

VIRTUAL REALITY EXPOSURE THERAPY FOR MUSIC PERFORMANCE ANXIETY: EVIDENCE, ADVANTAGES, AND FUTURE DIRECTIONS

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ABSTRACT

This study examines the use of Virtual Reality Exposure Therapy (VRET) as a novel intervention approach for addressing Music Performance Anxiety (MPA), a form of anxiety experienced by musicians during performance. MPA is a widespread phenomenon across levels of expertise, genres, and cultural backgrounds, and it negatively affects psychological well-being and musical performance quality. Although traditional interventions like cognitive-behavioral therapy (CBT), relaxation training, and in vivo exposure have proven effective, these methods often face constraints in terms of exposure intensity control, accessibility, standardization, and acceptability among highly anxious musicians. Findings indicate that VRET offers significant advantages, including immersive environments, adjustable and customizable exposure levels, repeatable performance scenarios, and improved access to treatment. The empirical studies reviewed suggest that VRET is effective in reducing performance anxiety, improving physiological responses such as heart rate variability, and enhancing overall music performance quality. However, the article also emphasizes that VRET should not be considered a complete replacement for traditional methods. Live performance continues to play a crucial role in artistic development, social communication, and stage sensitivity. Therefore, a more effective approach may lie in an integrative model that combines VRET with conventional interventions within a comprehensive therapeutic and music training framework. In conclusion, VRET holds substantial potential as a supportive tool in managing music performance anxiety, particularly in terms of flexibility, safety, and therapeutic effectiveness. Nevertheless, further research employing longitudinal designs, standardized protocols, and interdisciplinary collaboration is required to optimize its application and ensure sustainable long-term benefits for musicians' psychological well-being and artistic development.

Keywords: *Music performance anxiety; Virtual reality exposure therapy; Exposure therapy; Performance psychology; Music education*

1. INTRODUCTION

Musical performance anxiety (MPA) is a prevalent and multifaceted phenomenon affecting musicians across professional levels and cultural contexts. Characterized by fear of negative evaluation, heightened physiological arousal, and cognitive disruption during performance, MPA can impair artistic expression, career development, and psychological well-being. Although moderate arousal may enhance performance, excessive anxiety often disrupts attentional control and fine motor coordination. Traditional interventions including cognitive-behavioral therapy (CBT), relaxation training, and in vivo exposure have demonstrated efficacy, yet their implementation is frequently constrained by logistical, standardization, and accessibility challenges.

In recent years, Virtual Reality Exposure Therapy (VRET) has emerged as a technologically enhanced exposure-based intervention for anxiety disorders. Given the situational and evaluative nature of MPA, VRET may offer distinctive therapeutic advantages. This review therefore addresses three central questions: (1) What psychological and situational characteristics define MPA and limit traditional interventions? (2) How does VRET compare with conventional exposure-based approaches in reducing MPA? and (3) What unique advantages and limitations characterize VRET within clinical and educational contexts? By synthesizing theoretical and empirical evidence, this paper critically evaluates whether VRET represents a complementary enhancement or a transformative development in MPA intervention.

2. METHODOLOGY OF THE REVIEW

2.1 Review Design

This study adopts an integrative review design to synthesize theoretical and empirical evidence concerning the application of Virtual Reality Exposure Therapy (VRET) in the context of Music Performance Anxiety (MPA). An integrative review approach was selected because it permits the inclusion of diverse research methodologies, including randomized controlled trials, exploratory studies, theoretical analyses, and clinical reports. Unlike a strictly systematic review that limits inclusion to predefined experimental designs and narrowly defined outcome measures, the integrative approach facilitates a broader conceptual synthesis across methodological traditions.

Given the relatively limited yet expanding body of research specifically examining VRET within music performance contexts, this design was considered methodologically appropriate. It allows for the examination of theoretical foundations, intervention mechanisms, empirical findings, and applied implications within a unified analytical framework. Such an approach is particularly suitable for emerging interdisciplinary domains that intersect performance psychology, clinical intervention, and immersive technology.

2.2 Search Strategy

A structured literature search was conducted to identify relevant studies addressing MPA, exposure-based interventions, and virtual reality applications in anxiety treatment. Electronic databases searched included PubMed, PsycINFO, Web of Science, Scopus, and Google Scholar. These databases were selected to ensure comprehensive coverage across psychological, medical, and interdisciplinary research domains.

Search terms were developed using combinations of key concepts related to the research questions. Primary keywords included “music performance anxiety,” “musical performance anxiety,” “virtual reality exposure therapy,” “virtual reality intervention,” “exposure therapy,” and “performance psychology”. The search primarily targeted peer-reviewed journal articles published between 2000 and 2025 to reflect contemporary theoretical developments and technological advancements in virtual reality-based interventions.

2.3 Inclusion and Exclusion Criteria

To ensure conceptual relevance and methodological consistency, predefined inclusion and exclusion criteria were applied. Studies were included if they: (a) examined Music Performance Anxiety or closely related performance-based social anxiety constructs; (b) investigated Virtual Reality Exposure Therapy or VR-based exposure mechanisms; (c) reported empirical findings, theoretical models, or clinical applications; and (d) were published in peer-reviewed academic journals.

Studies were excluded if they focused exclusively on technological development without therapeutic or psychological application, did not address anxiety-related constructs, or were published in languages other than English. This selection strategy aimed to balance comprehensiveness with methodological rigor while maintaining focus on clinically and educationally relevant findings.

2.4 Study Selection and Synthesis Process

The study selection process proceeded in three sequential stages. First, titles and abstracts were screened to determine preliminary relevance to the research objectives. Second, full-text articles were assessed to confirm eligibility based on the established inclusion and exclusion criteria. Third, eligible studies were subjected to thematic synthesis.

Rather than conducting a quantitative meta-analysis—given the heterogeneity of research designs, outcome measures, and intervention protocols—this review applied a thematic analytic synthesis approach. Findings were organized into three analytical domains aligned with the guiding research questions: (1) psychological and situational characteristics of MPA and their implications for intervention; (2) empirical evidence and theoretical mechanisms underlying VRET; and (3) comparative evaluation of VRET and traditional exposure-based interventions.

This structured synthesis enhances transparency, supports analytical coherence, and strengthens the methodological positioning of the review as an

integrative scholarly contribution.

3. LITERATURE REVIEW

3.1 Conceptual and Psychological Characteristics of MPA

Music Performance Anxiety (MPA) is widely recognized as a multidimensional construct involving cognitive, physiological, affective, and behavioral components. It is typically defined as a persistent and situation-specific anxiety associated with public musical performance and the anticipation of negative evaluation. Although MPA does not always meet diagnostic criteria for social anxiety disorder, it shares core features such as fear of scrutiny, catastrophic thinking, and heightened self-focused attention (Papageorgi et al., 2007; Nicholson et al., 2015).

Cognitively, musicians experiencing MPA often report intrusive self-doubt, fear of memory lapses, and exaggerated perceptions of performance failure. Physiologically, symptoms may include increased heart rate, tremors, muscle tension, and gastrointestinal discomfort. Behaviorally, MPA can result in avoidance of performance opportunities or reliance on maladaptive coping strategies. Importantly, research suggests that MPA is shaped not only by individual vulnerability factors but also by contextual variables such as audience presence, performance stakes, and institutional expectations (Fernholz et al., 2019).

The situational and evaluative nature of MPA is particularly relevant for intervention design. Unlike generalized anxiety, MPA is strongly triggered by performance environments, suggesting that exposure-based approaches may hold theoretical relevance. However, the dynamic nature of pre-performance, performance, and post-performance anxiety phases complicates intervention delivery and outcome measurement.

3.2 Traditional Interventions for MPA

Traditional interventions for MPA have primarily drawn from cognitive-behavioral frameworks. Cognitive-behavioral therapy (CBT) remains the most empirically supported approach, targeting maladaptive beliefs, attentional biases, and avoidance behaviors (Kenny, 2005; Faur et al., 2023). Exposure-based techniques, including simulated concerts and graded live performances, aim to facilitate habituation and inhibitory learning by confronting feared stimuli directly.

Complementary approaches such as relaxation training, mindfulness, biofeedback, and Acceptance and Commitment Therapy (ACT) have also shown promise (Juncos & Markman, 2016). These methods focus on emotional regulation and psychological flexibility rather than solely symptom reduction.

Despite demonstrated effectiveness, several limitations persist. Live exposure is often difficult to standardize and control, particularly in educational settings where audience conditions vary. Highly anxious musicians may resist participation in real-world exposure, limiting treatment adherence. Additionally, many studies suffer from small sample sizes and heterogeneous outcome measures, complicating cross-study comparisons (Fernholz et al., 2019). These constraints highlight the

need for innovative approaches that preserve exposure principles while enhancing flexibility and accessibility.

3.3 Theoretical Foundations of VRET

Virtual Reality Exposure Therapy (VRET) is grounded in classical exposure therapy principles, particularly inhibitory learning and extinction mechanisms (Maples-Keller et al., 2023). By simulating anxiety-provoking environments within immersive digital contexts, VRET enables controlled and graded confrontation with feared stimuli.

The theoretical rationale for VRET rests on three key mechanisms. First, immersive presence enhances emotional activation, a necessary condition for effective exposure. Second, therapist-controlled environments allow precise manipulation of exposure intensity, duration, and contextual variables. Third, repeated exposure within standardized scenarios may facilitate new learning that weakens maladaptive threat associations.

Compared within vivo exposure, VRET reduces logistical barriers and perceived risk while preserving core therapeutic mechanisms. However, questions remain regarding the transferability of virtual learning to real-world contexts and the degree to which simulated environments can fully replicate complex social evaluation dynamics.

3.4 Empirical Evidence of VRET in Anxiety Disorders

Extensive research supports the efficacy of VRET across various anxiety disorders, including specific phobias, panic disorder, social anxiety disorder, and post-traumatic stress disorder (Opriş et al., 2012; Cho et al., 2023). Meta-analytic findings suggest that VRET produces symptom reductions comparable to traditional exposure therapies, with stable effects over time.

Moreover, technological advancements have enhanced realism and interactivity, increasing treatment engagement and reducing dropout rates in certain populations (Boeldt et al., 2019). Neuroimaging studies further indicate that VRET may influence anxiety-related neural pathways, providing emerging evidence for its neurobiological relevance (Guo et al., 2025). Nevertheless, heterogeneity in VR hardware, intervention protocols, and outcome measures continues to limit definitive conclusions regarding superiority over conventional methods.

3.5 Application of VRET in Music Performance Anxiety

Research specifically examining VRET in MPA remains limited but promising. Experimental and exploratory studies have demonstrated that VR-based simulated performance environments can effectively induce performance-related anxiety while providing opportunities for repeated graded exposure (Bissonnette et al., 2016; Bellinger et al., 2023). Evidence suggests that VRET may reduce subjective anxiety levels, improve physiological indicators such as heart rate variability, and enhance objective performance quality measures. Importantly, VR environments can simulate varying audience sizes and performance stakes, allowing musicians to progressively adapt to evaluative contexts. However, most existing studies involve small samples and short-term interventions. Longitudinal data examining sustained improvement

and transfer to live performance remain scarce. Thus, while preliminary findings are encouraging, the evidence base for VRET in MPA is still developing.

3.6 Comparative Analysis: VRET and Traditional Exposure

Both traditional exposure and VRET share theoretical foundations in exposure-based learning. However, they differ substantially in delivery, controllability, and standardization. Traditional in vivo exposure offers unparalleled ecological validity and authentic social interaction but lacks controllability and may be logistically demanding. In contrast, VRET provides immersive yet controlled environments that allow systematic manipulation of performance conditions. This standardization enhances research potential and may increase treatment accessibility. Current evidence indicates that VRET is at least comparable to conventional exposure in reducing anxiety symptoms across disorders. However, no conclusive evidence supports its superiority in MPA specifically. A hybrid model integrating virtual and real-world exposure may therefore represent the most balanced and developmentally appropriate approach.

4. DISCUSSION

4.1 Interpretation of Findings

The reviewed literature suggests that VRET demonstrates conceptual alignment with exposure-based intervention principles and offers practical advantages in controllability and scalability. In the context of MPA, where anxiety is closely tied to evaluative performance environments, immersive virtual simulation provides a theoretically coherent intervention pathway.

However, the strength of empirical evidence remains moderate. While symptom reduction and physiological improvements have been documented, methodological heterogeneity and limited longitudinal validation prevent definitive conclusions regarding long-term efficacy.

4.2 Clinical and Educational Implications

Clinically, VRET may serve as an intermediate step for musicians reluctant to engage in live exposure. Its controlled nature may enhance treatment adherence and reduce avoidance. In music education contexts, VR simulations could function as preparatory training tools for auditions and examinations. Importantly, VRET should not replace real-world performance experience. Rather, it may function as a scaffolded exposure stage that gradually transitions musicians toward authentic live settings.

4.3 Strengths and Limitations of Current Evidence

The primary strength of the current evidence lies in its theoretical coherence and cross-disorder validation of VRET. However, limitations include small sample sizes, inconsistent measurement tools, short follow-up periods, and variability in VR system design. Additionally, questions remain regarding ecological transfer, cost-effectiveness, and therapist training requirements. Ethical considerations related to data privacy and emotional safety must also be addressed.

4.4 Future Research Directions

Future studies should prioritize randomized controlled trials with larger samples and longitudinal follow-up. Standardized intervention protocols would improve comparability across studies. Research examining physiological markers alongside subjective anxiety ratings may deepen understanding of treatment mechanisms. Interdisciplinary collaboration between psychologists, music educators, and technology developers will be essential to refine VRET applications within MPA contexts.

5. CONCLUSION

This study systematically reviewed and comprehensively analyzed the theoretical basis, empirical evidence, and potential advantages of VR exposure therapy over traditional methods in music performance anxiety intervention. Overall, existing studies have shown that VRET, as an intervention that combines immersive technology with the principles of classical exposure therapy, has shown positive effects in reducing performance-related anxiety, improving physiological response indicators, and improving subjective and objective performance quality in musicians. Compared with traditional in vivo or imaginary exposure methods, the core value of VRET is that it is highly controllable, repeatable, and context-customisable. Virtual environments can accurately simulate performance scenarios at different scales and with different levels of socially assessed stress, allowing musicians to confront and deal with anxiety reactions under safe and predictable conditions. This feature not only helps to reduce avoidance behavior, but also alleviates to some extent the realistic limitations of traditional field exposure in terms of logistical arrangements, standardization implementation, and compliance of highly anxious individuals. In addition, the immersive experience provided by VRET can effectively induce real emotional and physiological responses, thus fulfilling the key treatment conditions of exposure therapy at the level of emotional activation.

However, current evidence similarly suggests that VRET is not a substitute for traditional interventions. Live performances in the real world still have irreplaceable value in terms of musical expression, social interaction and artistic communication. A more reasonable practical approach may be to use VRET as a complementary tool in the framework of a comprehensive intervention based on cognitive behavioral therapy or music education training. By conducting progressive exposure training in the virtual environment, musicians can build a higher sense of self-efficacy and psychological preparation before entering the real performance situation, thereby improving the overall effect of the intervention.

It is worth noting that the application of VRET in MPA still faces several challenges, including the limited study sample size, the lack of fully standardized intervention protocols, the lack of longitudinal validation of long-term efficacy, and the issues of technical accessibility and ethical norms. In the future, randomized controlled trials and multi-center cooperation are necessary to further clarify the mechanism of action of VRET, compare its different effects with traditional methods and mixed models, and explore the dynamic relationship between physiological indicators and subjective experience. At the same time, interdisciplinary collaboration

between psychologists, music educators and technology developers will be key to promoting the continued development of the field.

In conclusion, VR exposure therapy provides a new way for the intervention of music performance anxiety with theoretical rationality and practical potential. The future of MPA intervention may no longer be limited to a single treatment model, but will evolve toward a personalized and integrated direction that integrates virtual and real experience, and considers both mental health and artistic development.

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