# Evaluating Design Parameters in Therapeutic Landscapes: The Role of Natural and Built Elements in Stress Reduction and Healing

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## Abstract

This study investigates the role of natural and built elements in therapeutic landscapes, focusing on their impact on stress reduction and healing. By employing virtual reality (VR) technology and physiological data collection via EmotiBit, the research evaluates how different environmental scenarios influence participants' stress levels and overall well-being. The findings highlight the importance of integrating natural sounds, seasonal aesthetics, and balanced architectural interventions in landscape design to promote mental and emotional health.
Keywords : EmotiBit, Stress reduction, Therapeutic landscapes, Virtual Reality (VR)

## Introduction

Mental health is particularly important today, as we live in a world of mental and emotional stress. Accordingly, the World Health Organization and clinical psychiatrists consider stress resulting from environmental crises to be the main cause of many physical diseases in modern humans (Dragioti et al. 2023).The World Health Organization defines stress as a state of mental tension or worry resulting from challenging situations, which reflects the natural human response to life's challenges and dangers. Since everyone experiences stress to some extent throughout their lives, the reaction to stress makes a big difference in overall well-being. Some stress can be beneficial in daily activities, but excessive stress leads to physical and mental problems (WHO 2023).

Over the past three decades, research has increasingly highlighted the restorative effects of natural environments on human well-being. Since Kaplan first described these benefits in 1989 (Kaplan and Kaplan 1989), it has been well established that natural settings are more effective than urban environments in reducing stress (Cao and Hsu 2021). Urban green spaces, in particular, play a vital role in promoting environmental sustainability and public health. They mitigate heat island effects, reduce air pollutants, enhance biodiversity, and lower noise levels (Bolund and Hunhammar 1999) (Allahyar and Kazemi 2021). Moreover, increased access to green spaces has been linked to higher life satisfaction and improved mental health (White et al. 2013); (Fleming, Manning, and Ambrey 2016).

Stress affects not only mental health but also physical well-being. Organs innervated by neural tissue or influenced by stress hormones experience increased metabolic rates under perceived stress, which can lead to malfunction if not addressed (McEwen 2007). Many diseases, including stress-related conditions like Irritable Bowel Syndrome (IBS), begin as stress-induced symptoms and can escalate into major health issues if left untreated (Seaward 2017). IBS, for example, is a

chronic digestive disorder characterized by abdominal pain, bloating, and changes in bowel habits, often exacerbated by stress, anxiety, and depression (Seaward 2017).

Given the growing recognition of the role of therapeutic landscapes in stress reduction and healing, this study investigates how specific design parameters—such as natural sounds, architectural interventions, and seasonal aesthetics—influence human well-being. By employing virtual reality (VR) technology and physiological data collection via EmotiBit, the research evaluates the impact of different environmental scenarios on participants' stress levels and overall wellness. The findings aim to inform the design of therapeutic landscapes that promote mental and emotional health, particularly in urban contexts where access to restorative environments is limited.

## Method and Data

In recent years, there has been a growing recognition of the significance of therapeutic landscapes in enhancing stress reduction and overall well-being. Designed therapeutic landscapes, which integrate a diverse array of natural elements and architectural features, have the potential to impact human health and wellness in varying ways. Accordingly, understanding how specific environmental factors impact the healing potential of these landscapes is important for designing spaces that optimize their therapeutic benefits.

By examining the interaction between natural elements, architectural features, and human well-being, this research aimed to evaluate the impact of various environmental scenarios on participants' stress levels and wellness. To achieve this, the study focused on four distinct scenarios: a green space without sound, a green space enhanced with natural sounds, a green space featuring architectural interventions, and a landscape rich with colourful flowers in autumn. These scenarios were carefully crafted to test how variations in natural and artificial elements influence stress levels and promote healing. Through the use of virtual reality (VR) technology and EmotiBit Bio-sensor, participants were virtually immersed in these four scenarios, allowing for the collection of real-time physiological data to assess their stress responses. By immersing participants in these immersive environments and monitoring their physiological responses in real-time, including parameters such as heart rate variability (HRV) and skin conductance, this investigation aimed to explore the therapeutic potential of each scenario.

The first step in experimenting was to equip participants with virtual reality goggles and EmotiBit sensor, providing them with the necessary tools to engage in the activity. In the second step, the process was explained to the participants, and it was ensured that they were comfortable with the equipment. This step not only included providing instructions on how to use the equipment but also ensuring that the participants felt comfortable.

The scenarios were shown to each participant randomly. Each scene lasted 3 minutes, and to avoid the long-term effects of one scenario on the next, a two-minute rest period was included between scenarios to allow the participants' physiological responses to return to baseline before moving on to the next scenario (Fu et al. 2022).

| Preparation | Method | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Introducing the experiment process and equipping participants with the necessary tools. | First scenario | | Second scenario | | Third scenario | | Fourth scenario | |
| | Rest | Experiencing VR. | Rest | Experiencing VR. | Rest | Experiencing VR. | Rest | Experiencing VR. |
| | 2 min | 3 min | 2 min | 3 min | 2 min | 3 min | 2 min | 3 min |

**Table 1. Testing process**

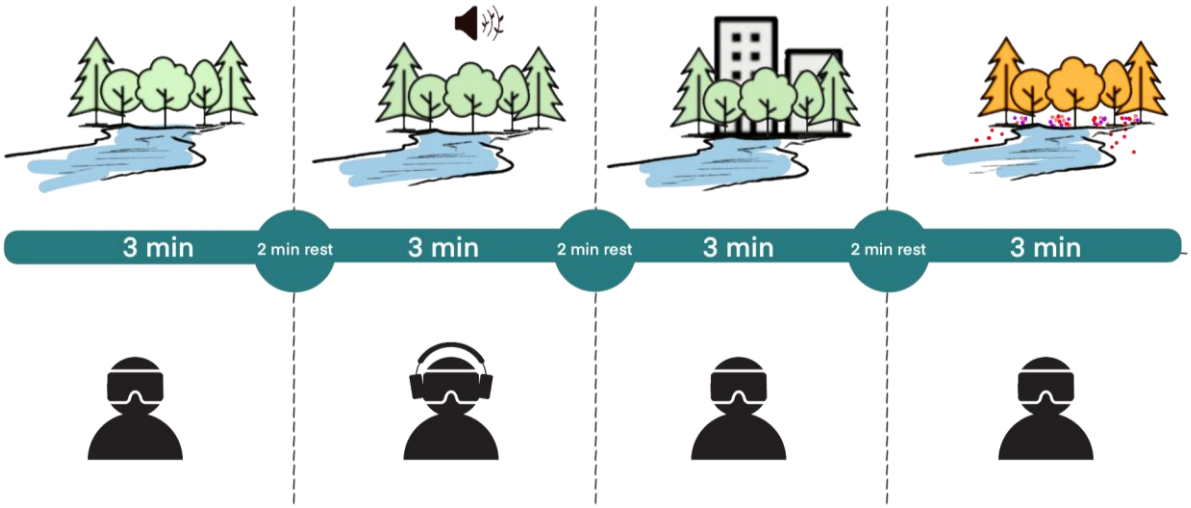


***Figure 1. Scenarios and testing process***

***Figure 2. 1st and 2nd scenarios***

***Figure 3. 3rd scenario***

***Figure 4. 4th scenario***

## Results

This study evaluated participants' physiological responses across four distinct virtual reality (VR) scenes, focusing on heart rate (HR) and skin conductance (SC) as key indicators of emotional and physiological states. Heart rate, measured in beats per minute (BPM), reflects cardiovascular responses, while skin conductance, measured in microsiemens (μS), indicates changes in autonomic nervous system activity, particularly arousal and stress levels. These parameters provide insights into how different environmental design elements influence stress, relaxation, and overall arousal.

### *Heart Rate (HR) Analysis*

According to Chart 1, Scene 2 (a green space with natural sounds) was identified as the most relaxing environment, as it was associated with the lowest heart rates among participants. This decrease in HR suggests that Scene 2 effectively promotes physiological relaxation, allowing individuals to feel more at ease. In contrast, Scene 3 (a green space with architectural interventions) was classified as the most stimulating scenario, with participants exhibiting the highest heart rates. This elevated HR indicates that Scene 3 contains elements—such as architectural complexity—that either stimulate the senses or induce stress, leading to heightened physiological arousal.

### *Skin Conductance (SC) Analysis*

The skin conductance data, presented in Chart 2, further supports these findings. Scene 2 consistently showed the lowest SC values, indicating that it was the most calming environment. The natural sounds in this scene likely contributed to a peaceful atmosphere, reducing participants' stress levels. Conversely, Scene 3 recorded the highest SC levels, suggesting that the architectural elements introduced visual complexity or sensory intensity, which increased physiological arousal and stress.

### *Gender Differences in Physiological Responses*

Chart 3 compares heart rates between girls and boys across the four scenes. In Scene 1 (a green space without sound), both groups exhibited similar HR levels, with boys showing slightly higher

values. This suggests that the absence of sound elicited a moderate physiological response, with minimal gender differences. In Scene 2, both groups showed lower HR compared to Scene 1, indicating that natural sounds had a calming effect on both genders. Scene 3 revealed the highest HR levels, with boys' HR slightly exceeding that of girls, likely due to the stimulating nature of the architectural elements. In Scene 4 (a landscape with colourful flowers in autumn), HR decreased again, suggesting a calming effect, though boys still displayed slightly higher HR than girls.

Chart 4 compares skin conductance levels between girls and boys. In Scene 1, both groups showed moderate SC levels, with boys exhibiting slightly higher values. Scene 2 saw a reduction in SC for both groups, indicating that natural sounds reduced arousal levels. Scene 3 recorded the highest SC levels, with boys showing notably higher values than girls, further supporting the idea that architectural interventions increase physiological arousal. In Scene 4, SC levels decreased again, aligning with the calming effects of colourful flowers and the autumn landscape.

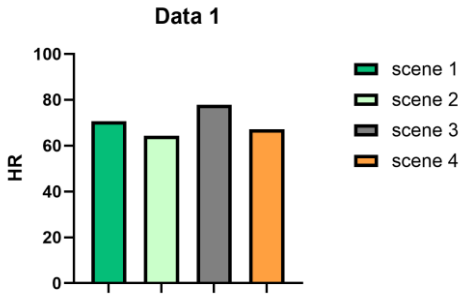


**Chart 1. Heart rate chart of participants across various scenes.**
**Scene 1: A green space without sound**
**Scene 2: A green space with natural sound**
**Scene 3: A green space with architectural interventions**

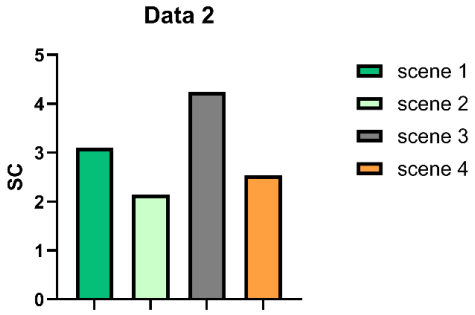


**Chart 2. Skin conductance chart of participants across various scenes.**
**Scene 1: A green space without sound**
**Scene 2: A green space with natural sound**
**Scene 3: A green space with architectural interventions**

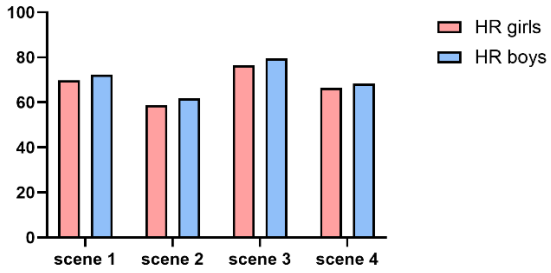


**Chart 3. Comparing heart rates of girls and boys across various scenes.**
**Scene 1: A green space without sound**
**Scene 2: A green space with natural sound**
**Scene 3: A green space with architectural interventions**
**Scene 4: A landscape with colorful flowers in autumn.**

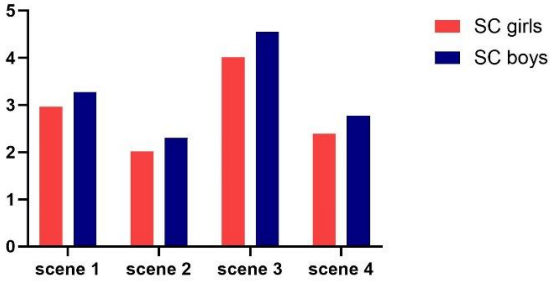


**Chart 4. Comparing Skin conductance of girls and boys across various scenes.**
**Scene 1: A green space without sound**
**Scene 2: A green space with natural sound**
**Scene 3: A green space with architectural interventions**
**Scene 4: A landscape with colorful flowers in autumn.**

## Discussion and Conclusion

This study highlights the significant role of thoughtfully designed landscapes in promoting healing and stress reduction. By examining various environmental design parameters—such as natural sounds, architectural interventions, and seasonal aesthetics—this research demonstrates how specific landscape elements contribute to mental and emotional well-being. The findings reveal that natural settings, particularly green spaces enriched with natural sounds (Scene 2), provide the most calming and restorative experiences, as reflected by participants' lower physiological stress markers. In contrast, environments with architectural interventions (Scene 3) elicit higher arousal, indicating the need to carefully consider built elements in therapeutic landscape design.

The use of virtual reality (VR) and EmotiBit devices in this study served as tools for immersing participants and collecting real-time physiological data, enabling a more precise evaluation of the healing potential of various landscape scenarios. However, the primary focus remains on the capacity of landscapes to foster relaxation and recovery through well-integrated natural and design elements. These results underscore the importance of incorporating natural sounds, visually engaging seasonal features, and balanced architectural interventions into landscape design, particularly in urban contexts where access to restorative environments can have a profound impact on public health. By aligning with the principles of therapeutic landscape design, urban planners and designers can create spaces that not only address mental health challenges but also contribute to a more sustainable and resilient urban environment.

## Future studies

This article investigates the impact of specific design parameters on healing experiences using virtual reality (VR) technology and physiological data collected via EmotiBit. For future studies, it is recommended that this approach be expanded by incorporating additional physiological and cognitive tools alongside VR and EmotiBit.

Specifically:

1. Electroencephalogram (EEG): Integrating EEG technology can provide valuable insights into brain activity and emotional states while participants interact with designed virtual environments. This will allow researchers to examine neural responses and better understand the cognitive impact of healing landscapes.
2. Eye Tracking: Eye-tracking technology can identify which visual elements in virtual scenarios attract the most attention or trigger physiological changes. This data can reveal how users interact with specific design features and help optimize stress reduction and healing environments.

Combining EmotiBit, EEG, and eye tracking with VR will create a more comprehensive framework for evaluating the impact of design parameters on healing. Such an approach can offer deeper insights into the relationship between visual, auditory, and emotional experiences, paving the way for designing more effective therapeutic environments.

**References**


Allahyar, Maryam, and Fatemeh Kazemi. 2021. "Effect of landscape design elements on promoting neuropsychological health of children." *Urban Forestry & Urban Greening* 65: 127333.

Bolund, Per, and Sven Hunhammar. 1999. "Ecosystem services in urban areas." *Ecological economics* 29 (2): 293-301.

Cao, Xin, and Yen Hsu. 2021. "RETRACTED: The Effects of Soundscapes in Relieving Stress in an Urban Park." *Land* 10 (12): 1323.

Dragioti, Elena, Joaquim Radua, Marco Solmi, Corentin J Gosling, Dominic Oliver, Filippo Lascialfari, Muhammad Ahmed, Samuele Cortese, Andrés Estradé, and Gonzalo Arrondo. 2023. "Impact of mental disorders on clinical outcomes of physical diseases: an umbrella review assessing population attributable fraction and generalized impact fraction." *World Psychiatry* 22 (1): 86-104.

Fleming, Christopher M, Matthew Manning, and Christopher L Ambrey. 2016. "Crime, greenspace and life satisfaction: An evaluation of the New Zealand experience." *Landscape and urban planning* 149: 1-10.

Fu, Erkang, Jiawen Zhou, Yuxin Ren, Xiaoyu Deng, Lin Li, Xinyun Li, and Xi Li. 2022. "Exploring the influence of residential courtyard space landscape elements on people's emotional health in an immersive virtual environment." *Frontiers in Public Health* 10: 1017993.

Kaplan, Rachel, and Stephen Kaplan. 1989. *The experience of nature: A psychological perspective*. Cambridge University Press.

McEwen, Bruce S. 2007. "Physiology and neurobiology of stress and adaptation: central role of the brain." *Physiological reviews* 87 (3): 873-904.

Seaward, Brian Luke. 2017. *Managing stress*. Jones & Bartlett Learning.

White, Mathew P, Ian Alcock, Benedict W Wheeler, and Michael H Depledge. 2013. "Would you be happier living in a greener urban area? A fixed-effects analysis of panel data." *Psychological science* 24 (6): 920-928.

WHO. 2023 "What is stress?". https://www.who.int/news-room/questions-and-answers/item/stress.