLIC SPEAKING ANXIETY SCALE (PSAS)									
	Decreased		Increased		Maintained		Total		*p*
Public Speaking Anxiety Scale (PSAS)	21	72%	6	21%	3	10%	30	100%	0.004

(p=Wilcoxon test)

5.6. Public Speaking Self-Assessment Scale (PSSAS)

PSSAS scores, which measure self-assessment in public speaking, were analysed before and after six virtual reality presentations. Higher scores indicate more critical self-assessments, while lower scores reflect increased confidence. The average score decreased from 1.65 to 1.27, suggesting participants felt more confident or perceived improved public speaking skills after the presentations. Although the standard deviation increased slightly (from 0.80 to 0.83), reflecting more variability in responses, both the P25 and P75 percentiles showed a general trend of improvement. 66% of participants reported improved self-assessments, while 34% experienced no change or worsening. The Wilcoxon test showed statistically significant results with a p-value of 0.040 (Table 8). Overall, the virtual reality presentations led to improved self-perceptions of public speaking skills, though some participants reported worsened self-assessments.

Table 8. Comparison of the number of participants in relation to the values of the PSSAS, between the moment before and the moment after the six public presentations using virtual reality.

PUBLIC SPEAKING SELF-ASSESSMENT SCALE (PSSAS)	Decreased		Increased		Maintained		Total		*p*
Public speaking self-assessment scale (PSSAS)	19	66%	10	34%	1	3%	30	100%	0.040

(p= Wilcoxon test)

6. Discussion

This study aimed to investigate the effectiveness of virtual reality as a tool to reduce public speaking anxiety, assessing physiological and psychological responses during presentations.

The results provide valuable insight into participants' reactions during the VR presentations. Electrodermal activity (EDA), an indicator of emotional arousal and stress, showed an upward trend, suggesting increased sympathetic nervous system activation in response to anxiety triggers (Critchley & Nagai, 2013). This rise across the six presentations indicates a strengthening of emotional responses rather than habituation, which may be explained by the 'insufficient dwelling' model, where repeated exposure fails to reduce stress responses (Boucsein, 2012). The specific anxiety associated with public speaking, often driven by fear of negative judgment, could have amplified this emotional reaction.

Conversely, heart rate (HR) exhibited a significant downward trend, indicating physiological adaptation to stress as participants became more familiar with the situation (Sánchez-Hechavarría et al., 2019). Literature supports this habituation, where repeated exposure to stress in controlled environments, like VR, reduces cardiovascular responses over time (Lim et al., 2023). This suggests that while emotional arousal remained high (as shown by EDA), participants' bodies adapted physiologically, reducing fear-related sympathetic activation (Boucsein, 2012).

Subjective measures also reflected significant adaptation. The PSAS scores showed reduced anxiety levels over the presentations, consistent with the efficacy of exposure-based interventions in reducing performance-related anxiety (Hinojo-Lucena et al., 2020; Lim et al., 2023). Repeated VR exposure promoted gradual desensitization, facilitating cognitive restructuring and reducing perceived anxiety, as predicted by cognitive-behavioral models of social anxiety (Geraets et al., 2019).

The participants' self-efficacy also improved significantly throughout the study, as evidenced by the results of PSSAS. Participants reported a decrease in the negative evaluation of their performance. According to Bandura (1997) theory of self-efficacy, this improvement in perceived competence may be associated with an anxiety reduction, since the individuals began to believe more in their ability to control the public speaking situation. Repetitive VR exposure increased self-efficacy, improving confidence and perceived ability two important aspects of being ready for real-world communication scenarios (Geraets et al., 2019). In some studies, individuals who used medicine did not significantly differ from those who did not in terms of their ability to reduce anxiety. This suggests that VR can be beneficial for a variety of participant profiles, irrespective of whether they use anxiety-reducing medications like antidepressants or tranquilizers. Nevertheless, medication might have helped stabilize these individuals' mental and physical reactions, potentially moderating the effects of VR (Baldwin et al., 2014).

Additionally, some research suggests that individuals who have previously received CBT are more receptive to using VR. These participants have shown a quicker reduction in anxiety symptoms compared to those who have never undergone CBT. This supports the notion that CBT, by equipping individuals with coping mechanisms, may enhance their ability to manage stressful situations, including those in virtual environments. Combining VR with CBT could, therefore, be an effective strategy to maximize the benefits of both therapies (Meyerbröker & Emmelkamp, 2010).

Regarding gender differences, studies have shown that women tend to report higher initial levels of anxiety, aligning with research suggesting that women are more likely to experience anxiety in public settings than men. However, men and women have shown similar progress in anxiety reduction during VR sessions, indicating that both genders benefit comparably from VR interventions (McLean & Anderson, 2009).

Integrating virtual reality (VR) into clinical and educational environments offers significant benefits. In clinical settings, particularly for social anxiety therapy, VR provides controlled simulations, allowing patients to practice communication skills in a safe environment (Maples-Keller et al., 2017). It facilitates a gradual introduction of stressors, such as public speaking, in low-risk scenarios. In educational contexts, VR aids students in developing communication skills, with studies showing reduced anxiety during real performance situations like presentations (Parong & Mayer, 2018). As VR technology becomes more accessible and affordable, its large-scale application in both clinics and educational institutions is increasingly feasible (Liu, 2023). Additionally, VR allows occupational therapists to customize difficulty levels in simulations, creating an immersive experience. Combining VR with techniques like gradual exposure, mindfulness, and relaxation helps desensitize stress associated with public speaking and enhances communication skills (Caiana et al., 2016). This comprehensive approach not only targets anxiety symptoms but also boosts patients' confidence and effectiveness in social interactions.

This research contributes in a meaningful way to comprehension of how VR can decrease public speaking anxiety. Nevertheless, it is important to acknowledge certain restrictions. One major constraint is the sample size, limited to 30 participants. While the current findings show statistical significance, a better sample size could lead to more reliable and applicable results. It would also enable a wider range of participant characteristics like age, presentation experience, and VR familiarity. Small sample sizes also restrict the ability to conduct thorough analyses of subgroups, such as comparing individuals with varying levels of pre-existing anxiety or differing levels of public speaking experience (Serdar et al., 2021).

Another important limitation is the artificial nature of virtual reality presentations. Although VR is effective at simulating presentation environments, it does not fully capture the nuances and emotional complexity of real-life situations in front of an audience. Studies indicate that stress in real presentations can be influenced by external variables, such as immediate feedback from the audience or specific social pressures, which are not replicated in the virtual environment (Bell et al., 2020). Thus, it is possible that the participants' levels of anxiety and emotional response could be different in a real environment.

The study primarily examined physiological variables (EDA and HR) and self-reports (PSAS and PSSAS), omitting objective behavioral measures such as external evaluations of speaking performance. Future research should include these measures to provide a more comprehensive understanding of VR's impact on public speaking skills. Additionally, integrating complementary stress and anxiety reduction techniques such as relaxation methods, mindfulness, or cognitive-behavioral training alongside VR may help mitigate heightened emotional stress indicated by EDA, fostering better adaptation during exposures. Investigating the long-term effectiveness of VR sessions, particularly the impact of repeated exposure over time, is also recommended to assess whether anxiety reduction and improvements in self-efficacy are sustainable. Personalizing VR simulations to meet participants' specific needs through varying difficulty levels, real-time feedback, or more complex virtual environments could enhance the tool's applicability and effectiveness across diverse individual profiles. Moreover, future studies should explore the effects of different medication dosages and therapeutic approaches, including cognitive-behavioral therapy and pharmacotherapy, in combination with VR. This could facilitate more personalized treatment strategies, addressing individual participant needs more effectively. Additionally, examining sociodemographic factors, such as gender and age, may reveal how these variables influence responses to VR exposure therapy, enabling further adaptations to improve treatment efficacy across different groups.

To sum up, this research emphasizes how virtual reality can effectively decrease anxiety while speaking in public by showing that regular exposure to stressful situations can lead to improved self-confidence and reduced physical reactions. Nonetheless, the rise in EDA levels suggests that emotional stress may persist at a high level, highlighting the necessity for additional interventions like relaxation methods and mindfulness to enhance therapeutic outcomes. These results add to the increasing evidence that backs the utilization of VR as a therapeutic tool in clinical and educational environments for improving social anxiety and communication skills.

7. Conclusion

The study primarily focused on physiological variables (EDA and HR) and self-reports (PSAS and PSSAS), neglecting objective behavioral measures like external evaluations of speaking performance. Future research should incorporate these measures to gain a more comprehensive understanding of VR's effects on public speaking skills. Additionally, integrating complementary stress and anxiety reduction techniques such as relaxation methods, mindfulness, or cognitive-behavioral training alongside VR may help alleviate heightened emotional stress indicated by EDA, promoting better adaptation during exposures.

Investigating the long-term effectiveness of VR sessions, particularly the impact of repeated exposure over time, is essential to determine whether anxiety reduction and improvements in self-efficacy are sustainable. Personalizing VR simulations to meet the specific needs of participants by varying difficulty levels, providing real-time feedback, or creating more complex virtual environments could enhance the tool's applicability and effectiveness across diverse individual profiles.

Moreover, future studies should explore the interplay between VR and OT. By tailoring VR experiences to facilitate the development of functional skills, OT can play a vital role in addressing public speaking anxiety. Investigating different medication dosages and therapeutic approaches, including cognitive-behavioral therapy and pharmacotherapy, in conjunction with VR could lead to more personalized treatment strategies that better meet individual needs.

Finally, examining sociodemographic factors, such as gender and age, may shed light on how these variables influence responses to VR exposure therapy, enabling further adaptations to improve treatment efficacy across different groups. This holistic approach could ultimately enhance the integration of VR within OT frameworks, maximizing its benefits for individuals facing public speaking challenges.

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Supplementary material

Appendix 1 – Flyer sent to students with 10 tips on how to perform well in public

Appendix 2 – Flyer sent to students with instructions on how to perform diaphragmatic breathing correctly