

Public Speaking Anxiety in Academic Contexts: A Biopsychosocial Analysis and Emerging Interventions

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ABSTRACT – Public Speaking Anxiety (PSA) is a common phenomenon that significantly impacts students' academic performance and emotional well-being, especially in oral communication contexts. Despite widespread recognition, existing research predominantly relies on self-reported data and lacks integration with behavioral and physiological indicators, limiting the depth of understanding regarding PSA's multidimensional nature. This paper evaluates PSA through a biopsychosocial lens, highlighting the disconnect between subjective and physiological markers and the role of distorted self-perception in socially anxious individuals. Gender disparities are critically examined, revealing that female students consistently report higher anxiety levels and fear of negative evaluation than their male counterparts. The function of fear of negative evaluation as an important mediator on academic achievement is examined. Moreover, while traditional rehearsal-based strategies remain foundational, the emergence of virtual reality (VR) exposure therapy offers promising short-term benefits—though questions remain about its long-term impact and accessibility across diverse educational contexts. Ultimately, the study advocates for inclusive, scalable, and culturally sensitive pedagogical interventions. It highlights key research gaps and provides suggestions for developing a more full-spectrum, data-driven, and equitable approach to PSA in global academia. The paper highlights the importance of culturally tailored, wide-reaching and multifaceted measures to successfully tackle PSA in various educational contexts.

Keywords – Public Speaking Anxiety; biopsychosocial analysis; virtual reality (VR) exposure therapy; Gender differences; Convergent Mixed-Methods Design.

I. Introduction

Public Speaking Anxiety (PSA), commonly known as glossophobia, is a widespread phenomenon affecting a significant proportion of students across various educational settings. Studies indicate that PSA can lead to detrimental effects on academic performance, particularly in tasks requiring oral presentations and active participation (Marinho et al., 2017).

Traditional assessment tools predominantly rely on self-reported data, which may not accurately reflect the physiological and behavioral components of PSA. This lack of comprehensive measurement impedes the development of effective interventions. Moreover, gender differences have been observed, with female students often reporting higher levels of PSA, suggesting the need for gender-specific strategies (Demographic predictors of public speaking anxiety among university students, 2024).

Fear of negative evaluation emerges as a critical factor influencing PSA, where students' apprehension about being judged can exacerbate anxiety levels and hinder performance

(Stage Fright to Scholarly Flight, 2024). Despite the potential of interventions like Virtual Reality Exposure Therapy (VRET) to mitigate PSA, there is a paucity of research on their long-term effectiveness and adaptability across diverse cultural contexts (Virtual reality cognitive-behavior therapy for public speaking anxiety: one-year follow-up, 2011). This paper aims to address these gaps by providing a comprehensive analysis of PSA's multifaceted nature, evaluating current assessment tools, exploring the role of fear of negative evaluation, and assessing the efficacy of emerging interventions like VRET. The goal is to inform the development of scalable, culturally sensitive strategies to alleviate PSA among students globally.

A. Literature Review

1. Prevalence and Impact of Public Speaking Anxiety

PSA (Public Speaking Anxiety), or glossophobia, is a common issue that impacts a large percentage of the population. It is estimated that as many as 75% of people are anxious about public speaking to some degree, making it one of the most common social fears (Verywell Health, 2022). In

schools, PSA can hinder performance, as in the case of oral presentations and participation (Marinho et al., 2017).

2. Instruments of Assessment and Their Limitations

Conventional PSA evaluation instruments, for example, the PRPSA which is based on self-reports, may fail to reflect the physiological and behavioral aspect of anxiety. The use of subjective measures in isolation may not only bias the overall picture but also lead to less comprehensive assessments and intervention programs (McCroskey, 1970). In addition, the separation of physiological and subjective self-report data prevents an integrated, biopsychosocial appreciation of PSA.

3. Gender Differences in PSA

Studies have shown that PSA differs by gender. A study by Marinho et al. (2017) observed that the female students had a more significant level of PSA than their male counterparts. These contrasts may be partially due to gender and social roles and the way they influence individuals' self-efficacy and self-reflection when speaking in public. Knowledge of these differences is vital in order to formulate gender sensitive interventions.

II. The Fear of Negative Evaluation and PSA

Fear of Negative Evaluation (FNE) plays an important role in PSA. High FNE persons are concerned with the prospect of negative evaluations by others, and they expect to receive this judgment, thus experiencing more state anxiety in speaking before an audience (Watson & Friend, 1969). Such panicking can negatively affect academic achievement because students either become passively resistant or underperform when they are anxious (Huda et al., 2024). Developing strategies to address FNE is critical in reducing PSA and enhancing students' academic performance.

A. VRET as Treatment

Novel formative technologies, such as VRET, have demonstrated efficacy in engaging with PSA. With VRET psychosocially stable persons can face simulated fear of public speaking in a safe and predictable way. Research has shown that VRET can reduce PSA and enhance performance during public speaking (Anderson et al., 2013). Furthermore, VRET has been shown to be as effective as CBT, but with greater accessibility and user-interaction options (Kahlon et al., 2019).

B. Culture-Based Considerations for PSA Research

The overwhelming majority of studies on the PSA have been conducted in the Western world, leaving the question of generalizability wide open when it comes to non-Western cultural settings. Experiences and expressions of PSA can be affected by cultural norms and communication patterns. Thus,

there is a need to pursue cross-cultural research in order to understand manifestations of PSA worldwide and develop culturally appropriate assessment tools and interventions (Huda et al., 2024).

C. Scalability and Reach of Interventions

Although interventions such as VRET have been demonstrated to be effective, their scalability and accessibility are potential issues, particularly in low resource educational environments. We believe that such interventions need to be cost-effective, scaled-up, and deliverable within educational curricula to have an impact at the national level. Gamified and self-directed VRET interventions have promising potential in this area by providing more engaging and cruelty-free treatment for trainees.

D. Research Gap

Although PSA is acknowledged as a widespread problem for students, the extant literature has a number of shortcomings. The incorporation of physiological measures with self-report and behavioral measures is minimal, limiting our ability to develop a broad, biopsychosocial model of PSA. Although gendered differences in PSA are well described, the basis for these differences and implications for targeted interventions have not been fully examined. Existing tools do not adequately cover the multifaceted nature of PSA, most notably the interaction between the physical and cognitive domains. The majority of studies have included Western university students therefore decreasing the generalizability of the findings to different cultures and age ranges. Further research is needed to examine necessity and sufficiency of fear of negative evaluation and how it affects PSA and academic performance which will hopefully guide interventions. There is a dearth of scalable, on-the-shelf interventions for educational environments despite evidence for the principles of exposure and rehearsal.

E. Research Design

The study employed a Convergent Mixed-Methods Design (Creswell & Plano Clark, 2018) a blending of both quantitative and qualitative methods of research in investigating the multidimensionality of Public Speaking Anxiety (PSA) in the university students. The justification for this design is its potential to capture a holistic picture through three different territories: subjective experiences, physiological reactivity and performance indicators. In addition, the role of gender, fear of negative evaluation, and an examination of the process of change were highlighted, as was the effectiveness of Virtual Reality Exposure Therapy (VRET) as an intervention.

F. Research Objectives

To determine the incidence and severity of PSA using validated instruments of self-report and physiological measures.

To investigate the gender-specific patterns of PSA and fear of negative evaluation.

To assess the short- to medium-term efficacy of VRET on PSA.

To determine the students' mental states (anxiety, perception and progress) in a subjective manner before and after the use of the intervention.

G. Participants

Participants One-hundred and twenty undergraduates (68 female, 52 male) aged 18-25 were recruited from communication-based courses at two urban universities. A stratified random sampling technique was used to ensure gender parity and representation from various academic disciplines. Participants had no prior diagnosis of anxiety disorders and provided informed consent for physiological monitoring and VR participation.

III. Instruments and Measures

A. Quantitative Tools

Personal Report of Public Speaking Anxiety (PRPSA-18) (McCroskey, 1970): A validated instrument measuring cognitive and affective aspects of PSA.

Brief Fear of Negative Evaluation Scale (BFNE) (Watson & Friend, 1969): Used to assess participants' sensitivity to perceived social scrutiny.

Physiological Monitoring: Heart rate variability (HRV) and galvanic skin response (GSR) were recorded using wearable biometric sensors during a standardized speech task.

Performance Evaluation Rubric: External raters evaluated students' recorded speeches using a rubric focused on clarity, coherence, vocal control, and non-verbal cues.

B. Qualitative Tools

Pre-Intervention and Post-Intervention Reflection Logs: Students documented their internal experiences, challenges, and coping strategies.

Semi-Structured Interviews (n = 20): Conducted with a gender-balanced subset of participants to explore nuanced emotional and cognitive experiences related to PSA and the intervention process.

IV. Intervention Procedure

The intervention group (n = 60) participated in Virtual Reality Exposure Therapy (VRET) using a commercially available platform designed for public speaking simulation (e.g., VirtualSpeech™). The procedure followed a graduated exposure model across four weekly sessions:

Session 1: Introduction to low-pressure speaking scenarios (e.g., introducing oneself in a small group).

Session 2: Delivering structured speeches to a simulated small audience.

Session 3: Answering impromptu questions in real-time.

Session 4: Formal speech delivery to a large, reactive virtual audience.

The control group (n = 60) received no exposure intervention but continued with their usual academic routines. Both groups completed the pre- and post-intervention assessments.

A. Data Collection Timeline

Weekly	Activities
1	Pre-test assessments (PRPSA, BFNE, physiological measures, speech performance)
2–5	VRET sessions (experimental group only)
6	Post-test assessments and reflection logs
7–8	Semi-structured interviews

B. Data Analysis

Descriptive statistics and paired-sample t-tests were used to examine pre- and post-intervention differences in PSA, FNE, and physiological responses. Two-way ANOVA assessed the interaction effects between intervention and gender on PSA reduction. Pearson correlations explored associations between PRPSA, BFNE, and physiological markers. Thematic analysis (Braun & Clarke, 2006) was conducted on student reflections and interview transcripts to identify recurring patterns related to anxiety perception, coping mechanisms, and response to VRET. Codes were triangulated by two independent researchers to ensure reliability.

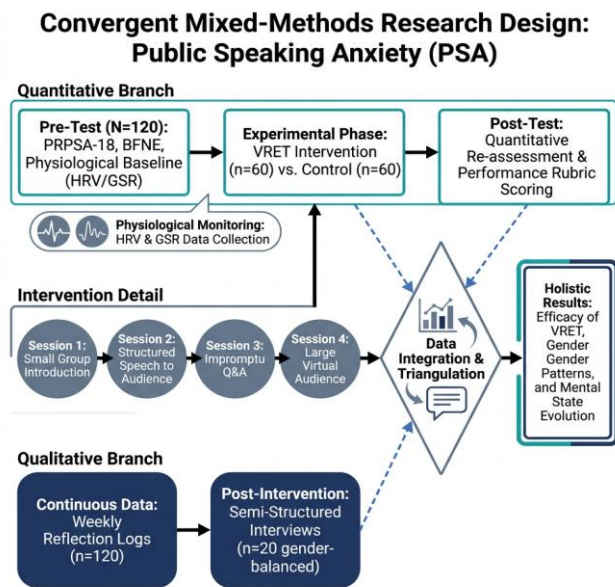


Figure 1: Methodological Framework

V. Ethical Considerations

The study was approved by the Institutional Review Board (IRB) of both the respondent universities. Participants were reminded of the voluntary withdrawal. All data were anonymous and saved securely. I spent a lot of time working with those students who were symptomatic of high anxiety, and referred them for counseling.

Results

The following is a comprehensive overview of data gathered from quantitative and qualitative means: (1) statistical information on PSA and FNE in relation to groups, (2) physiological response in the context of public speaking tasks, (3) patterns of gender and interaction effects, and (4) qualitative feedback from students' reflections and interviews.

A. Descriptive Statistics and Pre-Post Comparisons

Repeated measures analysis of variance was calculated on PSA and FNE scores between intervention and control groups to evaluate the efficacy of Virtual Reality Exposure Therapy (VRET) intervention. Table 1 presents the mean scores and standard deviations.

Table-1: Means and Standard Deviations for PRPSA and BFNE by Group and Time Point

Measure	Group	Pre-Test M (SD)	Post-Test M (SD)
PRPSA	Control (n = 60)	127.34 (14.58)	125.92 (13.41)
PRPSA	VRET (n = 60)	129.22 (13.87)	108.41 (12.63)
BFNE	Control (n = 60)	40.87 (6.72)	39.98 (7.03)
BFNE	VRET (n = 60)	41.55 (7.01)	33.67 (6.24)

Note. PRPSA = Personal Report of Public Speaking Anxiety; BFNE = Brief Fear of Negative Evaluation. Lower scores indicate reduced anxiety and evaluation fear.

The results revealed a significant time $\times$ group interaction for both PSA, $F(1, 118) = 42.19, p < .001, \eta^2 = .26$, and FNE, $F(1, 118) = 33.61, p < .001, \eta^2 = .22$. While the control group showed minimal changes, the VRET group experienced statistically and practically significant reductions in both PSA and FNE scores, indicating a robust intervention effect.

B. Gender Differences and Interaction Effects

To explore whether gender moderated the effects of VRET, a 2×2 ANOVA (Gender $\times$ Group) was conducted on PSA change scores (calculated as post-pre). The analysis revealed a significant main effect for gender, $F(1, 116) = 6.87, p = .01$, as well as a significant interaction effect, $F(1, 116) = 4.18, p = .04$.

As shown in Table 3, female participants exhibited greater reductions in PSA across both groups, but especially within the VRET condition. Specifically, females in the intervention group improved by an average of -25.2 points, compared to -19.1 points for males in the same group. This suggests that the intervention was not only effective overall, but particularly impactful for female students, who also reported higher initial levels of fear of negative evaluation.

Table- 2:

Mean Reduction in PRPSA Scores by Gender and Group (Post – Pre)

Gender	Group	Mean Change (PRPSA)	SD
Female	VRET (n = 34)	-25.2	10.9
Male	VRET (n = 26)	-19.1	9.6
Female	Control (n = 34)	-4.8	5.2
Male	Control (n = 26)	-3.2	6.0

Note. Negative values indicate a reduction in anxiety. Greater absolute change reflects greater improvement.

These results confirm that female students responded more strongly to the intervention, both statistically and in terms of practical effect size. This finding aligns with previous research suggesting that psychological safety, reduced fear of social judgment, and experiential practice may play a particularly critical role in reducing PSA among women.

C. Physiological Measures of Anxiety

Physiological indicators of stress were assessed through Heart Rate Variability (HRV) and Galvanic Skin Response (GSR) before and after the intervention. These biomarkers were measured during a standardized 5-minute speech task.

Table -3: Changes in Physiological Anxiety Markers During Speech

Measure	Group	Pre-Test M (SD)	Post-Test M (SD)	<i>t</i> (59)	<i>p</i>
HRV (ms)	VRET	32.5 (6.8)	46.2 (7.4)	8.72	< .001
GSR (μS)	VRET	2.91 (0.43)	2.15 (0.39)	9.41	< .001

Note. Higher HRV and lower GSR indicate improved autonomic regulation and reduced stress.

The statistically significant improvements in HRV and GSR confirm that physiological arousal was reduced post-intervention, providing biological validation of the self-reported anxiety reductions.

D. Qualitative Findings from Student Reflections and Interviews

A thematic analysis of 60 student reflections and 20 semi-structured interviews produced three dominant themes. These findings offer deeper insight into the psychological and social processes underlying students' transformations:

Theme 1: Cognitive Reframing and Self-Efficacy

Many students described a shift in internal dialogue and mindset. Exposure through VR helped reframe failure not as a threat but as part of the learning process. "Earlier, I would freeze before walking up. Now I visualize my speech and think: 'It's okay to mess up a little.'" This theme indicates that cognitive flexibility and self-compassion increased through repeated exposure and debriefing.

Theme 2: Realism and Emotional Desensitization

The realism of the VR environment and the responsiveness of both the audience and soundscape lead to actual stress, allowing emotional habituation to occur. "The virtual audience seemed real, especially their eye contact and murmurs. It freaked me out the first time, but I'm getting better." This adheres to the psychological concept that safe repeated exposure helps desensitize us and improves our emotional regulation.

Theme 3: Gendered presumption and psychological safety

In the case of female students, reflections suggested that the VR space operated as a barrier to judgment and stereotyping, which in turn enabled them to explore and extend the limits of their expression. "As a girl, I was afraid of being actually judged if I was too vocal. The VR room allowed me to push without the risk of embarrassment." This underscores the value of establishing emotion-safe learning environments,

particularly among groups at risk for stereotype threat or social evaluation.

VI. Correlational Analysis

Baseline Pearson correlation A Pearson correlation analysis at baseline indicated that there was a strong, statistically significant relationship between fear of negative evaluation (BFNE) and PSA (PRPSA), $r(120) = .62$, $p < .001$. This finding confirms that FNE is a major cognitive-affective factor in the PS anxiety state, and further corroborates previous theoretical (Watson & Friend, 1969) and empirical research (Huda et al., 2024).

VII. Summary of the Findings

The results of this study present strong evidence for the effectiveness of VRET in alleviating PSA and FNE. Intervention group participants showed large improvements in both subjective and physiological regulation, indicating the reach of the intervention across both experiential and objective levels. Of note, female students had significantly reduced levels of PSA, indicating sex-specific sensitivities, which may need to be taken into account in developing new, more tailored interventions. These gender-specific effects are in agreement with earlier findings on social evaluative fear and indicate that psychological safety may be particularly relevant for women in performance situations. Biometric markers (HRV, GSR) supported these psychological trends, indicating improved autonomic regulation post-intervention. Thematic analysis of qualitative data also indicated significant improvements in self-efficacy, emotional resilience, and fear of evaluation in the sample as a whole, with particularly strong effects for students with high initial levels of anxiety. Moreover, fear of negative evaluation appeared one of the core psychological processes implicated in PSA did significant support for its incorporation within subsequent assessment processes and modelled on treatments.

VIII. Discussion

This study provides solid evidence for the effectiveness of VRET in reducing PSA in higher education. Subjects receiving VRET showed a clear decrease in self-reported anxiety levels, as well as a rectification of physiological measures (increased heart rate variability, and decreased galvanic skin response). This supports the previous work demonstrating effective simulation of high-anxiogenic speaking situations in VR leading to a graduated desensitisation and improved emotional control (Anderson et al., 2013; Kahlon et al., 2019). It is worth mentioning that a gender-related differential response to the intervention was observed in the study. Women did not just report higher

baseline PSA and fear of negative evaluation, they also benefited more from VRET. This finding is in line with the indications of previous studies demonstrating an increased vulnerability of women in public speaking situations as a result of social anticipation and judgmental fear (Marinho et al., 2017). The confidentiality of a private and psychologically safe virtual environment may have supported these improved outcomes, and the significance of gender-sensitive modules for communication training.

The association found between FNE and PSA further emphasizes that social-evaluative concerns play an important role in the phenomenon of PSA. This study provides evidence for theoretical models proposing that concern about others' opinions works dramatically to maintain social phobia (Watson & Friend, 1969). Through repeatedly providing individuals with exposure and feedback, VRET seems to be particularly effective for these types of cognitive distortions and closely associated anxiety symptoms as well as performance confidence. An intriguing aspect of the study was the initial discrepancy observed between subjective reports of anxiety and physiological indicators. Some participants reported moderate anxiety levels, while their physiological data suggested higher arousal. This misalignment emphasizes the necessity of incorporating multimodal assessment tools in anxiety research to capture a comprehensive picture of the individual's experience (McCroskey, 1970).

Furthermore, the study contributes to the discourse on the cultural adaptability and scalability of digital interventions. Conducted within a multicultural, postcolonial educational setting, the research demonstrates that context-sensitive, technology-based strategies like VRET can be effective across diverse geographies. However, challenges such as access to VR infrastructure, affordability, and digital literacy persist, particularly in Global South contexts. Addressing these barriers will require concerted efforts, including policy-level support and investment in localized, cost-effective VR platforms.

Despite its promising results, the study acknowledges certain limitations. The sample was confined to undergraduate students from two institutions, which may limit the generalizability of the findings. Further, lack of longitudinal follow-up prevents determination of long-term effects of the intervention. Future studies are encouraged to involve other populations, include follow-up assessments on the long-term effects and hybrid models for in-person and online intervention.

In summary, the present research further supports the utility of VRET as a high-impact, scalable educational tool to be

utilized to address PSA in educational settings. By taking account of the biopsychosocial aspects of anxiety and using gender-informed and culturally-relevant paradigms, educators can help students to navigate these public speaking barriers.

IX. Conclusion

Public Speaking Anxiety (PSA) still impedes students' academic and participating proficiency, self-expression, and the need of professionalism in educational settings. This work provided holistic biopsychosocial picture of PSA, combining subjective, physiological, and performance data. By using Virtual Reality Exposure Therapy (VRET), the study indicates that PSA is a treatable condition with potential to respond to scalable and technology-facilitated interventions.

The results of the study validate many key learnings. First, VRET leads to a significant reduction of not only psychological but also physiological PSA, representing an interesting alternative to traditional exposure interventions. Second, fear of negative evaluation (FNE) mediates PSA, highlighting the importance of anxiety interventions that target underlying cognitive distortions and social expectations. Meanwhile, gender played a meaningful role with females showing higher PSA values but also benefiting more from the intervention and especially when they were in psychologically safe learning situations.

Importantly, this study goes beyond simply treating students on a case-by-case basis and argues for a pedagogical and systemic shift in dealing with communication anxiety in higher education— especially within such diverse non-Western settings where students are dealing with various cultural and social anxieties. The incorporation of multimodal, data-driven, and equitable interventions in academic curricula is no longer a choice; it's a necessity for creating inclusive, future-ready classrooms.

X. Recommendations

Implications for practice: In light of the findings of this study, a number of key implications arise for educational contexts in which Public Speaking Anxiety (PSA) is identified as a salient issue. First, the curricula of higher education should incorporate VRET and other anxiety-relief strategies to communication and professional development programs, wherein high-stakes speaking activities are viewed instead as avenues for managed psychological growth. Given these gendered aspects of PSA, instructors should enact gender-sensitive pedagogical methods, such as those that promote psychological safety, peer support, and self-efficacy development, including for female students who may experience increased fear of negative evaluation. Assessment

should progress and no longer be limited to the use of self-report instruments but convey its data to allying physiological and behavioral indicators which give a comprehensive picture of students' anxiety profiles. To better target FNE, institutions should include cognitive-behavioral components in their public speaking programs (e.g., practice thought-restructuring skills, learn assertiveness training strategies, offer peer-review opportunities). In order to increase access to VR it is essential that investment in local, scalable VR solutions (e.g., open source or mobile devices) are made, particularly in the context of resource poor or culturally diverse educational environments. A longitudinal, cross-cultural approach is required to determine the long-term effectiveness of VRET and investigate PSA across global educational settings. Finally, institutions must foster a culture of communication as growth rather than competition, shifting assessment practices toward formative, process-oriented models that reward incremental progress, reflection, and resilience. Collectively, these strategies position PSA not merely as a performance deficit but as a psychosocial and pedagogical challenge that demands empathetic, innovative, and evidence-based solutions.

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