MASTERARBEIT | MASTER'S THESIS

Titel | Title

Seeing Green: How Different Forms of Nature Imagery Influence Emotional Well-Being and Aesthetic Experience

verfasst von | submitted by

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angestrebter akademischer Grad | in partial fulfilment of the requirements for the degree of

Master of Science (MSc)

Wien | Vienna, 2025

Studienkennzahl lt. Studienblatt | Degree programme code as it appears on the student record sheet:	UA 066 840
Studienrichtung lt. Studienblatt | Degree programme as it appears on the student record sheet:	Masterstudium Psychologie
Betreut von | Supervisor:	Univ.-Prof. Dipl.-Psych. Dr. Helmut Leder

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List of Abbreviations

AI: Artificial Intelligence

AIC: Akaike Information Criterion

AESTHEMOS: Aesthetic Emotions Scale

AReA: Aesthetic Responsiveness Assessment

ART: Attention Restoration Theory

BIC: Bayesian Information Criterion

CI: Confidence Interval

CNS: Connectedness to Nature Scale

EEG: Electroencephalography

EWB: Emotional Well-Being

ICSU: International Science Council

MANOVA: Multivariate Analysis of Variance

fMRI: Functional Magnetic Resonance Imaging

NA: Negative Affect

PA: Positive Affect

PANAS: Positive and Negative Affect Schedule

ROS: Restoration Outcome Scale

SD: Standard Deviation

SE: Standard Error

SRT: Stress Reduction Theory

STAI-S: State-Trait Anxiety Inventory – State Version

SWB: Subjective Well-Being

TABS: Tellegen Absorption Scale – German Version

VR: Virtual Reality

WHO: World Health Organization

1. Introduction

The modern city is not simply a backdrop for human life, but an active force that shapes our minds, bodies, and communities. As urbanization accelerates, with projections that 68 percent of the world's population will reside in cities by 2050 (United Nations Department of Economic and Social Affairs, 2018), the environments we inhabit are in constant flux. Urban living brings opportunities for connection, creativity, and economic advancement, but also introduces profound psychological and physiological challenges. The relentless pace, sensory overload, and scarcity of natural spaces have been linked to heightened rates of anxiety, depression, and diminished well-being (Lederbogen et al., 2011; Xu et al., 2023; Ochnik et al., 2024). Recent neuroscientific research reveals that city life can alter brain function, particularly in regions such as the amygdala, that are central to stress processing, suggesting that the stressful urban environment itself becomes inscribed in our neural architecture (Lederbogen et al., 2011; Sudimac et al., 2022).

In this context, the question of how to cultivate well-being in cities is not only a matter of individual adaptation, but a collective and urgent societal challenge. Cities are more than just collections of buildings and streets; they are living mosaics of human aspiration, creativity, and contradiction. Within their boundaries, the pulse of collective life beats—sometimes in harmony, often in tension—with the natural rhythms that shaped our species for millennia. Urban life, with its density and dynamism, offers unparalleled opportunities for connection, innovation, and cultural flourishing (Hansen & Macedo, 2021). Yet, as philosophers from Plato to contemporary urban thinkers have observed, the city is also a crucible for existential questions: How do we sustain not just bodies, but spirits, in environments that can feel both exhilarating and alienating (Copleston, 1989; Manser, 2015)?

Amid the concrete and commotion, the search for well-being becomes not merely a personal pursuit, but a collective challenge—one that asks how we might cultivate moments of presence, reflection, and belonging within the very fabric of urban existence (Hansen & Macedo, 2021). The city, in this sense, is not only a site of stress and depletion, but also a canvas for reimagining our relationship with nature, beauty, and each other. Philosophical traditions from both East and West have long recognized that harmony with the environment—whether through the Taoist ideal of living in accordance with the natural flow, or the biophilic urge to seek connection with living systems—is foundational to human flourishing (Wilson, 1984; Copleston, 1989; Hansen & Macedo, 2021).

In the twenty-first century, urban well-being may depend on our ability to weave nature, art, and meaning back into daily life, not as luxuries, but as vital threads of the urban tapestry. Whether through a glimpse of greenery, an encounter with public art, or the quiet contemplation of a leaf's pattern on a painted canvas, these micro-experiences offer more than momentary respite—they invite us to reinhabit our cities with curiosity, care, and a renewed sense of possibility. In this way, the pursuit of well-being in cities is as much about reclaiming our capacity for wonder as it is about mitigating stress, ultimately shaping environments that nurture both individual and collective life (Manser, 2015; Hansen & Macedo, 2021).

To address this challenge, the present study adopts a perspective that bridges urban philosophy to empirical psychology and aesthetics. Rather than viewing the city merely as a source of stress, this research seeks to illuminate how thoughtfully designed micro-interventions—rooted in the restorative and aesthetic potential of nature and art—might foster moments of well-being and reflection amid urban life. By systematically comparing the effects of plant photographs and biophilic artworks, and by considering the moderating influence of individual traits, this study aims to advance both theoretical understanding and practical strategies for enhancing urban well-being. The following section will outline the theoretical frameworks and empirical foundations that inform this approach.

Defining Well-being

Well-being stands at the very heart of human existence, underpinning not only our health but also the quality, depth, and meaning of our lives. The question of what it means to live well has occupied philosophers, physicians, and poets for millennia—from Aristotle's notion of *eudaimonia* as the ultimate aim of life to the holistic traditions of ancient India and China, which viewed health, happiness, and virtue as inseparable (Michalos & Weijers, 2017; Jarden, 2023). Today, scientific research affirms that well-being is not a luxury or an abstract ideal, but a vital determinant of both physical and mental health, longevity, and social functioning (WHO, 2025). Higher well-being is associated with greater resilience, healthier behaviors, and even reduced risk of disease, while diminished well-being is recognized as a risk factor for a wide range of disorders. In this sense, the pursuit and maintenance of well-being is both a personal and societal imperative.

Despite its centrality, well-being remains a complex and multifaceted concept, with no single definition universally accepted across disciplines (Bautista et al., 2023). In psychological research, a variety of frameworks have been developed to capture its different dimensions. The United States Centers for Disease Control and Prevention, for example, describe well-

being as “the presence of positive emotions and moods, the absence of negative emotions, satisfaction with life, fulfillment, and positive functioning” (Chutiyami et al., 2022). Other frameworks distinguish between hedonic and eudaimonic well-being, and between subjective and emotional well-being (SWB and EWB). The following section will introduce these distinctions and clarify how they inform the measurement and interpretation of well-being in this study.

Subjective Well-Being: Diener´s Empirical Approach

Among the most influential advances in the scientific study of well-being is the groundbreaking work of Ed Diener, who fundamentally shifted the field by moving away from abstract or normative debates about the “good life” toward empirically measurable constructs. Diener (1984) introduced the concept of subjective well-being (SWB), defining it as an individual’s overall evaluation of their life, grounded in their own perspective and experience. His model comprises three distinct but interrelated components: the frequency of positive affect, experiencing pleasurable feelings, the infrequency of negative affect, experiencing few unpleasant feelings, and cognitive evaluations such as life satisfaction or health satisfaction (Diener et al., 1999; Diener et al., 2018). This tripartite structure allowed well-being to be operationalized and measured with scientific rigor, making it possible to compare well-being across individuals, cultures, and interventions (For instance: Diener, 2009; Diener, 2009b; Diener, 2009c).

Diener’s approach was groundbreaking in that it recognized the centrality of the individual’s own perception: well-being, in this view, cannot be fully understood without asking people how they feel about their own lives. As he argued, “nobody can feel well in terms of well-being if they do not perceive their own life as good and meaningful.” This insight paved the way for decades of empirical research and underscored the importance of subjective experience as both an outcome and a driver of health, resilience, and flourishing. Importantly, Diener also insisted that the three components of SWB—*positive affect, negative affect*, and *life satisfaction*—are related but distinct and should be measured separately to capture the full complexity of well-being (Diener et al., 1999).

By providing clear definitions and robust measurement tools, Diener’s work enabled a new era of research that could systematically explore how urban environments, nature, art, and other factors shape the lived experience of well-being.

Traditions: Hedonic vs. Eudaimonic Well-being

The question of what it means to live well has animated philosophical inquiry for centuries, and modern psychological science continues to wrestle with this fundamental issue. Two major traditions—*hedonic* and *eudaimonic well-being*—provide distinct yet complementary lenses through which to understand human flourishing. The hedonic perspective, with roots in ancient Greek hedonism and later utilitarian thought, centers on the pursuit of pleasure, happiness, and the avoidance of pain. In psychological research, this tradition is operationalized as the maximization of positive emotions, the minimization of negative emotions, and cognitive appraisals of life satisfaction (Kahneman et al., 1999; Ryan & Deci, 2001). These dimensions closely align with two of three parts of the structure of subjective well-being, as articulated by Diener and colleagues, and reflect the everyday experience of happiness and contentment.

In contrast, the eudaimonic tradition, inspired by Aristotle's notion of living in accordance with one's true self or "daimon," emphasizes meaning, personal growth, and self-realization as the highest aims of life (Waterman, 1993; Ryff et al., 2021). Eudaimonic well-being is not simply about feeling good, but about being good at being oneself—developing one's potential, pursuing meaningful goals, exercising autonomy, and cultivating positive relationships. Empirical research has shown that these two forms of well-being are related but distinct: hedonic well-being is more closely tied to immediate pleasure and affective states, while eudaimonic well-being is linked to deeper fulfillment, psychological functioning, and long-term resilience (Ryan & Deci, 2001; Keyes et al., 2002; Ryff & Singer, 2008). This reflects the third component of Diener´s structure of SWB, life satisfaction.

Recent studies suggest that both approaches are necessary for a comprehensive understanding of well-being in contemporary urban life. While the pleasures of the moment can buffer stress and provide emotional uplift, the search for meaning and personal growth anchors individuals amid the flux and challenges of city living (Ryan & Deci, 2001; Ryff et al., 2021). In practice, most people find that a balance of hedonic enjoyment and eudaimonic purpose is essential for a life that is both satisfying and significant (Zeng & Chen 2020; Van Halem et al., 2024). This dual perspective informs the present study's approach to measuring and enhancing well-being through micro-interventions in the urban environment.

Emotional Well-Being: Affection and Reflection

Emotional well-being (EWB) occupies a central place within the broader landscape of well-being research, serving as both a core outcome and an essential pathway through which interventions can exert their effects. Traditionally, EWB focused on the balance of positive and negative affect—how frequently individuals experience pleasurable versus distressing emotions in daily life (Connolly & Gärling, 2024). This affective dimension closely aligns with the hedonic tradition and with Diener's model of subjective well-being as mentioned before, emphasizing the importance of emotional experience as a barometer of life quality and resilience.

However, contemporary frameworks have expanded the scope of EWB beyond momentary feelings to include deeper, reflective aspects of psychological functioning. Park et al. (2022, p.16), for example, propose that:

> *"Emotional well-being is a multi-dimensional composite that encompasses how positive an individual feels generally and about life overall. It includes both experiential features (emotional quality of momentary and everyday experiences) and reflective features (judgments about life satisfaction, sense of meaning, and ability to pursue goals that can include and extend beyond the self). These features occur in the context of culture, life circumstances, resources, and life course."*

This broader view recognizes that EWB is shaped not only by fleeting moods but also by enduring judgments about one's life, purpose, and capacity for growth—dimensions that resonate with both hedonic and eudaimonic perspectives.

While concepts of subjective and eudaimonic well-being are distinct but do not fully explain how changes in emotions translate into broader life improvements, such as longevity or life satisfaction, nor do they capture the complex interaction of emotional, cognitive, and value-driven factors. The present study targets emotional well-being (EWB) through micro-interventions in urban environments, acknowledging that even subtle emotional shifts can meaningfully reduce stress and enhance resilience and quality of life. By integrating both experiential and reflective aspects of EWB, the research explores how nature and art contribute to emotional restoration and flourishing in city settings, using Disabato et al.'s dynamic and integrative framework to show how small EWB interventions can elevate quality of life.

A Hierarchy Model of Well-Being

Moving beyond traditional models, recent advances in well-being science have introduced hierarchical frameworks that clarify the complex structure and interrelations of well-being constructs, much like models in intelligence or psychopathology research (Gallagher et al., 2009; Disabato et al., 2025). The Hierarchical Framework of Well-Being (HiFWB) organizes well-being into four nested levels. At the broadest level sits a singular, general factor—sometimes called the "h" factor—representing the experience of personally valued fulfillment in life (Disabato et al., 2025). Beneath this, multiple "lenses" or perspectives, such as subjective, psychological, and social well-being, offer broad vantage points for understanding flourishing. Each lens is further divided into specific content domains—like affect, appraisal, meaning-making, self-concept, community, and relationships—which ultimately break down into discrete, measurable characteristics such as positive affect, life satisfaction, purpose in life, self-esteem, and social support (Ryff & Keyes, 1995; Disabato et al., 2025).

This hierarchical organization not only clarifies how the many facets of well-being interconnect, but also mirrors the dynamic, multidimensional nature of psychological health: just as mental health is understood as an integration of emotional, cognitive, and social functioning, well-being emerges from the interplay of specific psychological assets and experiences. These frameworks provide a scientifically grounded map for understanding how well-being operates as both a core component and a predictor of overall health, and they set the stage for exploring its links to stress, resilience, and disease (Ryff & Keyes, 1995; Disabato et al., 2025).

Crucially, this layered view of well-being helps us recognize how micro-interventions—like brief encounters with nature photographs or biophilic artworks—can have ripple effects across different levels of the hierarchy. While such interventions may begin by shifting momentary affect or reducing state anxiety at the most granular level, their cumulative impact can extend upward: repeated experiences of positive emotion or restoration may gradually enhance broader domains such as life satisfaction, meaning, or social connectedness, and ultimately contribute to a more enduring sense of fulfillment. By targeting both the immediate and reflective aspects of well-being, micro-interventions offer a practical and scalable strategy for nurturing resilience and flourishing in the urban context, even when larger structural changes are out of reach.

Urban Well-Being and Health

The cumulative impact of urban stressors—such as air and noise pollution, overcrowding, social deprivation, and a lack of green spaces—has been firmly linked to higher rates of anxiety, depression, and stress-related illnesses among city dwellers (ICSU, 2011; Rüger et al., 2023; Xu et al., 2023; Ochnik et al., 2024; Cacciatore et al., 2025; WHO, 2025). However, well-being in the city is not only at risk from these adversities; it also serves as a crucial protective factor. Even modest improvements in emotional well-being, such as increased positive affect or reduced stress, are associated with lower symptoms of depression and anxiety, greater coping and resilience, and better physical health outcomes (Apers et al., 2023; Müller et al., 2023). For instance, higher well-being is linked to healthier behaviors, stronger immune function, and reduced risk for non-communicable diseases like heart disease and diabetes (WHO, 2025).

Recent neuroscientific research has begun to illuminate the biological pathways through which urban environments shape mental health. Functional magnetic resonance imaging (fMRI) studies have shown that city living is associated with increased activity in the *amygdala*—a brain region central to stress processing and emotional regulation—while urban upbringing can affect the *perigenual anterior cingulate cortex*, a key area for regulating negative affect (Lederbogen et al., 2011; Sudimac et al., 2022; Xu et al., 2023). Large-scale studies further reveal that specific urban environmental profiles—such as high social deprivation, pollution, and density—are correlated with psychiatric symptom groups, mediated by differences in brain regions involved in reward and emotion regulation (Xu et al., 2023). Notably, access to green spaces and natural environments can buffer these neural and psychological risks: even brief exposure to nature, compared to urban settings, has been shown to decrease amygdala activity, supporting stress recovery and potentially lowering the risk of stress-related disorders (Sudimac et al., 2022; 2024).

With greater well-being, city dwellers show lower stress reactivity, improved emotion regulation, and enhanced resilience to the negative effects of urban living, including social isolation and environmental stress (Rüger et al., 2023; Xu et al., 2024). This highlights the importance of designing interventions that can foster well-being even in densely built environments with limited space. The present study focuses on micro-interventions—such as visual exposure to nature and art—that are accessible, scalable, and capable of supporting urban well-being by acting potentially on both psychological and neurobiological levels.

Nature Exposure and Well-being

The question of why contact with nature increases our well-being has been researched. The *biophilia hypothesis*, first articulated by Edward O. Wilson in 1984, posits that humans possess an innate tendency to seek connections with nature and other forms of life (Wilson, 1984; Kellert & Wilson, 1993; Grinde & Patil, 2009). This evolutionary perspective suggests that our affinity for the natural world is deeply rooted in our biology and has played a crucial role in shaping our psychological and emotional well-being (Kellert & Wilson, 1993; Grinde & Patil, 2009; Gaekwad et al., 2022). *Biophilia* is not simply a preference, but a fundamental aspect of human nature, manifesting as a drive to affiliate with life and lifelike processes. In the context of modern urban living—where direct access to nature is often limited—this intrinsic need for nature may remain unfulfilled, with potential consequences for mental health and well-being (Wilson, 1984; Hall & Knuth, 2019, Menzel at al., 2024a).

Two influential theoretical frameworks rooted in biophilia hypothesis explain these effects. *Attention Restoration Theory* (ART) (Kaplan & Kaplan, 1989; Kaplan, 1995) posits that natural environments provide a unique form of cognitive respite by engaging our involuntary, effortless attention through qualities such as "fascination," "being away," "extent," and "compatibility." This process allows our directed attention, often fatigued by urban demands, to recover—leading to improved concentration, reduced mental fatigue, and greater psychological restoration (Kaplan, 1995; Marois et al., 2021; Rhee et al., 2023). Recent meta-analytic efforts demonstrated that the evidence is diverse, and found confirmation for recovering attention in some, but not all attentional exercises (Ohly et al., 2016). *Stress Recovery Theory* (SRT) (Ulrich, 1983) complements this by emphasizing the immediate emotional and physiological responses to nature: exposure to natural scenes triggers positive affect, lowers physiological arousal (such as heart rate and blood pressure), and promotes relaxation, supporting rapid recovery from stress (Ulrich, 1983; Ulrich et al., 1991; Hartig et al., 2014).

Importantly, neuroscientific research has begun to reveal the biological mechanisms underlying these restorative and stress-reducing effects. FMRI studies show that even short exposures to nature—such as a one-hour walk in a forest or viewing natural scenes—lead to decreased activity in the amygdala, a brain region central to stress processing and emotional regulation (Kühn et al., 2021; Sudimac et al., 2022). EEG and neuroimaging studies further demonstrate that nature exposure enhances rhythmic brain activity associated with attention and cognitive flexibility and increases functional connectivity in brain networks related to

self-regulation and restoration including the *default mode network*, *executive control network* and *salience network* (Jimenez at al., 2021). These changes in brain activity correspond with participants' self-reports of feeling restored, less stressed, and more attentive after nature exposure (Jimenez et al., 2021; Sudimac et al., 2022). Additionally, exposure to nature has been associated with lower blood pressure, improved mood, and reduced symptoms of depression and anxiety in both experimental and observational studies (Repke et al., 2018; White et al., 2019; Shude et al., 2020; Jimenez et al., 2021).

Crucially, these restorative and stress-reducing effects are not limited to physical immersion in natural settings. Even brief visual exposure to photographs or videos of nature can evoke measurable improvements in mood, reductions in anxiety and tension, and enhanced cognitive functioning (Elsadek et al., 2019; Hall & Knuth, 2019; Menzel et al., 2024a). This is supported by both self-report and physiological data, with research showing that viewing tree-dense landscapes or greenery—even in image form—can reduce negative feelings such as tension, depression, and confusion, and foster psychological restoration (Astell-Burt & Feng, 2019; Elsadek et al., 2019). Thus, integrating visual nature exposure into daily urban environments offers a practical, evidence-based strategy to support emotional well-being and resilience to urban stressors, even where real green space is scarce. For the present study, ART and SRT offer key explanations of the fundamental biological mechanisms at play when visual contact with nature enhances our well-being.

Art Viewing and Well-being

While nature offers one pathway to urban well-being, the human capacity for aesthetic experience provides another fundamental avenue for restoration and flourishing amid city life. Throughout history, art has served not merely as decoration or entertainment, but as a catalyst for profound emotional and psychological transformation—a recognition that finds increasing support in contemporary neuroscience and empirical psychology. Research demonstrates that engagement with visual art, whether through active creation or passive appreciation, can reduce stress, alleviate symptoms of anxiety and depression, and promote positive emotional states (Law et al., 2021; Mastandrea et al., 2019; Mikuni et al., 2024).

The neurobiological mechanisms underlying art's therapeutic effects reveal why aesthetic experiences can be so powerful for urban well-being. Neuroimaging studies show that viewing a beautiful artwork activates the brain's reward system, particularly the *orbitofrontal cortex* and *ventral striatum*, triggering dopamine release and generating feelings of pleasure and satisfaction like other rewarding experiences (Kawabata & Zeki, 2004; Ishizu & Zeki,

2011; Mastandrea et al., 2019). Simultaneously, engagement with art can reduce activity in stress-related brain regions, including the *amygdala* and *insular cortex*, while enhancing connectivity within emotion regulation networks and the default mode network associated with self-referential processing and introspection (Cela-Conde et al., 2013; Bolwerk et al., 2014). These neural changes correspond to measurable reductions in cortisol levels and improvements in mood, suggesting that art exposure operates through both psychological and physiological pathways to support well-being (Mastandrea et al., 2019).

However, recent systematic reviews reveal that while art's benefits are genuine, effect sizes tend to be modest, with only a fraction of well-controlled studies showing statistically significant improvements compared to control conditions (Trupp et al., 2025). Despite this limitation, even brief art-viewing sessions can foster meaning in life, encourage personal growth, and enhance both hedonic and eudaimonic well-being, making visual art a potentially scalable and accessible intervention for urban environments (Trupp et al., 2025; Law et al., 2021). The capacity for art to activate multiple neural systems—from sensory processing to emotional regulation to reward—suggests that thoughtfully integrated artistic interventions in public spaces, healthcare settings, and urban design could serve as vital micro-experiences that support collective resilience and individual flourishing in the modern city.

Aesthetic Experience as a Pathway to Well-being

In the urban context, where daily life is often shaped by utility, routine, and sensory overload, the experience of art offers a rare opportunity to step outside the ordinary and encounter the world anew. Aesthetic experience is fundamentally distinct from everyday perception. While pragmatic concerns guide our usual interactions, aesthetic experience involves a qualitative shift: the object of attention becomes a source of fascination, symbolic meaning, and emotional resonance (Marković, 2012; Menninghaus et al., 2019). This shift is not merely about liking or preference but entering a heightened state of awareness—one marked by openness, reflection, and the capacity to be moved or transformed.

According to Marković (2012), aesthetic experience is structured by three core components: aesthetic fascination, aesthetic appraisal, and aesthetic emotion. Aesthetic fascination describes the exceptional attention and arousal directed toward an aesthetic object, while aesthetic appraisal involves deep cognitive engagement with its symbolic or compositional qualities. This engagement can transform even everyday objects into personal "objects of beauty," as preference and meaning merge through reflection and insight. The emotions that arise from this interplay—such as awe, beauty, being moved, joy, or even sadness—are

collectively known as aesthetic emotions and are central to the distinctive power of art (Schindler et al., 2017b; Marković, 2012).

The influential information-processing model of aesthetic appreciation developed by Helmut Leder and colleagues presents a nuanced account of how individuals engage with art and aesthetics, shedding light on the dynamic relationship between cognitive and affective processes as they relate to well-being. According to Leder's framework, the aesthetic experience unfolds across five interrelated stages: perceptual analysis, implicit memory integration, explicit classification, cognitive mastering, and evaluation. Rather than a strict linear progression, these processes are characterized by flexible feedback loops, allowing ongoing interaction between attention, interpretation, emotion, and personal meaning (Leder et al., 2004).

Central to the model—and its relevance for well-being—is the idea that aesthetic experience is inherently dialogical: cognitive understanding and emotional engagement not only co-occur but reciprocally influence one another. The process begins with the immediate, largely automatic perceptual response to an artwork, encompassing elements like color, contrast, and symmetry. As the experience deepens, implicit and explicit memory processes come into play, drawing on prior knowledge, familiarity, and prototypicality to frame further interpretation. These layers feed into explicit classification and cognitive mastering, through which the viewer generates hypotheses about meaning, style, and personal relevance. Importantly, the evaluation phase serves as both a checkpoint and a catalyst—prompting returns to earlier stages whenever ambiguity remains, and driving the search for clarity, coherence, and satisfying resolution (Leder et al., 2004).

This feedback-rich architecture is intrinsically rewarding; successful cognitive mastery—when an artwork's meaning or stylistic nuances are apprehended—activates positive affect and sustains intrinsic motivation, offering a self-reinforcing source of pleasure and engagement. Leder's model thus accounts for the "flow" states often described in aesthetic contexts—moments when focused attention, emotional resonance, and cognitive insight converge to produce a heightened sense of fulfillment (Csikszentmihalyi, 1999; Leder et al., 2004). Rather than being merely decorative or recreational, such experiences are deeply tied to well-being: they foster resilience, stimulate curiosity, and support reflective capacities that underpin both hedonic and eudaimonic aspects of flourishing.

Neuroscientific research has begun to map these processes onto specific brain regions, revealing why aesthetic experience can be so impactful for well-being. The orbitofrontal

cortex encodes the hedonic value of aesthetic stimuli and is reliably activated during experiences of beauty or pleasure in response to art and nature (Kawabata & Zeki, 2004; Zeki, 2013; Yang et al., 2021). The ventromedial prefrontal cortex and anterior cingulate cortex integrate emotional and cognitive information, supporting the appraisal and meaning-making aspects of aesthetic experience (Smith et al., 2010; Yang et al., 2021). The insula and posterior cingulate cortex contribute to the intensity and self-referential quality of aesthetic emotions, while the ventral striatum is implicated in reward and motivation, releasing dopamine during pleasurable encounters with art (Wang, 2025; Schindler et al., 2017b).

Through this unique combination of attentive focus, deep appraisal, and rich emotional response, aesthetic experience offers a pathway to well-being that is especially valuable in urban environments. By inviting moments of wonder, reflection, and connection—whether through public art, gallery visits, or even brief encounters with beauty in daily life—aesthetic experience can help city dwellers reclaim their capacity for presence and meaning amid the noise of the metropolis.

State of the research

A robust body of research demonstrates that both viewing images of nature and engaging with visual art can elicit measurable improvements in emotional well-being, even when exposure is brief and occurs in urban or indoor environments. Several experimental and meta-analytic studies have shown that viewing photographs of natural environments reliably reduces stress, improves mood, and enhances cognitive functioning, supporting both the biophilia hypothesis and the ART and SRT frameworks (Kaplan, 1995; Grinde & Patil, 2009; Hall & Knuth, 2019; Menzel et al., 2024a; Ulrich et al., 1991; Elsadek et al., 2019; Mostajeran et al., 2021; Astell-Burt & Feng, 2019). These benefits are observed in both self-report and physiological measures, including reductions in anxiety, blood pressure, and heart rate, and are present even in populations with limited access to real nature (Elsadek et al., 2019; Astell-Burt & Feng, 2019; Liu et al., 2021; van den Berg et al., 2015). Neuroscientific studies show that viewing images of nature reduces activation in stress-related brain regions, such as the amygdala (Kühn et al., 2021; Sudimac et al., 2022), while enhancing connectivity within networks responsible for self-regulation and restoration (Jimenez et al., 2022). This exposure also increases rhythmic brain activity, such as alpha oscillations, which are associated with relaxation and decreased arousal. Furthermore, functional connectivity within the distress network (e.g., left insula and subgenual anterior cingulate cortex) decreases during

nature image viewing, correlating with reductions in negative mood and perceived stress (Jimenez et al., 2022).

However, recent reviews and meta-analyses report that the effect sizes for these well-being improvements are small, with Cohen's f ranging from 0.15 to 0.25 for nature photographs (Menzel et al., 2024a; Hall & Knuth, 2019).

Parallel evidence from empirical aesthetics indicates that viewing visual art—whether in galleries, public spaces, or healthcare settings—can also reduce stress, alleviate symptoms of anxiety and depression, and promote positive emotional states (Mastandrea et al., 2019; Law et al., 2021; Mikuni et al., 2024). Art-viewing is associated with the activation of brain regions involved in emotion regulation and reward, supporting mood enhancement and emotional balance (Mastandrea et al., 2019). Recent systematic reviews confirm that even brief art-viewing sessions can enhance both hedonic and eudaimonic well-being, including life meaning and personal growth, but the reported effect sizes are small (f ~0.10–0.12), and many outcomes do not reach statistical significance compared to control conditions (Trupp et al., 2025).

Despite these advances, there are currently no studies that directly compare the effects of plant photographs and biophilic artworks on EWB. Most research on the well-being effects of nature imagery uses control groups exposed to unattractive images or photographs of random urban scenes, rather than comparing nature photographs with artworks or biophilic art (Grinde & Patil, 2009; Mostajeran et al., 2021; Menzel et al., 2024a). The term *biophilic art* refers to visual artworks that intentionally incorporate natural forms, patterns, or imagery to evoke the restorative and emotionally positive qualities associated with nature exposure. While the concept of biophilic art is increasingly discussed in architecture and design, empirical research in these fields has focused primarily on biophilic design in workspaces and urban planning, often demonstrating positive associations with occupant satisfaction, stress reduction, or perceived well-being, but rarely using validated psychological measures of emotional well-being, mood, or aesthetic experience (Xing et al., 2025; Hung & Chang, 2021; Chang et al., 2020; Hall & Knuth, 2019). To date, **no peer-reviewed studies have systematically examined the psychological well-being effects of biophilic artworks, nor have any studies directly compared biophilic art to plant photographs**.

This is a crucial gap, as the combination of art and nature imagery—biophilic art—may offer unique or even synergistic benefits that exceed the effects of viewing art or nature photos alone. The central idea of this study is to investigate whether the integration of artistic and

natural elements in biophilic artworks can create a more powerful micro-intervention for urban well-being than either modality by itself. By providing the first controlled comparison of plant photographs and biophilic artworks using established psychological measures, this research aims to illuminate not only the relative effects of these modalities but also the mechanisms and individual differences that may moderate their impact. Addressing these questions is essential for developing targeted, evidence-based interventions that maximize well-being in urban populations, especially where access to real green space is limited.

Interindividual differences In Well-being Effects

Moreover, the field has only begun to address the role of interindividual differences in moderating these effects. Traits such as aesthetic responsiveness, absorption and connectedness to nature have been identified as potential moderators, with preliminary evidence suggesting that individuals high in these traits may derive greater well-being benefits from both nature imagery and art (Schindler et al., 2017b; Schlotz et al., 2020; Gaekwad et al., 2022; Koivisto & Grassini, 2022; Golbabaei et al., 2024;). However, the mechanisms by which these traits interact with different aesthetic modalities remain poorly understood. By conducting a trait analysis together with the well-being effects in our intervention, we can potentially gain insight into how these interventions benefit us.

Aesthetic responsiveness

Aesthetic responsiveness refers to an individual's dispositional capacity to respond to aesthetic stimuli—such as art, music, or nature—with cognitive, emotional, behavioral, and physiological reactions. It is considered a stable personality trait that varies across individuals, influencing how deeply and frequently one is affected by aesthetic encounters (Sabadosh, 2015; Schlotz et al., 2021). This trait encompasses not only the ability to notice and appreciate beauty but also the propensity to experience intense emotional or transformative reactions in response to aesthetic objects or environments (Schlotz et al., 2021). It encompasses three core dimensions: aesthetic appreciation being the ability to recognize and value beauty, intense aesthetic experience is the propensity to be deeply affected or even transformed by aesthetic encounters, and creative behavior as engagement in creative or artistic activities (Schindler et al., 2017b).

Aesthetic responsiveness is closely linked to the concept of aesthetic experience.
While *aesthetic experience* describes the qualitative, immersive state that arises during deep engagement with an aesthetic object—marked by fascination, appraisal, and the elicitation of

aesthetic emotions—*aesthetic responsiveness* determines the likelihood, intensity, and richness of such experiences for a given individual (Schlotz et al., 2021). In other words, those with high aesthetic responsiveness are more likely to be captivated by aesthetic stimuli, to feel moved or inspired, and to derive meaning and pleasure from these encounters.

The consequences of possessing high versus low aesthetic responsiveness are significant and multifaceted. Individuals with high aesthetic responsiveness tend to experience more frequent and intense aesthetic emotions, such as awe, beauty, or being moved, which are associated with greater psychological well-being, increased positive affect, and even enhanced cognitive and creative functioning (Sabadosh, 2015; Schlotz et al., 2021). They are more likely to benefit from interventions involving art or nature imagery, as their heightened sensitivity allows them to absorb and be restored by such stimuli. Conversely, those with low aesthetic responsiveness may find aesthetic experiences less impactful or emotionally resonant, potentially missing out on the well-being and restorative benefits that art and nature can provide (Schlotz et al., 2021).

Absorption

Absorption is a personality trait and mental state characterized by deep mental involvement, intense focus, and a sense of complete immersion in an activity or experience, often leading to a loss of self-awareness and altered perception of time and surroundings (Tellegen & Atkinson, 1974; Jamieson, 2005). In the context of aesthetic experience, absorption has been identified as a potential moderator of the well-being effects resulting from viewing artworks or nature photographs. This trait reflects the disposition to become fully engrossed in visual or sensory stimuli, which can amplify the intensity and quality of aesthetic engagement (Marković, 2012; Schindler et al., 2017b).

Empirical research demonstrates that absorption is closely linked to the experience of awe and other positive emotions during aesthetic encounters. For example, Ballew and Omoto (2018) found that a brief experience in a natural environment significantly enhanced feelings of awe and positive emotions, with absorption mediating the relationship between nature exposure and these emotional benefits. Their mediation model explained a substantial portion of the variance in awe, indicating that the positive emotional effects of nature are largely driven by the degree to which individuals feel captivated and fully involved in their surroundings (Van Elk et al., 2016; Ballew & Omoto, 2018). Similarly, absorption has been shown to predict stronger feelings of awe during aesthetic experiences, regardless of the stimulus type (Van Elk et al., 2016).

Neuroscientific evidence further supports the role of absorption in aesthetic experience. Individuals high in absorption exhibit enhanced neural processing of emotional and aesthetic stimuli, as reflected in increased late positive potential amplitudes in response to emotional images, indicating greater emotional engagement (Benning et al., 2015). Functional neuroimaging studies have also shown that aesthetically appealing visual experiences engage brain regions involved in affective and self-referential processing, such as the ventromedial prefrontal cortex and the anterior cingulate cortex, which are associated with deep immersion and emotional resonance (Mastandrea et al., 2019; Yang et al., 2021). These findings suggest that absorption not only intensifies subjective aesthetic experience but also modulates underlying neural responses, thereby potentially amplifying the well-being benefits derived from viewing art or nature imagery.

Connectedness to nature

Connectedness to nature is defined as the degree to which individuals feel a sense of emotional, cognitive, and experiential affiliation with the natural world, reflecting a trait-like sense of belonging and identification with nature (Mayer & Frantz, 2004). While most research has focused on direct contact with nature, recent findings indicate that connectedness to nature also shapes how people respond to visual representations of nature, such as photographs and biophilic artworks. Individuals with higher trait connectedness to nature report greater pleasure, positive affect, and aesthetic emotion when viewing images of natural environments, even in the absence of real nature exposure (Harrison, 2023; Mayer & Frantz, 2004).

A closely related construct is *nature relatedness*, which also describes cognitive, affective, and experiential aspects of one's relationship with nature. While the terms are sometimes used interchangeably in the literature, some researchers distinguish *connectedness to nature* as focusing more on the emotional and experiential sense of unity with nature, whereas nature relatedness includes a broader range of cognitive beliefs, attitudes, and behaviors toward the environment (Nisbet et al., 2009). Both constructs are robust predictors of well-being and pro-environmental behavior, and they tend to overlap strongly in empirical studies, though subtle conceptual differences remain (Mayer & Frantz, 2004; Nisbet et al., 2009). This study is concerned with micro-restorative experiences which, due to their nature, do not provide far-reaching cognitive consequences, but are designed to have a short-term, emotional effect. Hence, we use *connectedness to nature*.

2. Proposed model

As outlined in the previous sections, substantial research demonstrates that brief visual exposure to both nature photographs and artworks can independently confer psychological benefits, including reduced stress, enhanced mood, and improved well-being (Hall & Knuth, 2019; Law et al., 2021; Menzel et al., 2024). However, these interventions consistently show different effect magnitudes. Nature photographs typically demonstrate stronger well-being effects (Cohen's f ~0.15-0.25) compared to visual artworks (f ~0.10-0.12), primarily due to the restorative potential that nature imagery provides through established mechanisms outlined in ART, SRT, and the biophilia hypothesis (Ulrich et al., 1991; Kaplan, 1995; Grinde & Patil, 2009; Trupp et al., 2025; Menzel et al., 2024).

The superior well-being effects of nature photographs can be attributed to their capacity to engage specific restorative processes. According to ART, natural scenes provide cognitive respite through fascination, being away, extent, and compatibility, allowing directed attention to recover from urban demands (Kaplan, 1995). SRT emphasizes the immediate emotional and physiological responses to nature, including positive affect and reduced arousal that promote stress recovery (Ulrich et al., 1991). The biophilia hypothesis suggests these effects stem from our innate affinity for natural environments, making nature imagery particularly effective for psychological restoration (Wilson, 1984; Grinde & Patil, 2009). Neuroscientific evidence further supports these mechanisms, showing that nature exposure reduces amygdala activity and enhances connectivity in attention and emotion regulation networks (Sudimac et al., 2022; Kühn et al., 2021).

While visual artworks also provide well-being benefits through aesthetic experience—characterized by fascination, deep appraisal, and aesthetic emotions such as beauty, awe, and being moved (Marković, 2012; Schindler et al., 2017b)—these effects appear to be smaller in magnitude than those produced by nature imagery. However, biophilic artworks represent a unique intervention that intentionally combines natural imagery with artistic expression. Theoretically, these works might carry the restorative potential of nature photographs together with the aesthetic and emotional value that art provides for certain individuals, potentially creating a synergistic effect that exceeds either modality alone. Since no empirical research has directly compared these stimulus types, the nature and magnitude of any differences remain unclear.

The effectiveness of both interventions is likely moderated by individual differences in aesthetic responsiveness, absorption, and connectedness to nature. Based on established

literature, individuals high in aesthetic responsiveness should experience greater well-being benefits from both stimulus types due to their enhanced capacity to respond to aesthetic stimuli with intense emotional and cognitive reactions (Schlotz et al., 2020). Similarly, those high in absorption should derive greater benefits through their ability to become deeply immersed in visual experiences, amplifying both restorative and aesthetic effects through enhanced emotional engagement (Ballew & Omoto, 2018; Benning et al., 2015). Finally, individuals with stronger connectedness to nature should show enhanced responses to nature-themed imagery due to their heightened attention to and appreciation of natural elements, regardless of artistic presentation (Harrison, 2023; Mayer & Frantz, 2004).

Research Questions and Hypotheses

While extensive research has examined the well-being effects of nature imagery and art separately, no studies have directly compared plant photographs with biophilic artworks using validated measures of emotional well-being and aesthetic experience. The present study addresses this gap by examining both the comparative effectiveness and underlying mechanisms of these visual interventions. The following research questions are therefore posed:

- **RQ1:** Do plant photographs and biophilic artworks differ in their effects on emotional well-being, as measured by changes in positive and negative affect and state anxiety?
- **RQ2:** Do plant photographs and biophilic artworks elicit different patterns of aesthetic emotions and perceived restoration?
- **RQ3:** Do individual differences in aesthetic responsiveness, absorption, and connectedness to nature moderate the well-being effects of viewing plant photographs versus biophilic artworks?

The findings will provide crucial insights into the mechanisms underlying nature-based and art-based interventions for urban well-being. Understanding which aesthetic modalities elicit specific types of emotional and restorative responses can inform evidence-based decisions about visual intervention placement in urban environments. For example, if plant photographs primarily elicit restoration-related emotions while biophilic artworks generate broader aesthetic emotions, this could guide whether to use photographic nature imagery in high-stress environments such as hospital waiting areas versus artistic nature representations in spaces designed for creative engagement such as community centers or cultural districts.

Based on the theoretical foundations and empirical evidence presented, the following hypotheses are posed:

- **H1: There will be a significant difference in EWB outcomes (positive affect, negative affect, and state anxiety as measured by PANAS and STAI-S) between participants viewing plant photographs versus biophilic artworks.**
  While the direction of this difference cannot be predicted from existing literature, it is expected based on the distinct mechanisms underlying restorative versus aesthetic experiences.

- **H2: Plant photographs and biophilic artworks will elicit significantly different patterns of aesthetic emotions, measured by AESTHEMOS and perceived restoration, measured by ROS.**
  Specifically, plant photographs are expected to generate stronger restoration-related responses, while biophilic artworks should elicit a broader range of aesthetic emotions. The ROS, which captures aspects of eudaimonic well-being through reflection and cognitive clearing, may show differential responses between conditions.

- **H3.1: Higher levels of aesthetic responsiveness, absorption, and connectedness to nature will predict greater improvements in well-being outcomes (positive affect, negative affect, state anxiety) across both conditions.**
  Individuals with higher aesthetic responsiveness, measured by AReA will experience significantly greater well-being benefits from both viewing conditions, as their enhanced capacity to respond to aesthetic stimuli should amplify the emotional and cognitive effects of both plant photographs and biophilic artworks (Schlotz et al., 2020). Individuals with higher absorption measured by TABS will experience significantly greater well-being benefits from both viewing conditions, as their propensity for deep immersion should intensify both the restorative effects of nature imagery and the aesthetic effects of artistic representation (Ballew & Omoto, 2018; Benning et al., 2015). Individuals with higher connectedness to nature measured by CNS will experience significantly greater well-being benefits from both viewing conditions, as their stronger emotional and cognitive affiliation with the natural world should enhance their responses to nature-themed imagery regardless of aesthetic modality (Harrison, 2023; Mayer & Frantz, 2004).

- **H3.2: *Connectedness to nature* predicts perceived restoration after exposure to both plant photographs and biophilic artworks.**

This trait has been shown to enhance the restorative impact of nature-related stimuli by increasing attentional engagement, emotional resonance, and perceived meaning during exposure. Therefore, it is hypothesized that individuals with higher connectedness to nature measured by CNS will report greater perceived restoration after viewing both plant photographs and biophilic artworks, as their intrinsic affinity for nature amplifies the restorative qualities present in both types of visual interventions.

3. Methods

Study Design

This experiment was conducted within the "Urban Art and Green" project at the University of Vienna (Faculty of Psychology, EVA Lab), which investigates the effects of art and greening interventions on urban well-being. The present study aimed to validate field findings on the well-being effects of urban greenery and art in a controlled laboratory setting.

A between-group experimental design was used. Participants were randomly assigned to view either plant photographs (photo condition) or artworks depicting plants (art condition). Apart from the presented stimuli, the procedure was identical for both groups. Stimuli were shown in a randomized design alternating between conditions for each trial, and the order of images within each group was randomized.

The main independent variable was **aesthetic condition** (photos vs. artworks). For Hypothesis 1, the dependent variables were **PA** and **NA** (measured by the Positive and Negative Affect Scale, PANAS) and **state anxiety** (measured by the State-Trait Anxiety Inventory-State, STAI-S), with anxiety serving as a proxy for stress. For Hypothesis 2, the dependent variables were **aesthetic experience** (measured by AESTHEMOS) and **perceived restoration** (measured by the Restoration Outcome Scale, ROS). For exploratory analyses, trait measures—Connectedness to Nature Scale (CNS), Aesthetic Responsiveness Assessment (AReA), and Tellegen Absorption Scale (TABS)—were included as potential moderators.

This design allows for a direct comparison of the emotional and restorative effects of nature photographs and biophilic artworks, while also enabling examination of how individual differences in nature connectedness, aesthetic responsiveness, and absorption may moderate these effects.

Participants

The sample consisted of adults of all genders aged 18 to 40, a range chosen to control for age-related effects and to minimize the risk of age-related vision loss that could impact engagement with visual stimuli while also bearing greater risk for mental health (Burmedi et al., 2002). To ensure that all participants could fully experience the images, only individuals with normal eyesight and without color blindness, specifically, no protanopia or deuteranopia were included (Wong, 2011). Participants were also required to be free from chronic or acute illness, pain, or mental health conditions, as these factors are closely linked to psychological

well-being (Axon & Kim, 2023; Macchia, 2023; Scott et al., 2021; Coffey, 2020; Gureje et al., 1999). Fluency in German language was necessary, as all study materials were in German, and individuals who had previously participated in related studies from the "Urban Art and Green" project were excluded to prevent bias. Students who identified as professional artists were excluded per disclaimer to avoid expert bias, while professional botanists or gardeners were not, as their numbers seemed negligible.

Most participants were recruited via the SONA system at the University of Vienna's Faculty of Psychology, which primarily consists of undergraduate students who receive course credits for participation. Additional participants were recruited opportunistically for logistical reasons. Of the 105 participants recruited, 21 were from the opportunity sample. Three participants were excluded due to color vision deficiency, and two were excluded for not bringing necessary visual aids, resulting in a final sample appropriate for the study's aims. The sample size was set to 100 for a balanced approach between power and feasibility of this study as master thesis. The empirical data-collection took place between April, 2nd 2025 and June, 26th 2025.

Materials

Nature photographs

To ensure the highest ecological and experimental validity, a pre-study with 16 participants was conducted in which 120 candidate images were rated on beauty and perceived artfulness using a 5-point Likert scale. Sixty photographs, free for non-commercial use, were selected from the professional platform Pexels. Selection criteria were based on established findings in environmental psychology and aesthetics: images had to be high-resolution (4k or higher), with high saturation and contrast, and predominantly feature green, brown, or yellow hues. Blue spaces, like water were excluded to focus attention on vegetation. The motifs were primarily detailed close-ups of leaves, as such images have been shown to maximize restorative potential and viewer immersion (Dillon & Cai, 2022; Menzel et al., 2024a). Only two-dimensional images were chosen, as excessive immersion like 360° virtual reality imaging can reduce restorative effects (Mostajeran et al., 2021).

Leaf and plant shapes were selected according to empirical findings: broad, soft-shaped, and heart-shaped leaves such as those of *Epipremnum aureum* are generally perceived as most attractive and restorative (Berger et al., 2022; Zhao et al., 2017; Hareli et al., 2016). While

most images followed these principles, a few exceptions such as ferns were included if their beauty ratings were comparable to the preferred shapes.

Biophilic artworks

For the biophilic artwork condition, 60 images were generated using OpenArt SDXL, an advanced AI art platform. Each original photograph was used as an image prompt, ensuring that the subject matter (plant species, leaf shape, composition) remained consistent between photograph and artwork. To introduce stylistic variety, the AI was further guided by referencing paintings from different art epochs and well-known artists, resulting in a diverse set of artworks ranging from realistic to cubistic, abstract, or modern. The iterative prompting process was continued until each artwork was visually appealing, stylistically diverse, and matched the photograph in content.

Many AI-generated images included features characteristic of physical artworks, such as visible brushstrokes, layered paint, or reflections and borders, enhancing their plausibility as "real" artworks. These features were not specifically prompted, but emerged from the AI's attempt to generate convincing art. All artworks were upscaled to a minimum of 1024 x 720 pixels to ensure visual clarity. The intention was not to test for human vs. AI origin, but to create two highly comparable sets of stimuli differing only in aesthetic modality.

Matching and final selection

To ensure comparability between the photograph and artwork sets, all 120 images were rated for beauty and artfulness in a pre-study using PsychoPy, the data-collection took place from February 26th, 2025 to March 7th, 2025. For the main experiment, the final selection of 15 image pairs per condition was made using a Euclidean distance model. This method calculates the geometric distance between each photograph and artwork in the two-dimensional space defined by beauty and artfulness ratings, pairing those with the least possible difference (Spiel et al., 2008; Holman, 1972). This ensured that each artwork-photograph pair was as closely matched as possible on these psychological dimensions addressing potential confounds related to subjective evaluations of the stimuli, hence we were able to pick 15 photographs and 15 artworks that match in their perceived beauty and artfulness.

This process was essential to ensure that any observed effects in the main experiment could be attributed to differences in aesthetic modality, rather than differences in content, beauty, or perceived artfulness.

Measures

Emotional Well-being (affective mood state and anxiety)

EWB was measured in this study by the Positive and Negative Affect Schedule (PANAS, Watson et al., 1988) and the State-Trait Anxiety Inventory- State Version (STAI-S, Spielberger et al., 1999) that can also be used as a proximity measure for perceived stress level. The German version of the PANAS (Krohne et al., 1996) consists of 20 items that measures affective mood on a 5-point Likert scale: 0= Gar nicht, 1= Ein bisschen, 2=einigermaßen, 3= erheblich, 4= äußerst (0=not at all, 1= a little bit, 2= to some extent, 3= definitely, 4= extremely). The items are grouped into one of the two dimensions positive affect (PA) and negative affect (NA). In this study, participants were asked to give their response in accordance with their present state before the image intervention and after. Breyer & Bluemke (2016) report a good reliability of Cronbach's α=.86 for PA and NA with Raykov´s ρ=.93 for PA and NA.

Measure Name	**Sample Item (English)**	**Sample Item (German)**
PANAS NA	*I feel distressed.*	*Ich fühle mich bekümmert.*
PANAS PA	*I feel excited.*	*Ich fühle mich freudig erregt.*

The German version of the State-Trait-Anxiety-Inventory – State Version (STAI-S) (Grimm, 2009) consists of 20 items that measure perceived level of anxiety on a four-Point Likert scale: 1= überhaupt nicht, 2= ein wenig, 3= ziemlich, 4= sehr (1= not at all, 2= a little bit, 3= quite, 4= very much). The reported internal consistency is excellent ($\alpha > .90$; Stensen et al., 2022; Gliem & Gliem, 2003) with Cronbach´s $\alpha = .92$ and slightly higher for repeated measures (Thomas & Cassady, 2021; Mikuni et al., 2024). The STAI-S is considered as gold standard in clinical studies (Delgado et al., 2016) and is often used to evaluate emotional states as anxiety is a key component to our well-being (Thomas & Cassady, 2021). Both scales have been chosen because they are widely acclaimed in the literature and thus provide homogeneity and comparability. All the questionnaires used in the study were completed self-employed, using our participants smartphone following a QuestionPro survey.

Measure Name	**Sample Item (English)**	**Sample Item (German)**
STAI-S	*I feel secure.*	*Ich fühle mich sicher.*

Aesthetic Emotion (Aesthetic Emotions Scale)

Schindler et al. (2017a) developed a questionnaire that measures aesthetic emotions as a fundamental part of aesthetic perception and judgement across various domains such as art, literature, design, music, architecture and nature. The Aesthetic Emotions Scale (AESTHEMOS) provides a validated, fine graded tool that measures aesthetic emotions on 21 subscales that each consist of two items. Participants give their agreement towards 42 emotional statements on a five-point Likert scale. The include prototypical aesthetic emotions like the feeling of beauty, being moved, fascination and awe, epistemic emotions like interest and insight and emotions of amusement like humor and joy. Additionally, the subscales capture activating and calming effects of aesthetic experiences and negative feeling like the feeling of ugliness, boredom or confusion that might counteract aesthetic pleasure (Schindler et al., 2017a). As the scale is multidimensional, Cronbach´s alpha is calculated for each subscale ranging from α= .55 for subscale *awe* to α= .85 for subscale *humor.* The validity has been established through multidimensional factor analysis, cross-cultural adaption, semantic profiling and alignment with expert criteria (Schindler et al., 2017b). As the AESTHEMOS was published in English and German, no translation was needed for this study.

Measure Name	**Sample Item (English)**	**Sample Item (German)**
AESTHEMOS	*I found it sublime.*	*Empfand ich als erhaben.*

Perceived Restoration (Restoration Outcome Scale)

The Restoration Outcome Scale (ROS) is a psychometric tool designed to measure the restorative effects or outcomes that individuals experience after contact with an environment, particularly natural or green environments (Korpela et al., 2008; Hartig et al., 1997). It assesses the extent to which a person feels recovered in terms of psychological state and cognitive functioning. This study uses a short German version with six items that collects the feedback on a 7-point Likert scale ranging from 1= ”not at all” to 7= ”very much so”. Three items represent relaxation and calmness; one represents reflection and two represent clearing someone’s thoughts. Results in the ROS showed a negative correlation with physiological markers of stress in a previous study, being systolic blood pressures, diastolic blood pressure and heart rate (Liu et al., 2021), meaning higher results in the ROS were accompanied by lower systolic & diastolic blood pressure and heart rate. The authors state an internal consistency range of Cronbach’s alpha from α= .71 to α= .94, factorial validity has not been checked (Han, 2018), still the measure is frequently used and acclaimed in environmental

psychology (Felappi et al., 2021, Subiza-Pérez et al., 2021). A recent study calculated a good ($\alpha > .80$; Stensen et al., 2022; Gliem & Gliem, 2003) internal consistency of $\alpha = .88$ for the German translated 6-item version of the ROS (Menzel et al., 2024b). From the variety of restoration outcome measures available, the ROS was chosen for this study as it is designed based on integrating both frameworks, the ART and the SRT (Han, 2018). It can also contribute to a rough estimation of eudaimonic well-being.

Measure Name	**Sample Item (English)**	**Sample Item (German)**
ROS	*I feel calmer after the experience.*	*Ich fühle mich nach der Erfahrung ruhiger.*

Aesthetic Responsiveness (Aesthetic Responsiveness Scale)

The Aesthetic Responsiveness Scale (AReA) is a psychometrically validated screening tool to assess how responsive a person is to aesthetic experience. It helps to understand why some individuals are deeply moved by art while others are less affected (Schlotz et al., 2020). It was developed at Max Planck Institute for Empirical Aesthetics and validated in English and German with a sample (N=781) of participants from the United States of America and Germany. The 14 items can be grouped into the three subscales: Aesthetic appreciation, intense aesthetic experience and creative behavior. The feedback is collected on a 5-point Likert scale as agreement towards a statement ranging from 0= “never” to 4= “very often”. The overall internal consistency is good (α>.80; Stensen et al., 2022; Gliem & Gliem, 2003) with Cronbach´s alpha α=.82, convergent and discriminant validity is established through expected associations between AReA and measures of related constructs. Structural validity is acceptable, and cross-cultural validity has been established through a scale validation with a Farsi version of the AReA (Golbabaei et al., 2022).

Measure Name	**Sample Item (English)**	**Sample Item (German)**
AReA	*I notice beauty when I look at art.*	*Ich sehe das Schöne in Kunst(werken), wenn ich sie betrachte.*

Connectedness to Nature (Connectedness to Nature Scale)

The Connectedness to Nature Scale (CNS) designed by Mayer and Frantz (2004) is a psychometric instrument to measure how much an individual feels emotionally and experientially connected to the natural world and environment. It records a person´s sense of belonging and identification with nature on a trait level. It consists of fourteen items that collect the feedback on a five-point Likert scale ranging from 1= "does not apply at all" to 5= "fully applies". The scale shows good (α>.80; Stensen et al., 2022; Gliem & Gliem, 2003) internal reliability in validation studies with Cronbach´s alpha α=.84 (Lovati et al., 2023; Navarro et al., 2017). This study used a validated German translation by Cervinka et al. (2011) that deleted one item with problematic validity. The authors identified a noteworthy robust correlation of the CNS score with psychological well-being among related constructs like vitality and meaningfulness and argued for the relevance of connectedness to nature for human health.

Measure Name	**Sample Item (English)**	**Sample Item (German)**
CNS	*I often feel a sense of oneness with the natural world around me.*	*Ich fühle mich oft eins mit der natürlichen Welt um mich herum.*

Trait Absorption (Tellegen Absorption Scale)

The Tellegen Absorption Scale was originally developed by Tellegen and Atkinson (1974) to research hypnotic susceptibility. They designed a questionnaire believed to be related to hypnotizability and found absorption as a higher order factor in their original dataset and interpreted absorption as a trait for experiencing moments of "total" attention where all attentional resources are allocated towards an object outside one´s self (Tellegen & Atkinson, 1974). The scale consists of 34 dichotomous items measuring openness to absorbing and self-altering experiences.

The original scale has an internal consistency of α= .88 and a 30-day test-retest reliability of *r= .91* (Tellegen, 1982), higher reliabilities $\alpha = .95$ are reported in the literature (Rózsa et al., 2022). After analysis, the factor structure raised concerns about construct ambiguity. The correlated factors are imaginative involvement, synesthesia, sensed presence, enhanced cognition and oblivious/dissociative involvement and they do not align with Tellegen´s original conceptualization of absorption (Terhune & Jamieson, 2021; Glisky et al., 1991). A modified version was published later (Jamieson, 2005). This study used a validated German

translation (TABS) by Ritz & Dahme (1995). The translation uses a modified scoring system, instead of yes and no participants had to select how much they agree with each of the 34 items on a 5-point Likert scale. 0 = “Trifft nicht zu”; 1 = “Trifft etwas zu”; 2 = “Trifft teilweise zu”, 3 = “Trifft überwiegend zu”; 4 = “trifft völlig zu” (0 = “Does not apply”; 1 = “Applies somewhat”; 2 = “Applies partially”, 3 = “Applies mostly”; 4 = “Applies completely”). The authors report an internal consistency of α=.88 and a split-half reliability of r=.86 for the TABS. Following the conventions, the values indicate a good ($\alpha > .80$) internal consistency (Stensen et al., 2022; Gliem & Gliem, 2003). The TABS was integrated as the last part of the QuestionPro questionnaire in the study. All the measurements used are administered as self-report.

Measure Name	**Sample Item (English)**	**Sample Item (German)**
TABS	*I like to watch how clouds change their shape.*	*Ich beobachte gern, wie Wolken ihre Form verändern.*

Measures Overview

Measure Name	**Items**	**Subscales**	**Scale Type**	**Reliability (α)**	**Validity/Notes**
PANAS	20	2	5-point Likert	0.86	Good convergent and discriminant validity, sensitive to momentary changes
STAI-S	20	-	4-point Likert	0.92	Strong construct validity for two factors: presence and absence of anxiety, strong concurrent and divergent validity, sensitive to momentary changes
AESTHEMOS	42	21	5-point Likert	0.55-0.85	Construct validity for seven subscales, clear distinction of aesthetic emotions
ROS	6	3	7-point Likert	0.88	Cross-cultural-, contextual validation, convergent and predictive validity
AReA	13	3	5-point Likert	0.82	Structural and construct validity, cross-cultural validity
CNS	13	-	5-point Likert	0.84	Construct validity, predictive and divergent validity and cross-cultural validity established
TABS	32	5	5-point Likert	0.88-0.95	Convergent validity: strong correlations with hypnotic susceptibility, hallucinations and psychedelic experiences, cross cultural validity. Problematic construct validity.

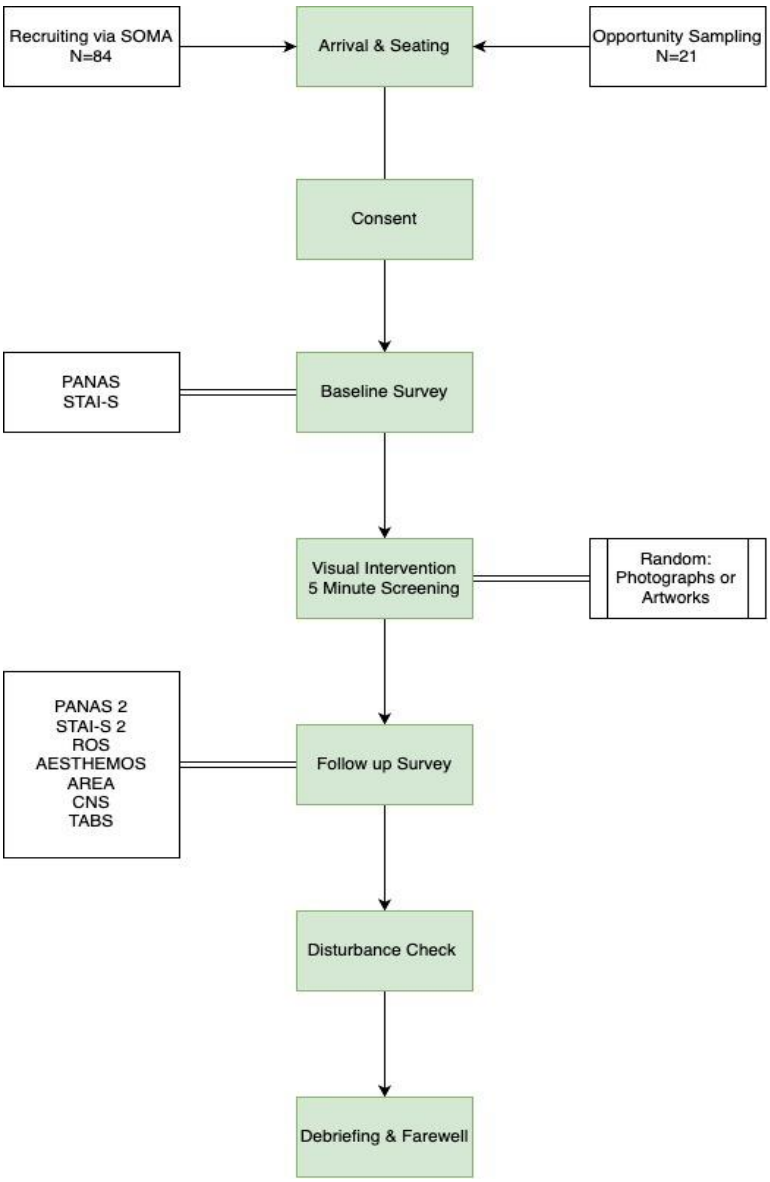
Procedure

Before data collection, the study was pre-registered in Open Science framework, the upload includes all metadata, and the stimuli included (https://osf.io/jhf2u/). Data collection was conducted by a single researcher following a standardized protocol. Participants registered for a time slot and arrived at the designated room in the faculty building, where up to four people could be seated at a table facing a large projection screen. Upon arrival, participants were greeted, seated, and provided with a written consent form outlining the study's purpose, duration, risks, and contact details. After giving written consent, participants received instructions and used their smartphones to access the baseline survey via a QR code linked to the QuestionPro platform.

Once baseline measures were completed, a pause screen on the survey prompted participants to shift their attention to the projected stimuli. Depending on random assignment, participants viewed either plant photographs or biophilic artworks, with each image displayed for 20 seconds and a total exposure time of five minutes. This timing was chosen based on evidence that 17–20 seconds per image maximizes aesthetic appreciation and emotional response, while shorter or longer durations are less effective (Brieber et al., 2018; Codispoti et al., 2009). The order of images within each condition was randomized to control for order effects. Lighting was standardized: overhead lights were switched off and window blinds dimmed sunlight during image viewing to ensure consistent visual conditions. Low-level traffic noise was unavoidable due to the building's location, but all sessions took place during working hours to maintain environmental consistency.

After the image exposure, participants completed follow-up measures on their smartphones, including emotional well-being, aesthetic emotion, and perceived restoration, as well as trait questionnaires for aesthetic responsiveness, absorption, and connectedness to nature. Participants were then asked if they experienced any disturbances during the session, debriefed, and given an opportunity to ask questions before leaving. The flowchart illustrates the experimental procedure. Throughout, the researcher maintained a soft, neutral tone to minimize experimenter bias. The procedure was designed to maximize ecological validity and comparability between the two aesthetic interventions, while controlling for extraneous variables and ensuring a consistent participant experience.

Procedure Flowchart



3. Results

Sample

The final sample comprised 100 participants (30 male, 70 female) with an age range of 19 to 37 years (M = 23.7, SD = 4.0). The age distribution showed a positive skew (skewness = 1.13), indicating that most participants were in the younger age brackets.
Regarding educational background, 2% reported completing an apprenticeship with professional training, 75% held a high school diploma, 17% had obtained a bachelor's degree, and 6% a master's degree. The vast majority of student participants (86%) were enrolled in psychology or a related field, while the remaining students were distributed across medicine (2%), veterinary medicine (1%), electrical engineering (1%), agricultural engineering (1%), law (1%), art education (1%), sociology (1%), food and biotechnical science (1%), cartography and geoinformation (1%), and landscape architecture (1%). The sample predominantly consisted of psychology undergraduate students, which may limit generalizability to other student populations or other populations in general. An overview table of the demographic data is provided in the supplementary materials (Supplementary Table 1).

Manipulation Check

Manipulation check was conducted to ensure that the two stimuli sets—plant photographs and biophilic artworks—were adequately matched for subjective beauty and perceived artfulness. Based on pre-study ratings from 16 participants, there was no statistically significant difference in perceived beauty between plant photographs (M = 3.34, SD = 0.52) and biophilic artworks (M = 3.00, SD = 0.61), $t(15) = 1.70$, $p = .100$.
However, artworks were rated significantly higher in artfulness (M = 3.63, SD = 0.81) than plant photographs (M = 2.66, SD = 0.84), $t(15) = -3.35$, $p = .002$. These results indicate that, while the two sets were comparable in terms of beauty, the artwork stimuli were perceived as more artful than the photographs. This difference should be considered when interpreting the main findings.

Descriptive Statistics for Main Variables

An overview of the descriptive statistics for the primary emotional well-being variables is presented in Table 1 for reasons of clarity. The sample included 100 participants evenly split between the two experimental conditions: biophilic artworks (A; N = 50) and plant photographs (P; N = 50). For **Positive Affect (PA)**, mean scores were higher in the

artwork condition both before (M = 29.4, SD = 6.19, range = 18–42) and after the intervention (M = 28.9, SD = 6.99, range = 15–45) compared to the photograph condition (Pre: M = 26.5, SD = 5.25, range = 16–38; Post: M = 25.9, SD = 6.50, range = 10–42). The mean change in PA (ΔPA) was −0.48 (SD = 5.98, range = −14 to 20) in the artwork group and −0.66 (SD = 5.15, range = −15 to 11) in the photograph group, indicating a slight decrease in both conditions.

For **Negative Affect (NA)**, participants in the artwork condition reported higher baseline scores (M = 14.8, SD = 4.54, range = 10–40) than those in the photograph condition (M = 13.8, SD = 3.67, range = 10–28), with both groups showing reductions after the intervention (A: M = 13.4, SD = 6.29, range = 10–42; P: M = 11.7, SD = 2.17, range = 10–19). The mean change in NA (ΔNA) was −1.36 (SD = 3.90, range = −8 to 21) for artworks and −2.16 (SD = 2.50, range = −13 to 2) for photographs, reflecting a larger reduction in negative affect in the photograph group.

Regarding **State Anxiety (STAI-S)**, pre-intervention scores were comparable between groups (A: M = 52.9, SD = 11.0, range = 29–70; P: M = 53.1, SD = 11.1, range = 30–78), with slight decreases post-intervention (A: M = 50.9, SD = 10.4, range = 24–68; P: M = 51.5, SD = 11.0, range = 30–72). The mean change in state anxiety (ΔSTAI-S) was −2.00 (SD = 3.24, range = −12 to 8) for artworks and −1.60 (SD = 3.32, range = −10 to 7) for photographs.

No missing data were present for these variables. All the descriptive statistic of the EWB outcomes including 95% CI´s is comparable in Table1. The descriptive statistic for change scores (Δ) are provided in a supplementary table in the appendix. The descriptive statistics for AESTHEMOS, ROS, AReA, CNS and TABS are provided in supplementary tables as well.

Table 1

Descriptive statistics for measures of PA and NA (PANAS) and Anxiety (STAI-S)

	Pre-Inter-vention (PA)			**Post-Intervention (PA)**		
Condition	Mean	SD	95% CI	Mean	SD	95% CI
Artworks	29.4	6.19	[27.6-31.2]	28.9	6.99	[26.9-30.9]
Photographs	26.5	5.25	[25.0-28.0]	25.9	6.50	[24.0-27.7]

	Pre-Intervention (NA)			**Post-Intervention (NA)**		
Condition	Mean	SD	95% CI	Mean	SD	95% CI
Artworks	14.8	4.54	[13.5-16.1]	13.4	6.29	[11.7-15.2]
Photographs	13.8	3.67	[12.8-14.9]	11.7	2.11	[11.1-12.3]

	Pre-Intervention (Anxiety)			**Post-Intervention (Anxiety)**		
Condition	Mean	SD	95% CI	Mean	SD	95% CI
Artworks	52.9	11.0	[49.8-56.0]	50.9	10.4	[47.9-53.9]
Photographs	53.1	11.1	[50.0-56.3]	51.5	11.0	[48.4-54.6]

Note. N=100 (50 per condition).

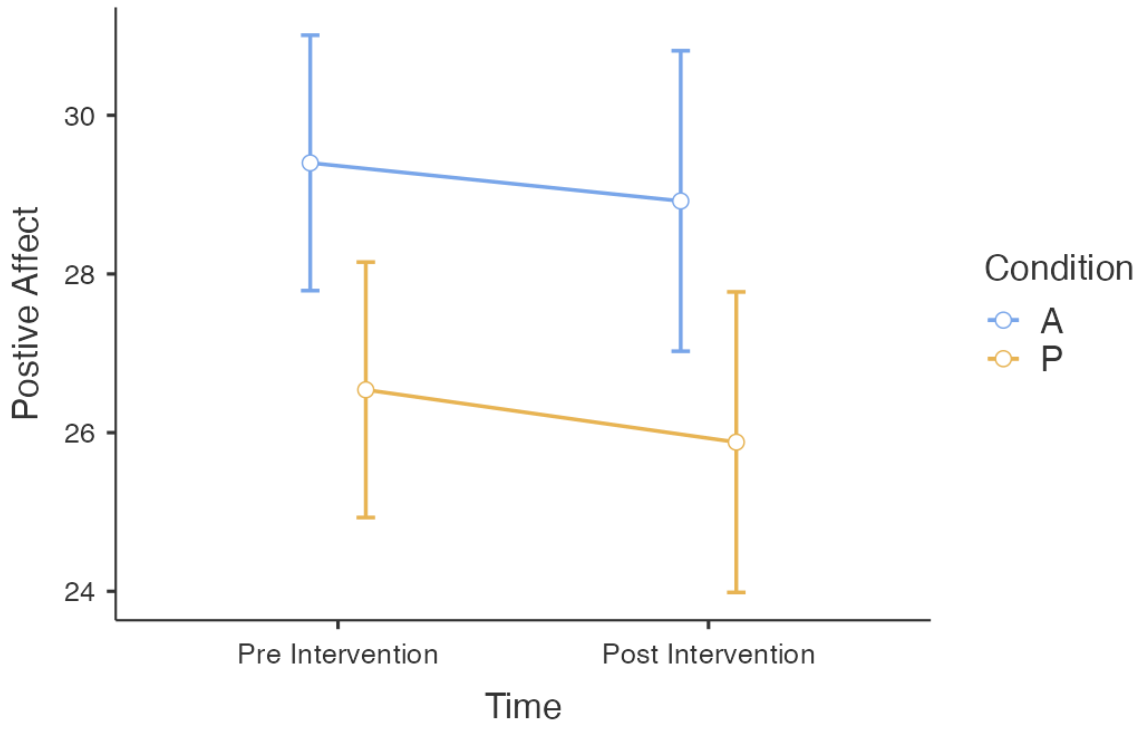
Hypothesis Testing: H1

To test Hypothesis 1, three mixed ANOVAs were conducted for positive affect (PA), negative affect (NA), and state anxiety (STAI-S), with condition (plant photographs vs. biophilic artworks) as the between-subjects factor and time (pre- and post-intervention) as the within-subjects factor.

For positive affect, there was no significant main effect of time, $F(1, 97) = 0.90$, $p = .345$, $\eta^2 = .009$, and no significant time × condition interaction, $F(1, 97) = 0.05$, $p = .823$, $\eta^2 = .001$. However, a significant main effect of condition was observed, $F(1, 97) = 7.34$, $p = .008$, $\eta^2 = .070$, indicating that the biophilic artwork group reported higher positive affect across both time points than the plant photograph group (mean difference = 3.06, SE = 1.13, $t(97) = 2.71$, $p = .008$).

Figure 1

Group × Time Interaction for Positive Affect

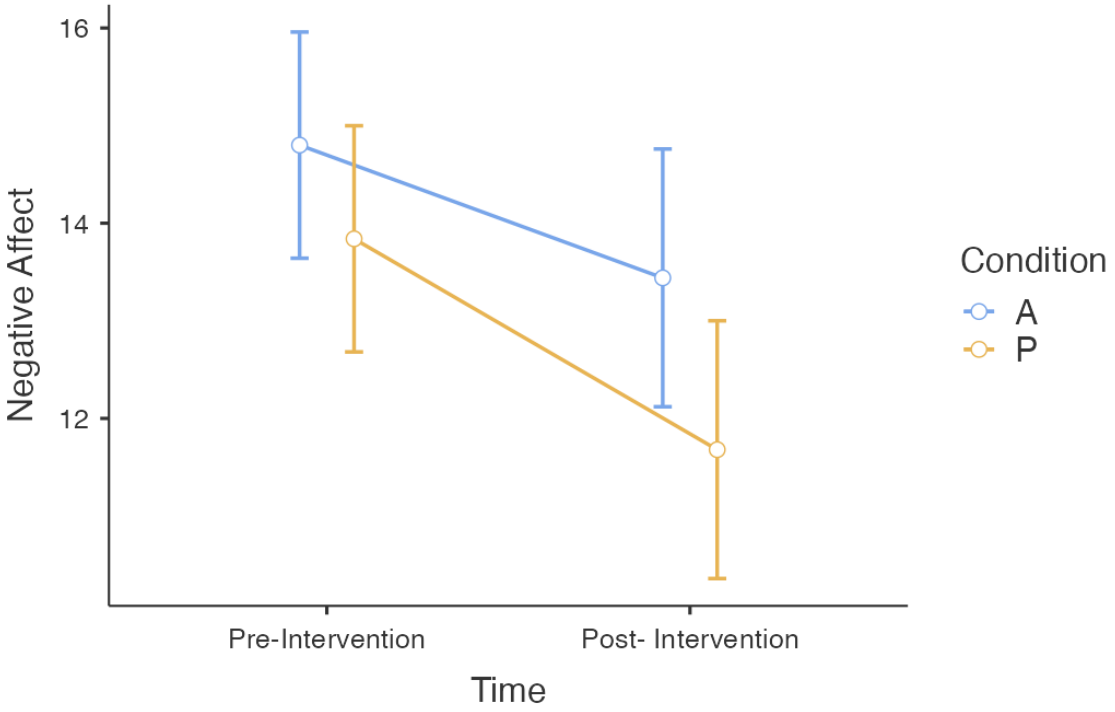


Note: Value range PA= {10,50}

For negative affect, there was a significant main effect of time, $F(1, 97) = 28.39$, $p < .001$, $\eta^2 = .226$, reflecting a reduction in negative affect from pre- to post-intervention in both groups. The time × condition interaction was not significant, $F(1, 97) = 1.43$, $p = .234$, $\eta^2 = .015$, nor was the main effect of condition, $F(1, 97) = 2.91$, $p = .091$, $\eta^2 = .029$.

Figure 2

Group × Time Interaction for Negative Affect

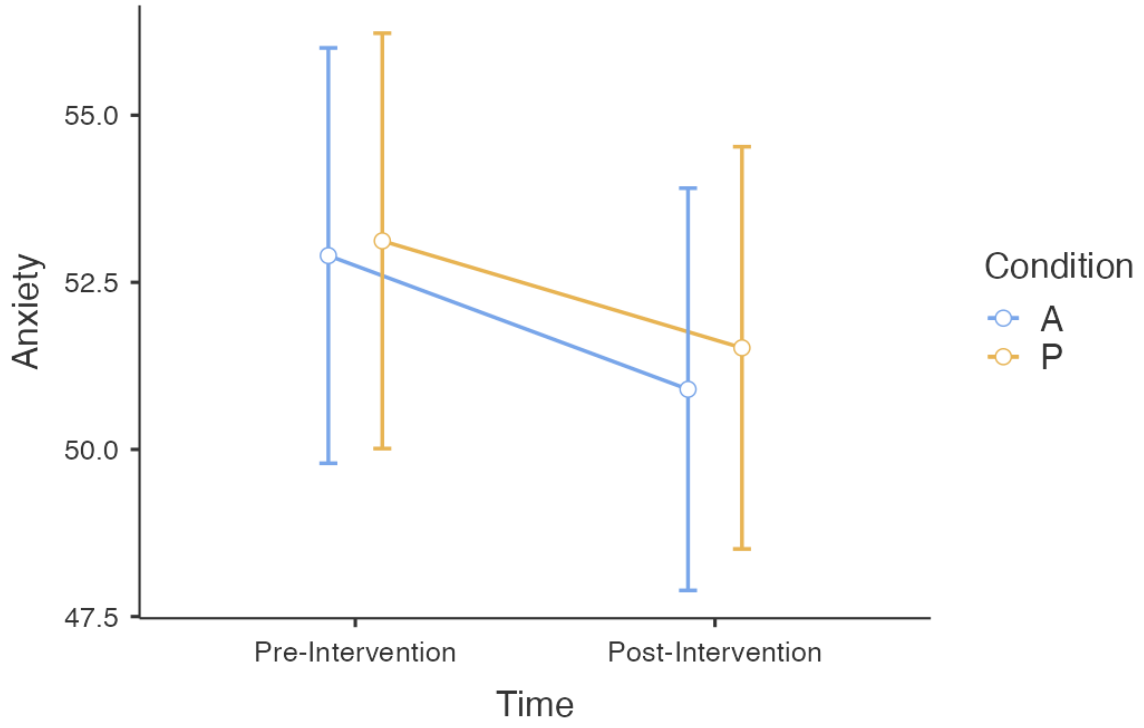


Note: Value range NA= {10,50}

For state anxiety, a significant main effect of time was found, $F(1, 97) = 30.31$, $p < .001$, $\eta^2 = .238$, indicating a decrease in state anxiety across both groups. Neither the time × condition interaction, $F(1, 97) = 0.44$, $p = .507$, $\eta^2 = .005$, nor the main effect of condition, $F(1, 97) = 0.089$, $p = .766$, $\eta^2 = .001$, reached significance.

Figure 3

Group × Time Interaction for State Anxiety



Note: Value range STAI-S= {20,80}

In summary, there were significant reductions in negative affect and state anxiety from pre- to post-intervention in both groups, but no evidence for a differential change between plant photographs and biophilic artworks. Only positive affect showed a significant overall difference between groups, with higher values in the artwork group, independent of time. No significant time × condition interactions were observed for any outcome.
H1 is not supported by the data.

Hypothesis Testing: H2

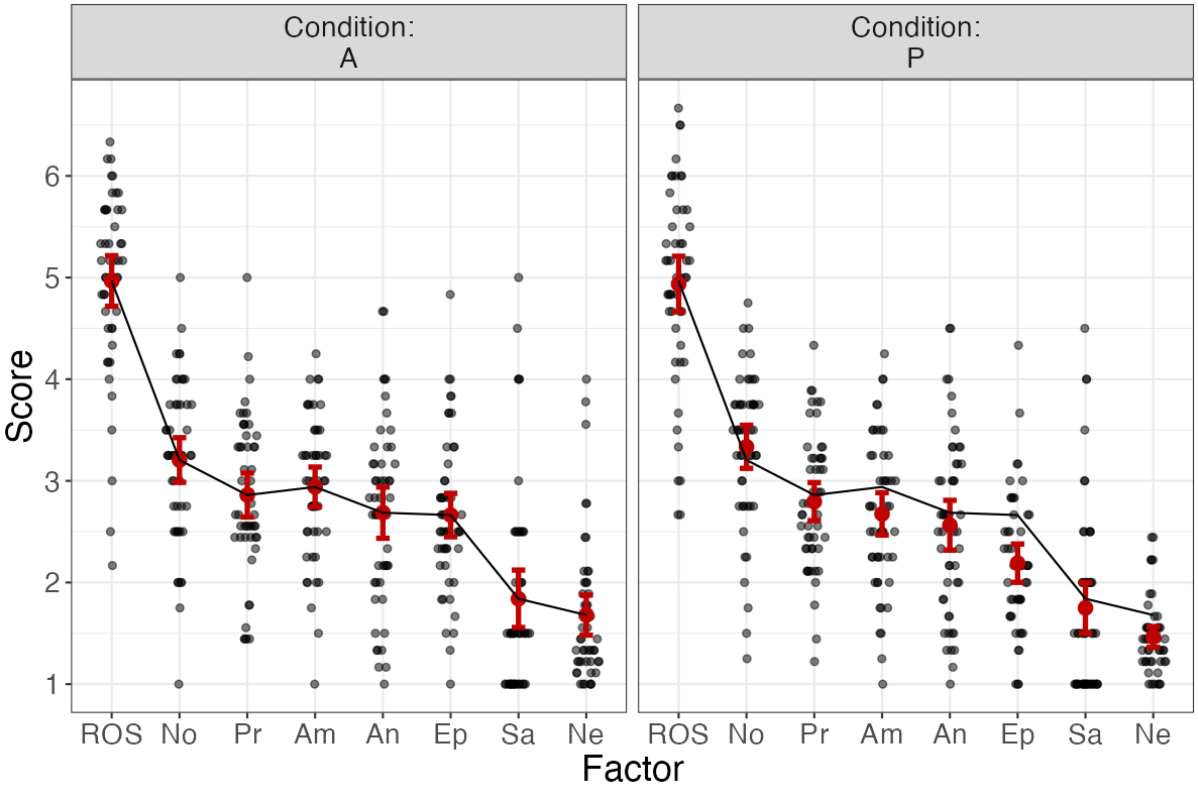
To test Hypothesis 2, a MANOVA was conducted with the seven overarching AESTHEMOS factors and the Restoration Outcome Scale (ROS) as dependent variables and condition (plant photographs vs. biophilic artworks) as the fixed factor. The multivariate test revealed a significant overall effect of condition, Pillai's Trace = 0.238, $F(8, 91) = 3.54$, $p = .001$, indicating that the pattern of aesthetic emotions and perceived restoration differed between groups.

Follow-up univariate ANOVAs, corrected for multiple comparisons using the Holm method, showed a significant group difference for Epistemic Emotions, $F(1, 98) = 10.80$, $p = .007$

(Holm-adjusted), mean difference = 0.47, 95% CI [0.19, 0.75]. Epistemic Emotions include Intellectual Challenge, Curiosity, Mental Engagement, Sense of deeper Meaning, Insight and Sparking Interest. (see the full factor-structure of AESTHEMOS in Supplementary Table 4 and full descriptive statistics in Supplementary Table 5). To further clarify the direction of this effect, an independent samples t-test was conducted. Results showed that the biophilic artwork group (A) reported significantly higher scores on Epistemic Emotions (M = 2.66, SD = 0.76) than the plant photograph group (P) (M = 2.19, SD = 0.67), t(98) = 3.29, p = .001, mean difference = 0.47, SE = 0.14, Cohen's d = 0.66.

Figure 4

Jittered density plot of Aesthetic emotions and perceived restoration



Note. N=100 (50 per condition). ROS= Perceived Restoration, No= Nostalgia and Relaxation Aesthetic Emotion, Pr=Prototypical Aesthetic Emotion, Am= Amusement Aesthetic Emotions, An= Animation Aesthetic Emotions, Sa= Sadness Aesthetic Emotion, Ne= Negative Aesthetic Emotions. A violin plot and the factor structure of the AESTHEMOS is provided in the supplementary materials.

No other factors, including ROS, reached significance after Holm-correction for multiple comparisons (all adjusted p > .05). A table of the descriptive statistics of univariate testing is provided in the supplementary materials. These results suggest that exposure to biophilic artworks elicits higher epistemic aesthetic emotions compared to plant photographs, while

perceived restoration and other emotional factors did not differ significantly between conditions.

H2 is partially supported by the data.

Hypothesis Testing: H3.1

General linear models (GLMs) were conducted to examine whether individual differences in aesthetic responsiveness (AReA), absorption (TABS), and connectedness to nature (CNS) predict changes in well-being outcomes (ΔPA, ΔNA, ΔSTAI-S) following the intervention. For each outcome, the full model included condition (artwork vs. photo), AReA, TABS, and CNS as predictors. To assess the unique contribution of each trait, additional models were estimated with one trait removed at a time.

Model fit statistics for all models are summarized in Table 2, and the figure provides a visual comparison of explained variance (R^2) for each model specification.

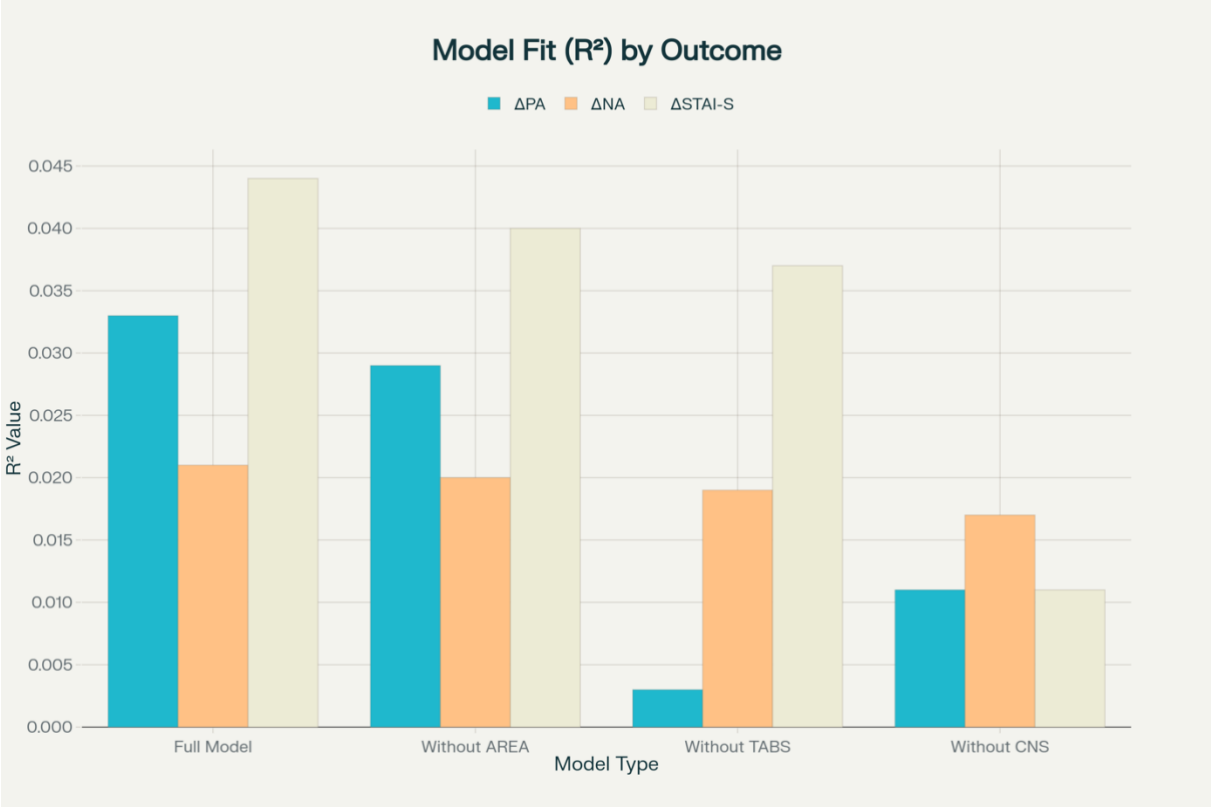
Table 2

R^2 Values for Full and Reduced General Linear Models controlling for trait variables

Outcome	Full Model R^2 (AIC, BIC)	R^2 (AIC, BIC) without AReA	R^2 (AIC, BIC) without TABS	R^2 (AIC, BIC) without CNS	Largest R^2 Drop
ΔPA	.033 (634, 650)	.029 (633, 646)	.003 (635, 648)	.011 (634, 647)	.026 (TABS)
ΔNA	.021 (531, 546)	.020 (529, 542)	.019 (529, 542)	.017 (529, 542)	.004 (CNS)
ΔSTAI-S	.044 (527, 543)	.040 (526, 539)	.037 (526, 539)	.011 (529, 542)	.033 (CNS)

Note. N=100 (50 per condition). None of the models reached significance.

Figure 5



Model diagnostics indicated that assumptions of homoscedasticity were met for all models (Breusch-Pagan and Levene's tests, all $p > .4$). Residuals were approximately normally distributed for ΔPA and ΔSTAI-S (Shapiro-Wilk $p > .02$) but deviated from normality for ΔNA (Shapiro-Wilk $p < .001$).

In summary, while absorption and connectedness to nature showed the largest incremental contributions to explained variance in positive affect and state anxiety, respectively, none of the trait predictors significantly explained changes in well-being following the intervention. Condition (artwork vs. photo) also had no significant effect in any model. Thus, individual differences in aesthetic responsiveness, absorption, and connectedness to nature did not significantly predict well-being improvements in this sample.

H3.1 is not supported by the data.

Hypothesis Testing: H3.2

A linear regression analysis was conducted to investigate whether connectedness to nature (CNS) predicts perceived restoration (ROS) following exposure to plant photographs and biophilic artworks, with experimental condition included as a predictor. The model including condition accounted for 2.63% of the variance in perceived restoration ($R^2 = .0263$, AIC = 274, BIC = 284, N = 100), while the model excluding condition explained 2.57% of the variance ($R^2 = .0257$, AIC = 272, BIC = 280). This minimal increase in explained variance and the slightly higher AIC and BIC values indicate that adding condition did not improve model fit. In the full model, neither CNS Score ($\beta = 0.0211$, SE = 0.0132, $t = 1.600$, $p = .113$) nor condition ($\beta = -0.0458$, SE = 0.1857, $t = -0.247$, $p = .806$) were significant predictors of perceived restoration. The intercept was significant ($\beta = 4.0053$, SE = 0.6151, $t = 6.511$, $p < .001$), reflecting the average restoration score when predictors are zero. Model diagnostics indicated that assumptions of linearity, homoscedasticity, and normality of residuals were checked and met. Residual plots showed no evidence of heteroscedasticity or non-linearity, and the Shapiro-Wilk test for normality of residuals was non-significant ($p > .05$), supporting the appropriateness of the linear regression model for these data.

These findings suggest that, in this sample, trait connectedness to nature and the type of visual stimulus (plant photograph versus biophilic artwork) did not significantly predict perceived restoration, and the inclusion of condition as a factor did not meaningfully enhance the model's explanatory power.

H3.2 is not supported by the data.

4. Discussion

Summary and discussion of main results

The aim of this study was to systematically compare the effects of plant photographs and biophilic artworks on emotional well-being, aesthetic emotions, and perceived restoration among young adults in an urban context. Additionally, the study examined whether individual differences in aesthetic responsiveness, absorption, and connectedness to nature would moderate the effects of these visual interventions. The results indicated that both interventions led to reductions in negative affect and state anxiety, with no significant differences in the magnitude of change between the conditions. Positive affect was, on average, higher in the artwork group, regardless of measurement time. Patterns of aesthetic emotions differed between conditions: biophilic artworks elicited significantly higher epistemic emotions, while all other aesthetic emotions and perceived restoration remained comparable. The trait variables examined did not significantly predict changes in well-being, and the explanatory power of the models was generally low.

These findings confirm and extend previous research showing that both nature imagery and art can produce short-term, moderate improvements in emotional well-being and stress reduction in urban populations (Hall & Knuth, 2019; Law et al., 2021; Menzel et al., 2024a; Trupp et al., 2025). The observed effect sizes correspond to those reported in meta-analyses for nature photographs (Cohen's f ~0.15–0.25) and art viewing (f ~0.10–0.12) (Menzel et al., 2024a; Trupp et al., 2025). The absence of significant differences in restoration and most emotional outcomes between plant photographs and biophilic artworks suggests that the hypothesized synergy from combining nature and art is limited, at least with brief exposure in a sample that is AI-generated and matched to the beauty and artfulness of professionally produced plant photography. The higher epistemic emotions in the artwork group align with theories attributing stronger cognitive activation and curiosity to art, while nature images primarily trigger affective and restorative processes (Schindler et al., 2017b; Marković, 2012).

Contrary to some earlier studies, neither absorption not aesthetic responsiveness nor connectedness to nature significantly moderated the intervention effects (Ballew & Omoto, 2018; Harrison, 2023; Schindler et al., 2017b). This may be due to the relative homogeneity of the sample, measurement limitations, or the short exposure duration. The overall low explained variance and lack of significant trait effects suggest that other, unmeasured factors may have a greater influence on well-being after visual interventions.

Contrary to the hypotheses, the trait variables did not significantly predict changes in well-being. Possible explanations include: The relatively homogeneous, predominantly psychology-educated sample had limited variance in trait levels (see supplementary Figures 2,3 and 4). The short, laboratory-based exposure may not suffice to allow individual differences in the depth of aesthetic experience to manifest. Lastly, the self-report instruments used may not capture subtle or physiological changes adequately.

Integrating Field and Laboratory Evidence

This thesis, part of the Urban Art and Green project, builds on Mikuni et al. (2024), which found that public art installations in urban settings can reduce anxiety, stress, and negative mood. While Mikuni et al. demonstrated these effects in-situ, the present study confirms that even brief, carefully designed visual interventions can reliably reduce negative affect and state anxiety in a controlled laboratory setting. The reductions observed in both experimental conditions in the laboratory mirror the improvements reported in the field, supporting the robustness and generalizability of these findings.

Importantly, the laboratory approach enabled direct comparison of different aesthetic modalities and exploration of underlying mechanisms, such as aesthetic emotions and restoration. Although effect sizes in the lab were modest, they align with those from Mikuni et al. (2024) and recent meta-analyses, suggesting that the well-being benefits of art and nature imagery are replicable across contexts. This convergence of field and laboratory evidence strengthens the case for integrating art and nature-based micro-interventions into urban environments to enhance collective well-being.

Limitations

The sample consisted predominantly of young, female psychology students. Which limits the generalizability of the findings. The brief, controlled laboratory intervention restricts conclusions about long-term effects and real-world applicability. Conducting trials with up to four participants simultaneously may have introduced social facilitation or group conformity biases, potentially influencing responses (Bond & Titus, 1983). Reliance on self-report measures, despite their validation, limits insight into physiological, neurological or qualitative changes that complementary methods might capture.

Regarding the absence of the expected synergistic effect of the biophilic artworks, we propose two potential reasons. First, due to the geographical matching approach used to select the final sample, we were limited in the perceived beauty of the artworks. Although the original set

contained biophilic artworks rated as more beautiful, the final selection prioritized comparability, which excluded more aesthetically impactful pieces. Since artworks generally perceived as more beautiful tend to elicit stronger aesthetic emotions, this could have led to higher outcomes for EWB. Second, during debriefing, ten out of 50 participants in the biophilic artworks condition asked whether the images were AI-generated. The perception that the images might be AI-generated appeared sufficiently salient or aversive that several participants raised the issue unprompted during debriefing, suggesting a notable degree of reactivity or cognitive dissonance. This implies that participant involvement and responses may have been impacted by reactivity or attribution bias regarding AI-generated art.

A growing amount of research suggests that AI is negatively viewed, particularly in the arts (Horton et al., 2023; Millet et al., 2023). Bias arises even when the source is suspected of being artificial intelligence but not confirmed (Grassini & Koivisto, 2024). Additionally, this bias appears to operate implicitly, whereby people who assume that the stimuli are artificial intelligence (AI)-generated pay less attention to them and obey instructions less. This was demonstrated in behavioral and eye-tracking investigations (Zhou & Kawabata, 2023; Horton et al., 2023). The effect appears to be trait and age related, according to the author of a recent meta-analysis that is available as a preprint, suggesting that it is unlikely to be a structural matter (De Rooij, 2025).

Implications for Future Research

Future studies should include more diverse and larger samples to enhance generalizability. This could be achieved in an online experiment that should also eliminate all group effects. Longitudinal and field studies can investigate sustained effects and real-world application. Integrating physiological as well as neurobiological methodologies would improve the understanding of the underlying mechanism with the potential to thread valuable knowledge into the neuroscientific frameworks we have today. Additional assessment of trait variables for instance openness for experience or mindfulness and their interactions with natural or artistic environments would benefit city design and support audience based, tailored interventions for specific settings or populations within the city.

Conclusion: Integrating Art and Nature for Urban Well-Being

This study set out to explore how brief visual interventions—plant photographs and biophilic artworks—can foster emotional well-being, restoration, and aesthetic emotions in an urban population. The findings demonstrate that both modalities offer accessible means to

enhance well-being, with biophilic artworks particularly stimulating mental engagement and curiosity, and nature images primarily supporting restorative effects. While the overall effect sizes were modest and not strongly moderated by individual trait differences, the results underscore the potential of even small, thoughtfully designed interventions to make a difference in the urban context.

Crucially, these findings reinforce the perspective introduced at the outset: that cultivating well-being in cities is not a luxury, but a necessity for individual and collective resilience. As highlighted in the introduction, the modern city is both a source of stress and a canvas for reimagining our relationship with nature, beauty, and each other. The integration of art and nature into daily urban life—through micro-experiences such as a glimpse of greenery or a moment of reflection before a biophilic artwork—can offer more than momentary respite. These experiences invite us to reclaim presence, curiosity, and a sense of belonging within the urban fabric.

By demonstrating that accessible visual interventions can promote well-being, this research supports the broader vision of cities as spaces where nature, art, and meaning are woven into the everyday environment. Such interventions, even when brief, can help counteract the psychological challenges of urban living, nurture resilience, and contribute to a more humane and flourishing urban experience. This conclusion circles back to the study's starting point: in the twenty-first century, the pursuit of urban well-being depends on our ability to intentionally design environments that nourish both body and spirit, making beauty and reflection vital threads in the tapestry of city life.

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6. Appendix

Demographics

Supplementary Table 1.

Sample Demographics

Variable	Category	Value	n	%
Age	Mean (SD)	23.7 (4.00)		
	Range	19-37		
Sex	Female		70	70
	Male		30	30
Education	High School		75	75
	Apprenticeship		2	2
	Bachelor		17	17
	Master		6	6
Academic Major	Psychology		86	86
	Medicine		2	2
	Veterinary Medicine		1	1
	Electrical Engineering		1	1
	Agricultural Engineering		1	1
	Law		1	1
	Art Education		1	1
	Sociology		1	1
	Food and Biotechnical Science		1	1
	Cartography and Geoinformation		1	1
	Landscape Architecture		1	1

Note. Missing Data for Academic Major: n=1

Descriptive Statistics

Supplementary Table 2

Descriptive statistics for ΔPANAS (PA, NA) and ΔSTAI-S (Anxiety)

	Condition	Mean	SD	Min	Max	SEM
ΔPA	Artworks	-0.48	5.98	-14	20	0.85
	Photogrpahs	-0.66	5.15	-15	11	0.73
ΔNA	Artworks	-1.36	3.90	-8	21	0.55
	Photographs	2.16	2.50	-13	2	0.35
ΔAnxiety	Artworks	-2.00	3.24	-12	8	0.46
	Photographs	-1.60	3.32	-10	7	0.47

Note. N=100 (50 per condition).

Supplementary Table 3

Descriptive statistics for AESTHEMOS and its seven factors grouped by condition.

Score/Factor	Condition	Mean	SD	95% CI Lower	95% CI Higher	Min	Max
AESTHEMOS Total	Artworks	56.4	10.6	53.4	59.4	37.0	88.0
	Photographs	53.0	9.02	50.5	55.6	33.0	71.0
	Total	54.7	9.96	52.8	56.7	33.0	88.0
Prototypical Aesthetic Emotions	Artworks	2.98	0.81	2.75	3.21	1.38	5.00
	Photographs	3.00	0.76	2.79	3.22	1.38	4.63
	Total	2.99	0.78	2.84	3.14	1.38	5.00
Epistemic Emotions	Artworks	2.79	0.82	2.56	3.03	1.00	5.00

Score/Factor	Condition	Mean	SD	95% CI Lower	95% CI Higher	Min	Max
	Photographs	2.54	0.82	2.32	2.77	1.00	5.00
	Total	2.67	0.83	2.50	2.83	1.00	5.00
Amusement	Artworks	2.94	0.70	2.74	3.14	1.00	5.00
	Photographs	2.67	0.74	2.46	2.89	1.00	5.00
	Total	2.81	0.73	2.66	2.95	1.00	4.25
Activation	Artworks	2.40	0.81	2.17	2.64	1.00	4.00
	Photographs	2.06	0.71	1.85	2.26	1.00	4.25
	Total	2.23	0.78	2.07	2.39	1.00	4.25
Relaxation	Artworks	3.87	0.98	3.59	4.15	1.00	5.00
	Photographs	4.15	0.89	3.09	4.40	1.50	5.00
	Total	4.01	0.95	3.82	4.20	1.00	5.00
Negative Emotions	Artworks	1.74	0.71	1.54	1.95	1.00	4.00
	Photographs	1.59	0.42	1.47	1.17	1.00	3.00
	Total	1.67	0.59	1.55	1.78	1.00	4.00
Confusion	Artworks	1.45	0.74	1.24	1.66	1.00	4.00
	Photographs	1.17	0.33	1.08	1.26	1.00	2.00
	Total	1.31	0.59	1.19	1.43	1.00	4.00

Note. N=100 (50 per condition). Higher scores indicate greater intensity of aesthetic emotions during the intervention.

Supplementary Table 4

Factor structure of AESTHEMOS

Prototypical aesthetic emotion:	*Nostalgia and relaxation aesthetic emotion:*
1. I found it beautiful	4. Calmed me
6. Liked it	20. Relaxed me
7. Fascinated me	26. Made me feel sentimental
11. Baffled me	28. Made me feel nostalgic
14. Felted deeply moved	*Sadness aesthetic emotion:*
29. Surprised me	15. Made me feel melancholic
34. Was impressed	23. Made me sad
36. Felt touched	*Amusement aesthetic emotions:*
40. Felt awe;	3. Delighted me
Epistemic aesthetic emotion:	22. Amused me
2. Challenged me intellectually	39. Made me happy
5. Made me curious	42. Was funny to me
10. I Was mentally engaged	*Negative aesthetic emotions:*
13. Sensed a deeper meaning	12. I found it ugly
21. Felt a sudden insight	17. Made me angry
38. Sparked my interest	19. Bored me
Animation aesthetic emotion:	24. Felt confused
8. Felt something wonderful	27. Worried me
9. Invigorated me	30. Felt oppressive
16. Energized me	33. Felt indifferent
18. Was enchanted	35. I found it distasteful
32. Spurred me on	37. Was unsettling to me
41. Felt motivated to act	

Supplementary Table 5

Descriptive Statistics for Univariate Testing AESTHEMOS and ROS (H3.2)

Factor	Mean (SD)	95% CI	ΔM	95% CI ΔM	F	p	p (Holm) corr.
Prototypical: Artworks	2.86 (0.77)	[2.64-3.08]	0.06	[-0.22-0.35]	0.20	.657	1.00
Prototypical: Photographs	2.80 (0.67)	[2.61-2.99]	-	-	-	-	-

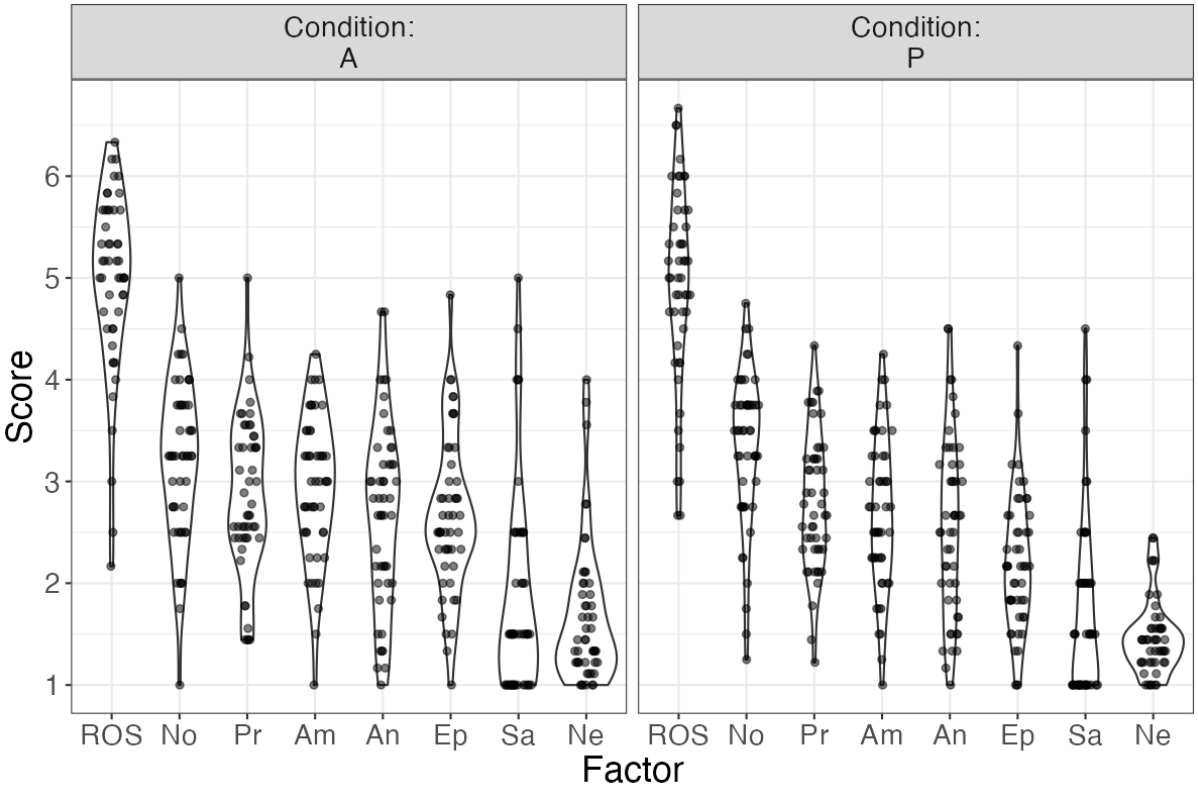
Factor	Mean (SD)	95% CI	ΔM	95% CI ΔM	F	p	p (Holm) corr.
Epistemic: Artworks	2.66 (0.76)	[2.45-2.88]	0.47	[0.19-0.76]	10.80	001*	.008*
Epistemic: Photographs	2.19 (0.67)	[2.00-2.38]	-	-	-	-	-
Animation: Artworks	2.69 (0.90)	[2.43-2.94]	0.13	[-0.22-0.48]	0.48	.489	1.00
Animation: Photographs	2.56 (0.86)	[2.32-2.81]	-	-	-	-	-
Amusement: Artworks	2.94 (0.70)	[2.74-3.14]	0.18	[-0.02-0.55]	3.37	.070	.420
Amusement: Photographs	2.76 (0.74)	[2.46-2.89]	-	-	-	-	-
Negative: Artworks	1.68 (0.70)	[1.48-1.88]	0.22	[0.00-0.43]	3.69	.058	.406
Negative: Photographs	1.46 (0.36)	[1.36-1.57]	-	-	-	-	-
Nostalgic: Artworks	3.21 (0.79)	[2.98-3.43]	-0.12	[-0.44-0.18]	0.71	.401	1.00
Nostalgic: Photographs	3.33 (0.76)	[3.12-3.55]	-	-	-	-	-
Sadness: Artworks	1.84 (1.00)	[1.55-2.13]	0.09	[-0.29-0.47]	0.23	.638	1.00
Sadness: Photographs	1.75 (0.89)	[1.50-2.00]	-	-	-	-	-
Restoration: Artworks	4.97 (0.89)	[4.71-5.22]	0.03	[-0.34-0.40]	0.06	.87	1.00

Factor	Mean (SD)	95% CI	ΔM	95% CI ΔM	F	p	p (Holm) corr.
Restoration: Photographs	4.94 (0.98)	[4.66-5.21]	-	-	-	-	-

Note. N100 (50 per condition). *=significant result.* *=trend.

Supplementary Figure 1

Violin plot of the 7 Overarching Factors for AESTHEMOS and perceived restoration (ROS)



Note. N=100 (50 per condition). ROS= Percieved Restoration, No= Nostalgia and Relaxation Aesthetic Emotion, Pr=Prototypical Aesthetic Emotion, Am= Amusement Aesthetic Emotions, An= Animation Aesthetic Emotions, Sa= Sadness Aesthetic Emotion, Ne= Negative Aestehtic Emotions.

Supplementary Table 6

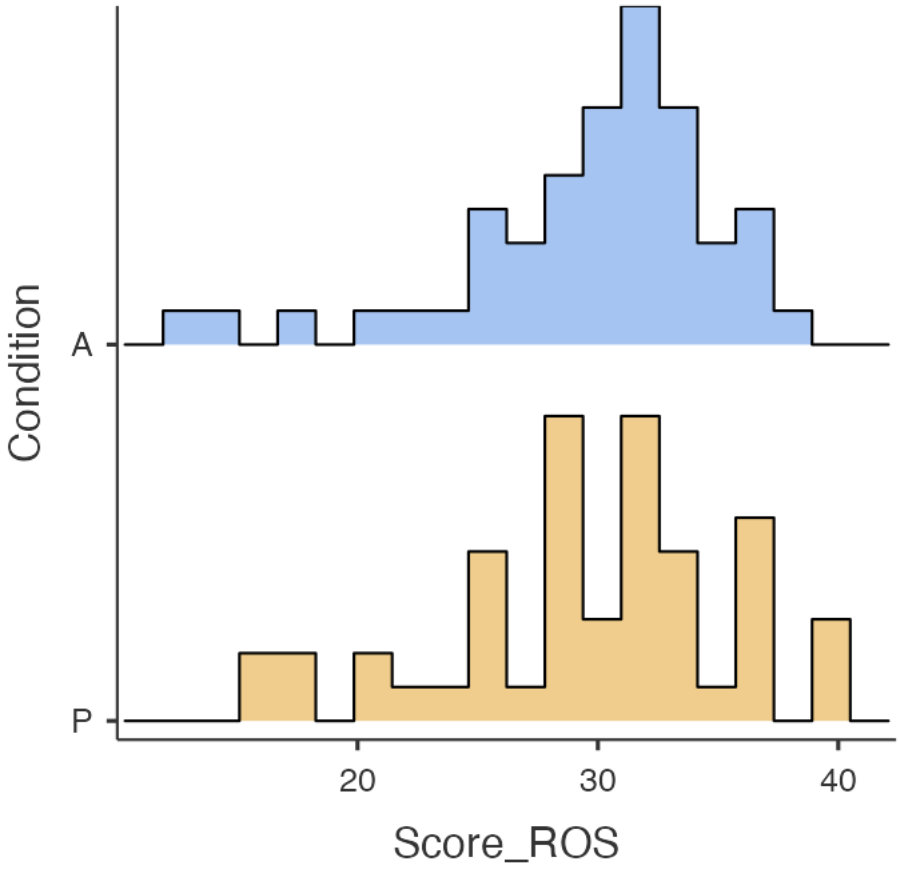
Descriptive Statistics for ROS and subscales

Score/Subscale	Condition	Mean	SD	95% CI Lower	95% CI Higher	Min	Max
ROS Total	Artworks	29.8	5.33	28.3	31.3	13	38
	Photographs	29.5	5.98	27.8	31.2	16	40
	Total	29.7	5.59	28.6	30.8	13	40
Relaxation/ Calmness	Artworks	4.89	1.05	4.59	5.18	1.00	6.33
	Photographs	4.97	1.89	4.63	5.30	1.33	6.67
	Total	4.93	1.11	4.71	5.15	1.00	6.67
Attention Restoration	Artworks	4.88	1.36	4.49	5.27	1.00	7.00
	Photographs	4.80	1.43	4.39	5.21	1.00	7.00
	Total	4.84	1.39	4.56	5.12	1.00	7.00
Other Outcomes	Artworks	5.13	0.81	4.90	5.36	3.00	6.50
	Photographs	4.91	1.01	4.62	5.20	2.00	7.00
	Total	5.02	0.93	4.84	5.20	2.00	7.00

Note. Higher Scores indicate greater percieved restoration. N=100 (50 per condition).

Supplementary Figure 2

Bar plot of the distribution of ROS per condition



Note. Y-axis = Frequency. X-axis = ROS Score. N=100 (50 per condition). Art condition not normally distributed (Shapiro wilk p= .002). Photograph condition normally distributed (Shapiro wilk p= .101)

Supplementary Table 7

Descriptive statistics for AReA and subscales

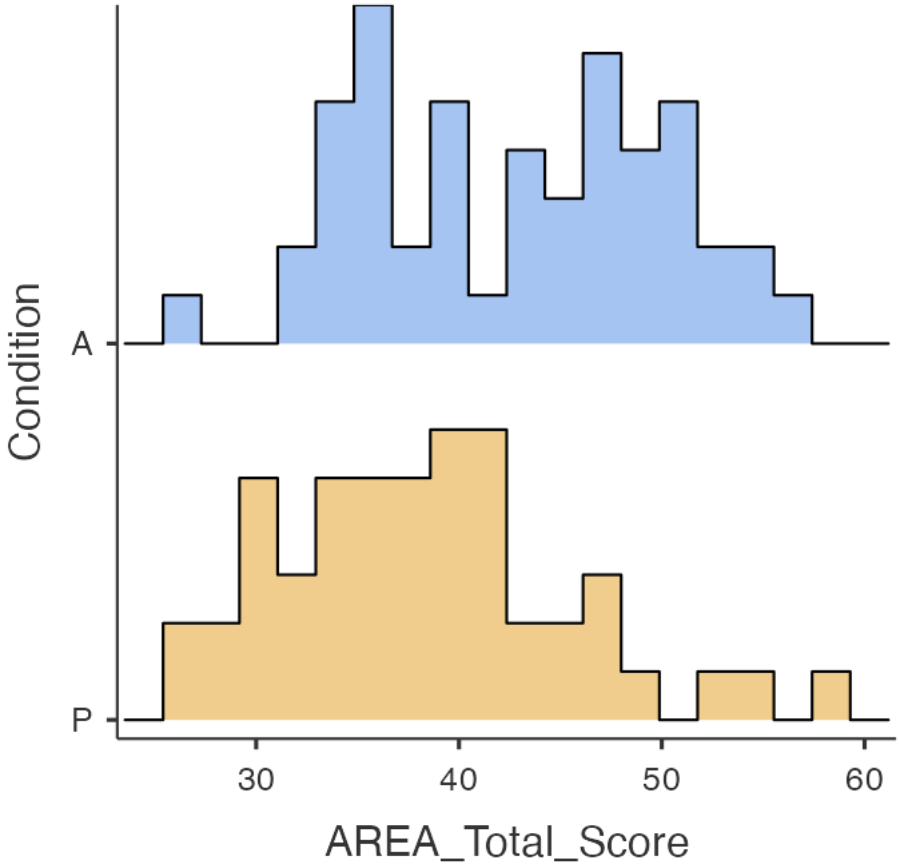
Score/Subscale	Condition	Mean	SD	95% CI Lower	95% CI Higher	Min	Max
AReA Total	Artworks	42.6	7.36	40.5	44.7	27	56
	Photographs	38.1	7.06	36.1	40.1	27	59
	Total	40.4	7.52	38.9	41.9	27	59
Aesthetic Appreciation	Artworks	3.64	0.54	3.48	3.79	2.63	4.75
	Photographs	3.33	0.50	3.18	3.47	2.25	4.38

Score/Subscale	Condition	Mean	SD	95% CI Lower	95% CI Higher	Min	Max
Intense Aesthetic Experience	Total	3.48	0.54	3.37	3.59	2.25	4.75
	Artworks	2.52	0.71	2.32	2.72	1.25	4.00
	Photographs	2.23	0.70	2.03	2.43	1.25	4.25
Creative Behavior	Total	2.38	0.72	3.37	3.59	2.25	4.75
	Artworks	2.87	0.72	2.66	3.07	1.33	4.33
	Photographs	2.57	0.67	2.38	2.76	1.33	4.33
	Total	2.27	0.71	2.58	2.86	1.33	4.33

Note. Higher scores indicate greater aesthetic responsiveness. N=100 (50 per condition).

Supplementary Figure 3

Bar plot of the distribution of AReA per condition



Note. Y-axis = Frequency. X-axis = AReA Score. N=100 (50 per condition). Art condition not normally distributed (Shapiro wilk p= .042). Photograph condition normally distributed (Shapiro wilk p= .089)

Supplementary Table 8

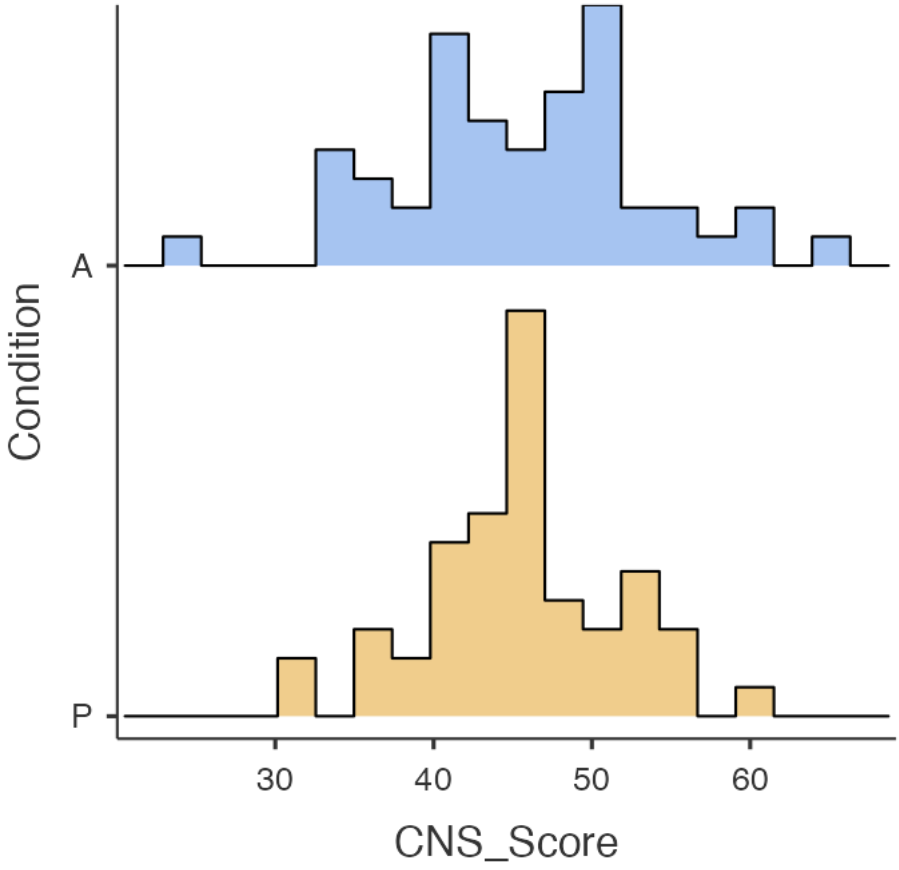
Descriptive statistics for CNS per condition

Score	Condition	Mean	SD	95% CI Lower	95% CI Higher	Min	Max
CNS Total	Artworks	45.6	8.00	43.3	47.8	23	64
	Photgraphs	45.5	6.63	43.8	47.3	31	60
	Total	45.5	7.07	44.1	46.9	23	64

Note. Higher values indicate higher connectedness to nature. N=100 (50 per condition).

Supplementary Figure 4

Bar plot of the distribution of CNS per condition



Note. Y-axis = Frequency. X-axis = CNS Score. N=100 (50 per condition). Both normally distributed (Shapiro wilk p>.05).

Supplementary Table 9

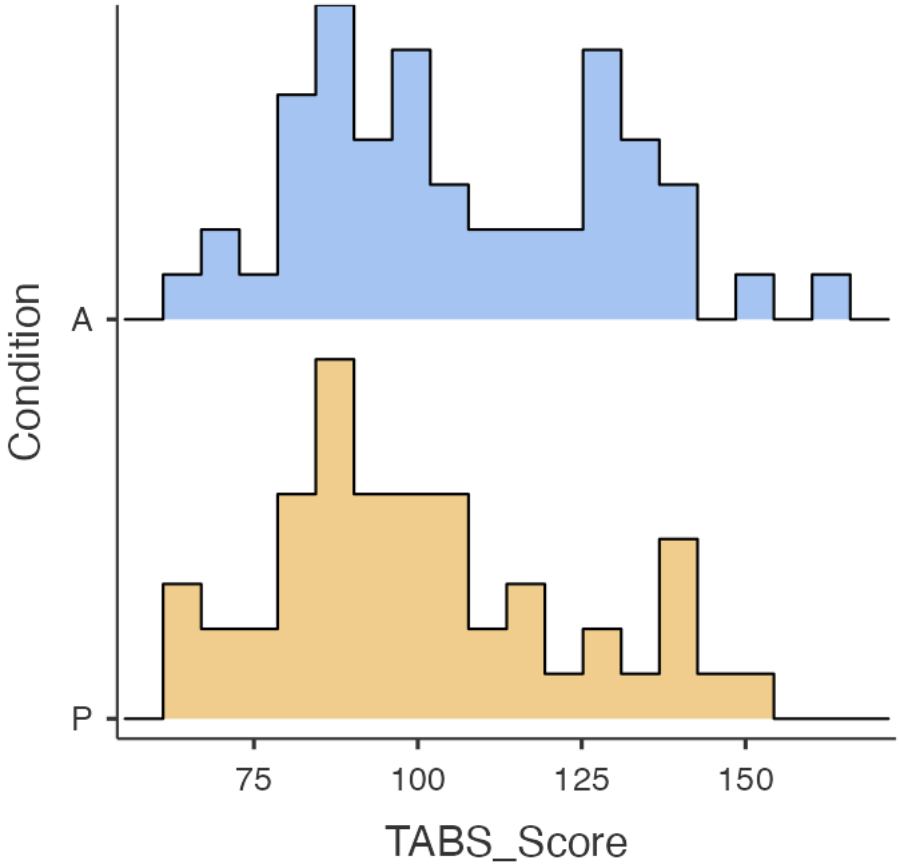
Descriptive statistics for TABS

Score	Condition	Mean	SD	95% CI Lower	95% CI Higher	Min	Max
TABS Total	Artworks	107	23.5	99.9	113	62	161
	Photographs	100	22.9	93.5	107	62	150
	Total	103	23.3	98.7	108	62	161

Note. Higher Values indicate greater trait absorption. N=100 (50 per condition).

Supplementary Figure 5

Bar plot of the distribution of TABS per condition



Note. Y-axis = Frequency. X-axis = TABS Score. N=100 (50 per condition). Both normally distributed (Shapiro wilk p >.05).

Study Information including Inclusion Criteria

As displayed to participants using the LABS-System

Study Name	AllgBioPsych_25SS_Art_and_Nature
Study Type	Standard (lab) study This is a standard lab study. To participate, sign up, and go to the specified location at the chosen time.
Study Status	Visible to participants : Approved Active study : Appears on list of available studies
Duration	30 minutes
Credits	2 Credits
Abstract	In dieser Studie wird untersucht, wie Menschen auf unterschiedliche Bilder von unserer Natur reagieren.
Description	Ausfüllen von Fragebögen die ihren momentanen Affekt und Stress erheben, danach werden Sie Bilder in Ruhe betrachten und darauffolgend weitere Fragebögen ausfüllen, die ihren Affekt, Stress und ihr Verhältnis zu Kunst und Natur abfragen. Sprache der Studie: Deutsch.
Eligibility Requirements	Normale oder korrigierte Sehfähigkeit, keine psychische Krankheit (wie zB. Depression, Angstzustände) und keine akute Erkrankung oder Verletzung (wie Grippe, Frakturen)
Preparation	Bitte bringen Sie ihr Smartphone mit. Alternativ ist auch ein Tablet oder Notebook möglich.

Debriefing

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TeilnehmerInneninformation und Einwilligungserklärung zur Teilnahme an der Studie:

"Seeing Green: How Different Forms of Nature Imagery Influence Emotional Well-Being and Aesthetic Experience"

Was ist der Zweck der Studie?

Mit zunehmender Urbanisierung steigt das Risiko für stressbedingte Gesundheitsrisiken in einem großen Teil der Bevölkerung. In vergangenen Untersuchungen konnte gezeigt werden, wie das Bereitstellen von Grünflächen, wie Parks diese Risiken deutlich vermindern kann und einen Beitrag zum Wohlbefinden leistet. Bereits das bloße betrachten von Pflanzen kann uns helfen, mentale Ermüdung und negative Emotionen abzubauen und damit unsere geistige Gesundheit unterstützen. Das Betrachten von Kunst birgt ebenfalls das Potential, zu unserem Wohlbefinden beizutragen, indem wir bei der ästhetischen Erfahrung positive Emotionen erleben. Kunst kann unter anderem ein Gefühl von Schönheit, Ehrfurcht oder Verwunderung auslösen und damit unser Wohlbefinden steigern. Es konnte bereits gezeigt werden, wie Kunstwerke von Landschaften in Krankenhauszimmern die Dauer des Aufenthalts und damit die Heilung positiv beeinflusst. Diese Studie fragt danach, wie mit Abbildungen von Pflanzen Wohlbefinden gesteigert werden kann, insbesondere an Orten wo kein Raum für Grünanlagen vorhanden ist. Es liegt die Vermutung zugrunde, dass Kunst von Pflanzen und Fotografien von Pflanzen unterschiedliche Effekte für das Wohlbefinden erzielen. Um einen Eindruck davon zu gewinnen, wie sich welche Art der Darstellung von Natur auf unser Wohlbefinden auswirken kann, wird dieses Projekt die Effekte quantifizieren.

Written Consent Form

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TeilnehmerInneninformation und Einwilligungserklärung zur Teilnahme an der Studie:

Der Titel und der Zweck der Studie werden nach Abschluss bekannt gegeben, um jegliche Erwartungshaltung vor dem Experiment zu vermeiden.

Sehr geehrte Teilnehmerin, sehr geehrter Teilnehmer,

Ihre Teilnahme an dieser Studie erfolgt freiwillig. Sie können jederzeit, ohne Angabe von Gründen, Ihre Bereitschaft zur Teilnahme ablehnen oder auch im Verlauf der Studie zurückziehen. Die Ablehnung der Teilnahme oder ein vorzeitiges Ausscheiden aus dieser Studie hat keine nachteiligen Folgen für Sie.

Diese Art von Studien ist notwendig, um verlässliche neue *wissenschaftliche* Forschungsergebnisse zu gewinnen. Unverzichtbare Voraussetzung für die Durchführung von Studien ist jedoch, dass Sie Ihr Einverständnis zur Teilnahme an dieser Studie schriftlich erklären. Bitte lesen Sie den folgenden Text als Ergänzung zum Informationsgespräch sorgfältig durch und zögern Sie nicht, Fragen zu stellen.

Bitte unterschreiben Sie die Einwilligungserklärung nur,

- wenn Sie Art und Ablauf der Studie vollständig verstanden haben,
- wenn Sie bereit sind, der Teilnahme zuzustimmen und
- wenn Sie sich über Ihre Rechte als Teilnehmer/in an dieser Studie im Klaren sind.

1. Was ist der Zweck der Studie?

Der vollständige Zweck der Studie wird bekannt gegeben, sobald das gesamte Experiment abgeschlossen ist.

2. Wie läuft die Studie ab?

Rechnen Sie mit einem Zeitaufwand von etwa 30 Minuten. Sie werden gebeten einige Fragebögen auszufüllen. Zwischen den Fragebögen werden Sie einige Bilder aufmerksam betrachten.

3. Worin liegt der Nutzen einer Teilnahme an der Studie?

Sie erhalten die Möglichkeit, an einer wissenschaftlichen Studie teilzunehmen. Dank Ihrer Studienteilnahme können die Ergebnisse schließlich auch anderen Personen zugutekommen. Außerdem erhalten Sie 2 LABS-Credits.

4. Gibt es Risiken bei der Durchführung der Studie und ist mit Beschwerden oder anderen Begleiterscheinungen zu rechnen?

Die Teilnahme an der Studie ist nach menschlichem Ermessen mit keinem oder nur mit einem zu vernachlässigenden Risiko verknüpft. Zu Studienzwecken werden keine Medikamente sowie invasive Methoden eingesetzt. Sie können an dieser Studie teilnehmen, wenn Sie zwischen 18 und 40 Jahre alt sind, und fließend Deutsch sprechen. Während dieser Studie werden Sie keine Behandlungen oder

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TeilnehmerInneninformation und Einwilligungserklärung zur Teilnahme an der Studie:

Der Titel und der Zweck der Studie werden nach Abschluss bekannt gegeben, um jegliche Erwartungshaltung vor dem Experiment zu vermeiden.

Sehr geehrte Teilnehmerin, sehr geehrter Teilnehmer,

Ihre Teilnahme an dieser Studie erfolgt freiwillig. Sie können jederzeit, ohne Angabe von Gründen, Ihre Bereitschaft zur Teilnahme ablehnen oder auch im Verlauf der Studie zurückziehen. Die Ablehnung der Teilnahme oder ein vorzeitiges Ausscheiden aus dieser Studie hat keine nachteiligen Folgen für Sie.

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universität wien

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Abstract English

This master's thesis explores whether biophilic artworks—artistic representations intentionally incorporating natural elements—can generate a synergistic effect on emotional well-being, aesthetic emotions, and restoration in young adults living in urban environments, beyond the purely restorative effect of plant photographs. The study is grounded in the biophilia hypothesis, Attention Restoration Theory, positive psychology and empirical aesthetics.

Using a randomized between-subjects design, 100 participants (aged 19–37) viewed either plant photographs or AI-generated biophilic artworks. The intervention consisted of a five-minute exposure to 15 carefully matched images per condition, assessing changes in positive and negative affect (PANAS), state anxiety (STAI-S), aesthetic emotions (AESTHEMOS), and perceived restoration (ROS). Personality traits such as aesthetic responsiveness, absorption, and connectedness to nature were examined as potential moderators.

Results indicate that both image types led to short-term reductions in negative affect and state anxiety, but no significant synergistic effect of biophilic artworks beyond the restorative impact of plant photographs was found. However, biophilic artworks elicited stronger epistemic aesthetic emotions. The investigated personality traits did not significantly moderate the effects.

These findings highlight the potential of low-threshold, visual-aesthetic interventions to promote well-being in urban settings, while also delineating the limits of a synergistic advantage of biophilic artworks over traditional plant photographs.

Abstract Deutsch

Diese Masterarbeit untersucht, ob biophile Kunstwerke – also künstlerische Darstellungen, die gezielt natürliche Elemente integrieren – einen synergistischen Effekt auf das emotionale Wohlbefinden, ästhetische Emotionen und die Erholung junger Erwachsener im urbanen Kontext entfalten können, der über den rein restorativen Effekt von Pflanzenfotografien hinausgeht. Theoretisch basiert die Studie auf der Biophilie-Hypothese, der Attention Restoration Theory sowie Ansätzen der positiven Psychologie und empirischen Ästhetik.
In einem randomisierten Between-Subjects-Design wurden 100 Teilnehmende (19–37 Jahre) entweder Pflanzenfotografien oder KI-generierte biophile Kunstwerke präsentiert. Die Intervention bestand aus einer fünfminütigen Betrachtung von 15 sorgfältig vorselektierten Bildern pro Bedingung, wobei Veränderungen in positivem und negativem Affekt (PANAS), Zustandsangst (STAI-S), ästhetischen Emotionen (AESTHEMOS) und wahrgenommener Erholung (ROS) erfasst wurden. Zusätzlich wurden Persönlichkeitsmerkmale wie ästhetische Responsivität, Absorption und Naturverbundenheit als potenzielle Moderatoren untersucht.
Die Ergebnisse zeigen, dass beide Bildtypen kurzfristig negative Affekte und Zustandsangst reduzieren, wobei kein signifikanter synergistischer Effekt der biophilen Kunstwerke über den restorativen Effekt der Pflanzenbilder hinaus nachgewiesen werden konnte. Biophile Kunstwerke lösten jedoch stärkere epistemische ästhetische Emotionen aus. Die untersuchten Persönlichkeitsmerkmale moderierten die Effekte nicht signifikant.
Die Befunde unterstreichen das Potenzial niedrigschwelliger, visuell-ästhetischer Interventionen zur Förderung des Wohlbefindens im urbanen Raum, zeigen aber auch die Grenzen eines synergistischen Mehrwerts biophiler Kunstwerke gegenüber klassischen Pflanzenfotografien auf.