https://doi.org/10.36315/2026inpact119
Psychological Applications and Trends 2026

VIRTUAL LANDSCAPES TO COMBAT STUDENT ANXIETY: WHICH ONE HELPS THE MOST?

Irene Aliagas[1], Manuela Fernández[1], Anna Lisova[1], Mª Dolores Merino[1], & Jesús Privado[2]
[1]*Department of Social, Work and Differential Psychology, Universidad Complutense de Madrid (Spain)*
[2]*Department of Psychobiology and Methodology of the Behavioral Sciences, Universidad Complutense de Madrid (Spain)*

Abstract

Psychological health issues, particularly anxiety, have become more prevalent among university students in recent years, impacting both academic performance and overall well-being. While previous research has shown that natural environments tend to reduce anxiety more than urban ones, it remains unclear whether all types of natural landscapes are equally effective. This study examined the impact of five distinct landscape types—green, autumn, rainy, desert, and urban—on state anxiety. A sample of 127 university students (Mage = 21 years, SD = 2.40; 82.7% female) participated during a high-stress period, characterized by upcoming exams and assignment deadlines. Among them, 47.2% had previously tried virtual reality, 97.6% reported no weekly exposure to virtual environments, and only 7.1% had regular daily contact with natural spaces. Using the State-Trait Anxiety Inventory, total state anxiety scores were measured before and after exposure to each landscape in a repeated-measures design. Results indicated a significant reduction in state anxiety following exposure to natural landscapes, with the green landscape yielding the greatest decrease, followed by the autumn landscape. In contrast, the rainy, desert, and urban landscapes did not produce significant reductions, with the desert landscape showing the least benefit. These findings suggest that not all natural environments are equally effective in alleviating anxiety, highlighting the importance of specific environmental characteristics when designing virtual interventions to support psychological well-being in high-pressure academic settings.

Keywords: *State anxiety, virtual landscapes, nature, virtual reality, university students.*

1. Introduction

In recent years, growing concern for psychological well-being has intensified interest in how environmental factors—particularly natural spaces—can influence mental health (Spano et al., 2023). University students are a population especially vulnerable to psychological distress due to high academic demands, time pressure, and limited contact with restorative environments (Beiter et al., 2015). Among the emotional symptoms affecting students, state anxiety—a transient emotional condition triggered by situational stressors—has become especially prevalent, underscoring the urgent need for accessible and effective strategies for its regulation (Regehr, Glancy, & Pitts, 2013).

Research has consistently shown that exposure to natural elements, such as green (vegetation) and blue (water) spaces, is positively associated with psychological well-being (Browning et al., 2023; Dzhambov, 2018). Moreover, both real and virtual contact with nature have demonstrated potential to reduce symptoms of anxiety and promote emotional balance (Jiménez et al., 2021; Browning et al., 2020). In particular, virtual reality (VR) has emerged as a promising tool in mental health promotion due to its immersive nature and capacity to simulate complex environments in a controlled manner (Maples-Keller et al., 2017; Spano et al., 2023). Despite its growing application in clinical or professional training contexts (Valmaggia et al., 2016; Freeman et al., 2017), its use among university students for anxiety regulation remains largely unexplored.

While existing research has consistently shown that natural environments are more beneficial than urban settings for psychological well-being (Browning et al., 2023; Hammoud et al. 2024; Samus et al., 2022), most studies treat nature as a uniform category. This overlooks important variations in natural landscapes, such as seasonality, brightness, aridity, or atmospheric conditions, which may shape emotional responses differently. Although virtual landscapes have proven useful for promoting well-being (Spano et al., 2023; Yeo et al. 2020), it is still unclear whether all types of virtual nature elicit the same effects.

Considering these gaps, there is a clear need to identify the specific environmental landscapes that most effectively alleviate anxiety, particularly in virtual settings. These findings could inform the design of both educational spaces and psychological interventions that harness the restorative potential of nature in accessible, scalable formats.

2. Objective

This study aims to evaluate the impact of five types of virtual landscapes—green, autumn, rainy, arid, and urban—on state anxiety levels in a sample of university students during a period of elevated academic pressure. Given prior evidence highlighting the psychological relevance of water features in natural environments (blue spaces) (Browning et al., 2020; Dzhambov, 2018), special attention is paid to how the presence or absence of water, and how water is presented in the landscape (e.g., rain, waterfall), may influence anxiety responses. Using a repeated-measures design, we explore whether the benefits associated with nature exposure differ based on the specific characteristics of each landscape. In doing so, the study fills a gap in the literature and provides practical implications for developing targeted, evidence-based virtual interventions aimed at reducing anxiety in university students.

3. Methodology

3.1. Design

A within-subjects repeated-measures design was used to assess the impact of five virtual landscape environments on state anxiety in university students. The independent variable was the type of virtual landscape (green, autumn, rainy, arid, and urban), and the dependent variable was state anxiety. Each participant was exposed to all five environments in a counterbalanced order to control for order effects.

3.2. Participants

The study included a total of 65 university students. Participants were recruited during a high-stress academic period, characterized by upcoming exams and assignment deadlines. The age range was between 18 and 31 years, with a mean age of 21.40 years (*SD* = 2.55). The sample was predominantly female (75.4%), and nearly half of the participants (46.2%) had experienced virtual reality at least once. However, 95.4% reported not using virtual reality regularly, and only 7.7% had frequent daily contact with natural environments, suggesting that a significant portion of the sample may experience nature only sporadically.

Participation was voluntary, and all individuals provided informed consent prior to taking part in the study. Convenience sampling was used, based on student availability and willingness to participate. The inclusion criteria specified that participants had to be university students aged 18 or older, with normal or corrected-to-normal vision (via eyeglasses or contact lenses), to ensure a consistent experience within the virtual environment. Participants were also instructed to refrain from wearing facial makeup or voluminous hairstyles, as these could interfere with the proper adjustment of the virtual reality equipment. Individuals with a diagnosis of epilepsy or other neurological conditions were excluded from the study to minimize potential risks. The research followed the ethical principles outlined in the Declaration of Helsinki and received approval from the university's Ethics Committee.

3.3. Stimuli

The study employed five virtual landscapes, each selected to represent different natural and non-natural environments with varying characteristics related to vegetation and water presence. All of them were presented using the Guided Meditation VR software (https://guidedmeditationvr.com/), available on the Steam platform (https://store.steampowered.com/). Below is a description of each landscape, along with its corresponding label:

Green landscape: a lush green forest featuring dense vegetation and a central waterfall.

Autumn landscape: a leaf-covered, seasonally transitional forest with warm colors and visible footpaths, but no water elements.

Rainy landscape: a moody, overcast mountain landscape with ongoing rain and low lighting, lacking visible water bodies.

Arid landscape: a dry, expansive landscape characterized by sandy soil and distant mountains, with no vegetation or water.

Urban landscape: an indoor scene from a modern building without water elements.

3.4. Measure and instrument

State anxiety was assessed using the *State-Trait Anxiety Inventory* (STAI; Spielberger, Gorsuch, & Lushene, 1970), a widely used self-report instrument designed to measure temporary fluctuations in anxiety in response to specific situations. For this study, only the state anxiety subscale was employed, consisting of 20 items rated on a 4-point Likert scale (0 = Not at all to 3 = Very much so). Total scores ranged from 0 to 60, with higher scores indicating greater levels of state anxiety. Several items are reverse-scored to control for response bias, and these were recoded accordingly prior to calculating total scores. The reliability coefficient (Cronbach's alpha) for the state anxiety subscale in this study was 0.939, indicating excellent internal consistency.

3.5. Data collection and analysis

Data collection took place in a controlled and supervised environment, where participants were exposed to the virtual reality landscape conditions during scheduled sessions. Prior to the study, the necessary permissions were obtained from university authorities, and informed consent was collected from all participants. Participation was voluntary, and students were informed about the study's purpose and procedures. The assessments were administered individually. Confidentiality and anonymity were maintained throughout the data collection process, ensuring that all personal data remained protected.

Participants experienced five immersive landscape conditions—green, autumn, rainy, arid, and urban—via virtual reality. All scenes were standardized in duration (6 minutes) and presented using high-definition, computer-generated environments through MetaQuest VR headset to maintain consistent exposure and minimize external variability. The order of presentation was counterbalanced across participants to control for sequence effects. The STAI was administered immediately before and after exposure to each landscape, and anxiety change scores were calculated by subtracting pre-exposure from post-exposure values. Before calculating the change scores, the relevant items were reverse-coded. These change scores were used to assess the effectiveness of each landscape in reducing anxiety.

Descriptive statistics were computed for each condition, and comparisons across the five landscapes were made using non-parametric tests, since most of the variables did not follow a normal distribution. To analyze the data, a Friedman test was used to assess differences in anxiety change scores across the five landscape conditions. Post hoc pairwise comparisons were conducted using the Wilcoxon signed-rank test to examine specific differences between pairs of landscapes. Statistical significance was set at $p < .05$ for all analyses and were performed with SPSS v. 28.

4. Results

Normality tests were performed using the Kolmogorov-Smirnov test, given that the sample exceeded 50 participants. The results showed that the scores did not follow a normal distribution in almost all variables ($p < .05$), with the exception of green (K-S = .111, $p = .044$) and rainy landscape (K-S = .133, $p = .006$). To test whether there were statistically significant differences between the change variables as a function of landscape type, and taking into account that most of them did not follow a normal distribution, the Friedman Test was used. There was a statistically significant difference in state anxiety as a function of the type of landscape experienced through virtual reality, $\chi^2(4) = 79.387$, $p < .001$. The descriptive analysis of STAI change scores and the results of the Wilcoxon signed-rank test across the five experimental conditions can be found in Table 1. A positive value in the mean change variable indicates an increase in anxiety levels after the intervention, while a negative value reflects a decrease in these levels.

Table 1. Descriptive statistics and Wilcoxon signed-rank test results for changes in anxiety across the five experimental conditions.

Anxiety State Change Variable	*N*	*M*	*SD*	*Rank comparisons*
Green Landscape	65	-10.11	9.04	
Autumn Landscape	65	-7.38	9.39	$Z = -2.49$, $p = .013$*
Rainy Landscape	65	-.38	12.61	$Z = -6.04$, $p < .001$**
Arid Landscape	65	-.66	11.81	$Z = -6.22$, $p < .001$**
Urban Landscape	65	-3.34	8.52	$Z = -5.72$, $p < .001$**
Autumn Landscape	65	-7.38	9.39	

Anxiety State Change Variable	*N*	*M*	*SD*	*Rank comparisons*
Rainy Landscape	65	-.38	12.61	Z = -4.94, p < .001**
Arid Landscape	65	-.66	11.81	Z = -4.77, p < .001**
Urban Landscape	65	-3.34	8.52	Z = -4.29, p < .001**
Rainy Landscape	65	-.38	12.61	
Arid Landscape	65	-.66	11.81	Z = -.13, p = .898
Urban Landscape	65	-3.34	8.52	Z = -.86, p = .392
Arid Landscape	65	-.66	11.81	
Urban Landscape	65	-3.34	8.52	Z = -.55, p = .583

Note. p < .05 (*), p < .01 (**).

Wilcoxon signed-rank tests were conducted to compare anxiety reduction across conditions. The green landscape led to significantly greater reductions than the others. The autumn landscape also outperformed the rainy, arid, and urban landscapes in reducing anxiety. No significant differences were found between rainy and arid, rainy and urban conditions, or arid and urban conditions.

5. Discussion and conclusions

This study explored the impact of five types of virtual landscapes—green, autumn, rainy, arid, and urban—on state anxiety in university students. Findings revealed that not all natural environments are equally effective in reducing anxiety, challenging prior assumption that any exposure to nature—often narrowly understood as green spaces—universally promotes psychological well-being (Browning et. al., 2020, 2023; Hammoud et al., 2024; Jiménez et al., 2021).

In particular, the green landscape led to the most significant reduction in anxiety levels, followed closely by the autumn environment. Although both natural settings were effective, the slightly lower impact of the autumn landscape may be attributed to differences in color palette, vegetation density, or symbolic associations tied to seasonal change. Nevertheless, both types of natural environments significantly outperformed the rainy, arid, and urban landscapes in terms of effectiveness, supporting the idea that richly vegetated environments offer stronger restorative benefits (Dzhambov, 2018; Samus et al., 2022; Spano et al., 2023).

Conversely, the rainy, arid, and urban landscapes were considerably less effective, with some even associated with stable or slightly increased anxiety levels. This suggests that not all natural or outdoor environments are inherently beneficial. This finding could be related to the lack of restorative stimuli or negative cultural associations linked to these environments, such as loneliness, hostility, or sensory overload in urban settings.

Several limitations should be acknowledged. First, the use of a convenience sample may limit the generalizability of the findings. Second, although virtual reality provides high experimental control, it lacks the multisensory depth of real-world nature (Samus et al., 2022). Third, the study assessed only short-term effects (Yeo et al., 2020).

Future research should consider individual differences (e.g., nature connectedness or personality traits), which may influence responses to virtual environments. Longitudinal studies are also needed to examine the cumulative effects of repeated or prolonged exposure. Replicating the study in clinical, educational, or occupational settings would help determine the broader applicability of virtual nature interventions.

Moreover, future studies should investigate specific environmental features that drive the restorative effects of nature, such as color schemes, visual complexity, and soundscapes. Finally, combining physiological indicators of stress (e.g., heart rate variability, cortisol) with self-reported anxiety could offer a more comprehensive understanding of the underlying mechanisms (Spano et al., 2023).

In conclusion, the integration of virtual nature environments into educational contexts offers a promising, easily accessible tool for reducing anxiety in students. By providing students with an opportunity to engage with calming, nature-based experiences, universities can help mitigate the impact of academic stress, contributing to a healthier and more supportive learning environment.

5.1. Practical applications

Virtual nature exposure offers a promising, low-cost tool to manage student anxiety, particularly during high-stress periods like exams. Universities could integrate virtual nature breaks into wellness programs, offering short sessions of green or autumn-themed environments during study breaks or in designated relaxation spaces. This would provide students with an accessible, non-invasive way to manage anxiety and improve emotional well-being (Browning et. al., 2020).

Moreover, virtual nature could be incorporated into mental health strategies, available through mobile apps or campus spaces where students can access calming environments during times of personal stress. Educators might also use these virtual environments in classrooms, helping students to relax before exams or challenging tasks. Such interventions could complement mindfulness and resilience-building programs, supporting long-term emotional health.

References

Beiter, R., Nash, R., McCrady, M., Rhoades, D., Linscomb, M., Clarahan, M., & Sammut, S. (2015). The prevalence and correlates of depression, anxiety, and stress in a sample of college students. *Journal of Affective Disorders, 173,* 90-96. https://doi.org/10.1016/j.jad.2014.10.054

Browning, M. H. E. M., Mimnaugh, K. J., van Riper, C. J., Laurent, H. K., & LaValle, S. M. (2020). Can Simulated Nature Support Mental Health? Comparing Short, Single-Doses of 360-Degree Nature Videos in Virtual Reality With the Outdoors. *Frontiers in Psychology, 10*, 2667. https://doi.org/10.3389/fpsyg.2019.02667

Browning, M. H. E. M., Shin, S., Drong, G., et al. (2023). Daily exposure to virtual nature reduces symptoms of anxiety in college students. *Scientific Reports, 13,* 1239. https://doi.org/10.1038/s41598-023-28070-9

Dzhambov, A. M. (2018). Residential green and blue space associated with better mental health: A pilot follow-up study in university students. *Archives of Industrial Hygiene and Toxicology, 69*(4), 340-349. https://doi.org/10.2478/aiht-2018-69-3166

Freeman, D., Reeve, S., Robinson, A., Ehlers, A., Clark, D., Spanlang, B., & Slater, M. (2017). Virtual reality in the assessment, understanding, and treatment of mental health disorders. *Psychological Medicine, 47*(14), 2393-2400. https://doi.org/10.1017/S003329171700040X

Hammoud, R., Mechelli, A., et al. (2024). Smartphone-based ecological momentary assessment reveals an incremental association between natural diversity and mental wellbeing. *Scientific Reports, 14*, 55940. https://doi.org/10.1038/s41598-024-55940-7

Jiménez, M. P., DeVille, N. V., Elliott, E. G., Schiff, J. E., Wilt, G. E., Hart, J. E., & James, P. (2021). Associations between nature exposure and health: A review of the evidence. *International Journal of Environmental Research and Public Health, 18*(9), 4790. https://doi.org/10.3390/ijerph18094790

Maples-Keller, J. L., Bunnell, B. E., Kim, S.-J., & Rothbaum, B. O. (2017). The use of virtual reality technology in the treatment of anxiety and other psychiatric disorders. *Harvard Review of Psychiatry, 25*(3), 103-113. https://doi.org/10.1097/HRP.0000000000000138

Regehr, C., Glancy, D., & Pitts, A. (2013). Interventions to reduce stress in university students: A review and meta-analysis. *Journal of Affective Disorders, 148*(1), 1-11. https://doi.org/10.1016/j.jad.2012.11.026

Samus, A., Freeman, C., Van Heezik, Y., Krumme, K., & Dickinson, K. J. M. (2022). How do urban green spaces increase well-being? The role of perceived wildness and nature connectedness. *Journal of Environmental Psychology*, 100310. https://doi.org/10.1016/j.jenvp.2022.101850

Spano, G., Theodorou, A., Reese, G., Carrus, G., Sanesi, G., & Panno, A. (2023). Virtual nature and psychological and psychophysiological outcomes: A systematic review. *Journal of Environmental Psychology, 89*, 102044. https://doi.org/10.1016/j.jenvp.2023.102044

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). *State-Trait Anxiety Inventory (STAI)*. Consulting Psychologists Press.

Valmaggia, L. R., Latif, L., Kempton, M. J., & Rus-Calafell, M. (2016). Virtual reality in the psychological treatment for mental health problems: An systematic review of recent evidence. *Psychiatry Research, 236*, 189-195. https://doi.org/10.1016/j.psychres.2016.01.015

Yeo, N. L., White, M. P., Alcock, I., Garside, R., Dean, S. G., Smalley, A. J., & Gatersleben, B. (2020). What is the best way of delivering virtual nature for improving mood? An experimental comparison of high definition TV, 360° video, and computer generated virtual reality. *Journal of Environmental Psychology, 72,* 101500. https://doi.org/10.1016/j.jenvp.2020.101500