

# Biophilic Design and its Influence on Stress Reduction in High-Density Living Environment

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## Abstract

This research investigates the impact of biophilic design on stress reduction in high-density living environments. As urbanization intensifies, the challenges of stress in densely populated areas become increasingly pronounced. The study employs a mixed-methods approach, combining case studies and surveys to explore the relationship between biophilic design elements—such as natural light, greenery, and water features—and stress levels in high-density urban settings. Drawing on existing literature in environmental psychology, the research establishes a theoretical framework for understanding the potential of biophilic design to alleviate stress. Through in-depth analysis of real-world case studies, this paper aims to provide insights into the effectiveness of biophilic interventions and their implications for architects, urban planners, and policymakers seeking to create healthier and more sustainable high-density living environments. The findings contribute to the growing body of knowledge on the intersection of design, well-being, and urban living.

**Keywords:** Biophilic design, sustainability, stress, architecture.

## 1. Introduction

### Biophilic Design: A Harmony Between Nature and the Built Environment

In an era dominated by concrete landscapes and technological advancements, biophilic design emerges as a transformative philosophy that seeks to reintegrate nature into the fabric of our constructed environments. Rooted in the biophilia hypothesis, which asserts that humans possess an innate affinity for nature, biophilic design represents a holistic approach to architectural and interior planning. Its fundamental premise is to create spaces that not only accommodate human needs but also nurture a deep and intrinsic connection with the natural world.

### The Essence of Biophilia:

The term "biophilia," coined by biologist E.O. Wilson, encapsulates the innate human tendency to seek connection with living organisms and the outdoors. Biophilic design, then, extends beyond conventional architectural norms, aiming to

satisfy a profound human longing for nature within the spaces we inhabit. It acknowledges that our separation from the natural world, exacerbated by rapid urbanization, has implications for physical health, mental well-being, and overall quality of life.

### Key Principles of Biophilic Design:

- 1. Nature Integration:** Inclusion of natural elements like plants, water features, and natural materials into the built environment to blur the boundaries between indoor and outdoor spaces. Incorporation of green roofs, walls, and atriums to introduce vegetation and create a sense of continuity with the natural environment.
- 2. Natural Light and Ventilation:** Prioritization of abundant natural light through strategically placed windows, skylights, and open floor plans. Promotion of natural ventilation systems to enhance air quality and create a connection with the changing outdoor environment.
- 3. Biomimetic Forms and Patterns:** Utilization of organic shapes, patterns, and textures inspired by nature in architectural elements, furnishings, and decor.

Integration of fractals and other naturally occurring geometries to evoke a sense of order and complexity found in the natural world.

- 4. Prospect and Refuge:** Designing spaces that offer a balance of openness (prospect) and cosiness (refuge), allowing occupants to feel both connected to the broader environment and secure within their surroundings. Incorporation of outdoor spaces or views that provide a sense of prospect, while cozy nooks and alcoves offer refuge.
- 5. Sensory Engagement:** Stimulation of multiple senses through the use of natural materials, sounds, and scents to create a sensory-rich experience. Incorporation of water features, such as indoor fountains or reflecting pools, for their calming visual and auditory effects.

The application of biophilic design is diverse, spanning residential, commercial, and institutional settings. From office spaces designed to boost employee well-being and productivity to healthcare environments fostering patient healing, biophilic design is a versatile concept with tangible benefits. Biophilic design represents a paradigm shift in how we conceive and interact with the spaces we inhabit. It is a response to the imperative of reconnecting with nature in the face of urbanization. As cities grow denser, and technology becomes more pervasive, the principles of biophilic design offer a holistic and sustainable approach to designing environments that not only meet human needs but also enhance our well-being. By fostering a harmonious coexistence between the built environment and the natural world, biophilic design provides a blueprint for creating spaces that resonate with our deepest instincts and contribute to a more balanced and fulfilling human experience.

## 2. Project Discussion

The allure of urban life, characterized by bustling cityscapes and vibrant communities, has drawn a significant portion of the global population into high-density living environments. While these urban hubs promise opportunities and connectivity, they also present a complex tapestry of challenges, with stress emerging as a prevalent and multifaceted concern.

1. **Population Density and Social Overload:** High-density living environments are characterized by tightly packed residential areas, leading to an unprecedented concentration of individuals. This proximity can result in heightened social interactions and a constant buzz of activity. For many residents, the ceaseless influx of stimuli and the challenge of maintaining personal space contribute to a sense of social overload, fostering stress and mental fatigue.

2. **Limited Green Spaces and Nature Deprivation:** The concrete expanses of high-density urban landscapes often leave minimal room for green spaces. This lack of access to nature, compounded by the absence of parks or natural retreats, contributes to what is known as nature deprivation. Residents are deprived of the restorative and calming effects that natural environments provide, amplifying stress levels.

3. **Noise Pollution and Sensory Overstimulation:** In the heart of high-density living, noise pollution becomes an omnipresent stressor. The constant hum of traffic, the chatter of pedestrians, and the clangor of urban life create a symphony of sounds that can be overwhelming. Sensory overstimulation, exacerbated by the cacophony of city living, can lead to heightened stress, fatigue, and a reduced ability to concentrate.

4. **Commuting Challenges and Time Pressures:** High density living often correlates with employment centers and economic opportunities. However, this centralization can result in lengthy and stressful daily commutes. The time pressures associated with navigating crowded public transportation or congested roadways contribute

significantly to stress levels. The constant rush to meet deadlines and balance professional and personal responsibilities further exacerbates the challenges faced by urban dwellers.

5. **Limited Privacy and Social Isolation:** Paradoxically, while high-density living environments foster social interactions, they can also lead to a sense of isolation. The close proximity of living spaces and the constant exposure to neighbors may limit privacy, contributing to feelings of vulnerability and stress. Striking a balance between community engagement and the need for personal space becomes a delicate challenge in densely populated areas.

6. **Economic Pressures and Cost of Living:** The economic allure of urban hubs is often offset by the high cost of living. The competitive nature of these environments places economic pressures on residents, leading to stress related to financial stability, housing affordability, and the pursuit of a satisfactory quality of life.

In the face of these challenges, the need to address stress in high-density living environments becomes imperative. Understanding the intricacies of stressors in urban settings is a crucial step toward devising holistic solutions and implementing design principles, such as biophilic design, that can mitigate the impact of stress and promote the well-being of individuals navigating the complexities of urban life.

### 2.2 How does biophilic design contribute to stress reduction in high-density living?

In the throbbing heart of our urban landscapes, where high-density living has become the norm rather than the exception, the escalating challenges of stress cast shadows on the well-being of inhabitants. It is within this complex urban tapestry that the research question unfurls its significance: How does biophilic design, an emerging architectural paradigm inspired by nature, serve as a therapeutic ally in alleviating stress within the bustling crucible of high-density living.

The dynamism of contemporary urban living, with its rapid pace and perpetual stimuli, has given rise to stressors that manifest in various forms. From noise pollution and limited access to green spaces to the psychological strain of navigating social interactions in close quarters, high-density living environments present a confluence of challenges that impact the mental and physiological health of their residents. At the intersection of this urban conundrum and the evolving discourse on well-being, biophilic design emerges as a potential antidote. The research question encapsulates a multidimensional inquiry that seeks to dissect the nuanced ways in which biophilic design, with its incorporation of nature-inspired elements, contributes to the reduction of stress in high-density living. Central to this investigation is an exploration of specific biophilic design principles and their implementation within the urban milieu. Elements such as verdant greenery, the rhythmic flow of water

features, and the optimization of natural light are scrutinized as potential stress-alleviating agents. The research endeavors to unravel the ways in which these design interventions create a symbiotic relationship with the psychological and physiological well-being of high-density residents. A pivotal aspect of the research involves an in-depth examination of stress reduction metrics. By employing established psychological and physiological indicators, the study aims to measure and quantify the impact of biophilic design on stress levels. Cortisol levels, heart rate variability, self-reported stress assessments, and other pertinent metrics form the bedrock of this analysis, providing a comprehensive understanding of the tangible effects of biophilic interventions. In order to contextualize the research findings, the study delves into the unique stressors embedded in high-density living environments. Population density, limited privacy, noise pollution, and the perpetual hustle and bustle of city life serve as the backdrop against which the efficacy of biophilic design is gauged. This contextual analysis adds depth to the understanding of how biophilic interventions can act as a counterbalance to the stressors inherent in densely populated urban settings. Furthermore, the research explores the experiential dimension, aiming to capture the lived experiences and perceptions of individuals residing in biophilically designed high-density spaces. By tapping into the narratives of residents, the study seeks to unravel the subjective impact of biophilic design on daily stressors, coping mechanisms, and overall satisfaction with the living environment.

A comparative analysis between biophilically designed high-density spaces and conventional urban settings adds a nuanced layer to the research. By contrasting stress levels, well-being, and the effectiveness of biophilic design with non-biophilic counterparts, the study aims to highlight the distinctive contributions of biophilic principles to stress reduction. In the grand tapestry of urban living, where stress weaves its intricate patterns, the research question stands as a beacon of inquiry, beckoning us to unravel the potential of biophilic design as a salve for the urban soul. As cities burgeon and the need for resilient, well-designed living spaces intensifies, this research endeavors to contribute a rich narrative to the evolving dialogue on the intersection of architecture, nature, and the human experience in high-density living environments.

## 6. Literature study

Biophilic design, with its emphasis on incorporating natural elements into the built environment, has garnered significant attention for its potential psychological effects on individuals. This literature review delves into existing research to elucidate the psychological impacts of biophilic design, exploring key themes and findings across various domains.

**1. Stress Reduction and Well-being:** Numerous studies have investigated the stress-reducing effects of biophilic design.

Ulrich's seminal research on the "restorative environment" theory found that exposure to nature or nature-inspired settings positively influences stress recovery. Further studies, such as those by Kaplan and Kaplan, have supported these findings, demonstrating that interactions with nature contribute to enhanced well-being and psychological restoration.

**2. Cognitive Performance and Creativity:** Biophilic design's influence on cognitive performance and creativity has been a subject of interest. Research by Berman et al. suggests that exposure to nature enhances cognitive functioning, including attention and memory. Moreover, studies by Shibata and Suzuki indicate that nature-based environments stimulate creative thinking and problem-solving skills. Biophilic elements, such as greenery and natural light, are identified as facilitators of improved cognitive outcomes.

**3. Mood Enhancement and Emotional Well-being:** The literature consistently underscores the positive impact of biophilic design on mood and emotional well-being. Studies by Herzog and Black suggest that exposure to natural elements induces positive emotions and reduces feelings of anxiety. Indoor plants, water features, and views of nature have been identified as key contributors to mood enhancement, promoting a positive emotional atmosphere within designed spaces.

**4. Restorative Environments in Healthcare Settings:** Biophilic design has found particular application in healthcare settings, where stress reduction and patient well-being are paramount. Research by Cooper Marcus and Barnes reveals that hospital environments incorporating nature result in improved patient outcomes, reduced recovery times, and increased overall satisfaction. The incorporation of biophilic elements, such as healing gardens and natural views, contributes to a sense of calm and comfort for patients.

**5. Workplace Productivity and Satisfaction:** The impact of biophilic design on workplace environments is a burgeoning area of research. Studies by Browning et al. and Heschong Mahone Group highlight that offices with biophilic elements report higher levels of employee productivity and job satisfaction. Access to natural light, greenery, and outdoor spaces has been linked to reduced workplace stress and increased overall well-being.

**6. Physiological Responses to Biophilic Elements:** Researchers have delved into physiological responses to biophilic elements to provide a comprehensive understanding of the mind-body connection. Studies using biomarkers such as heart rate variability and cortisol levels suggest that exposure to nature or nature-inspired settings elicits positive physiological responses, indicative of reduced stress and enhanced relaxation.

**7. User Preferences and Perceptions:** Exploring user preferences and perceptions is crucial in understanding the

effectiveness of biophilic design. Research by Kaplan and Kaplan indicates that individuals show a preference for environments with biophilic elements. Furthermore, perceived connections to nature within designed spaces positively influence overall satisfaction and comfort levels. A plethora of studies has probed the intricate relationship between exposure to nature and stress reduction, shedding light on the profound impact that natural environments or elements can have on human well-being. This review synthesizes key findings from diverse studies, illuminating the multifaceted ways in which nature exposure contributes to stress reduction.

Numerous studies, inspired by the Attention Restoration Theory (ART) proposed by Kaplan and Kaplan, have explored how nature exposure facilitates cognitive restoration. Kaplan's seminal research posits that natural environments, with their soft fascination and restorative qualities, allow individuals to recover from mental fatigue more effectively than urban settings. Subsequent studies by Joye and Van den Berg support these findings, establishing a direct link between exposure to nature and improved attention, focus, and cognitive function.

Research delving into physiological responses to nature exposure has uncovered compelling evidence of stress reduction. Studies employing measures such as heart rate variability (HRV) and cortisol levels consistently demonstrate that contact with natural environments induces a relaxation response. For instance, research by Li and Sullivan reveals a significant decrease in cortisol levels after participants spent time in nature. The physiological benefits extend beyond immediate exposure, suggesting a lasting impact on stress-related biomarkers.

Urban green spaces, despite their proximity to urban life, have emerged as vital sanctuaries for stress reduction. Research by van den Bosch and Ode Sang, focusing on urban nature, emphasizes that even small pockets of greenery within cities can contribute to stress alleviation. The presence of green spaces, including parks and tree-lined streets, is associated with improved mental well-being and reduced perceived stress among urban residents.

The workplace, often a locus of stress, has been a focal point for studies investigating the stress-reducing effects of nature exposure. Research by Kjellgren and Buhrkall demonstrates that incorporating natural elements into the workplace, such as indoor plants and nature views, positively influences stress levels and job satisfaction. Furthermore, studies by Rana et al. highlight the potential of workplace gardens and greenery to act as effective stress buffers.

Studies exploring the broader connection between nature exposure and psychological well-being consistently affirm the stress-reducing benefits. Work by White et al. and Bratman et al. underscores the positive impact of nature walks and exposure on mood enhancement and emotional well-being. These studies reveal that individuals who engage with natural settings report lower levels of stress, anxiety, and depression, signaling a holistic improvement

in psychological health.

Research exploring the relationship between nature exposure and attentional focus has unveiled a noteworthy connection. Studies by Berto and Hartig demonstrate that exposure to natural environments fosters a sense of mindfulness and mental clarity. This heightened awareness and attentiveness contribute to stress reduction by diverting attention from stressors and promoting a state of tranquility.

Several studies delve into the intersectionality of nature exposure and stress, particularly examining socioeconomic disparities. Research by Markevych et al. suggests that individuals with lower socioeconomic status experience greater stress reduction benefits from green spaces. These findings underscore the potential of nature exposure as an equitable means of stress reduction, with implications for public health and urban planning.

## 7. Theoretical framework

In the domain of environmental psychology, understanding the intricate interplay between the environment and human well-being is a nuanced exploration guided by several relevant theories. This introduction illuminates key theoretical frameworks that delve into the relationships between environmental factors, stress, and well-being.

Central to the field of environmental psychology is the Biophilia Hypothesis, articulated by biologist E.O. Wilson. This theory posits that humans possess an innate affinity for nature and other living organisms. According to Wilson, our evolutionary history has shaped a deep-seated connection with the natural world. In the context of stress and well-being, the Biophilia Hypothesis suggests that exposure to natural environments or nature-inspired elements in built environments can positively influence mental health, reduce stress, and enhance overall well-being.

The Attention Restoration Theory (ART), proposed by Rachel and Stephen Kaplan, delves into the cognitive aspects of well-being. ART posits that the urban environment, characterized by constant stimuli and attention-demanding tasks, can lead to mental fatigue and stress. Natural environments, on the other hand, offer a restorative escape by providing "soft fascination" – gentle, restful stimuli that capture attention without requiring intense focus. ART suggests that exposure to nature facilitates cognitive restoration, reduces mental fatigue, and contributes to improved well-being.

Building upon the foundation of the Biophilia Hypothesis, Stress Reduction Theory posits that natural environments have an inherently stress-reducing effect on individuals. Developed by Roger Ulrich, this theory suggests that exposure to nature or nature-inspired settings can lead to physiological and psychological benefits, including reduced stress levels, improved mood, and enhanced overall well-being. The theory underscores the importance of incorporating natural elements into built environments to counteract the stress-inducing aspects of



modern urban living. The Psych evolutionary Theory, proposed by environmental psychologist Gary W. Evans, explores the evolutionary origins of human responses to the environment. This theory posits that humans have evolved to respond to certain environmental cues based on their adaptive value. In the context of stress and well-being, the theory suggests that the built environment can evoke stress or well-being responses depending on its alignment with evolutionarily relevant cues. Natural elements that mimic ancestral environments are more likely to promote well-being, while discordant environments may induce stress. Person-

Environment Fit Theory, rooted in the work of John L. Holland, explores the congruence between individual characteristics and environmental features. In the context of stress and well-being, this theory suggests that individuals experience optimal well-being when there is a match between their personality traits, needs, and the characteristics of their environment. For example, an individual with a high preference for natural settings may experience greater well-being in environments that offer ample greenery and natural elements.

As we navigate the intricate terrain of environmental psychology, these theories provide a foundational understanding of how environmental factors influence stress and well-being. They guide research, design practices, and interventions aimed at creating environments that promote human flourishing, cognizant of the profound impact that our surroundings can have on the human psyche.

## 8. Methodology (Case Study)

Singapore, known for its bustling urban landscape, showcases a remarkable synergy between nature and architecture in the iconic Pinnacle at Duxton. This high-density residential complex redefines urban living through innovative biophilic design principles, transforming the towering structures into verdant sanctuaries that resonate with both residents and the surrounding city.

At the heart of Pinnacle at Duxton's biophilic design are the striking sky gardens that cascade down the interconnected towers. These elevated green spaces, featuring a rich tapestry of flora, not only enhance the aesthetics of the complex but also play a pivotal role in fostering a connection with nature. The intentional layering of greenery at various levels creates a vertical landscape, providing residents with a visual and sensory respite from the density of urban living.

The use of natural materials in the construction and design of Pinnacle at Duxton further underscores the commitment to biophilic principles. Wood, stone, and other organic elements seamlessly blend with the urban fabric, softening the architectural lines and invoking a sense of harmony. The juxtaposition of these natural materials against the backdrop of the cityscape creates a dynamic interplay between the built environment and nature.

Water features, strategically integrated into the design, enhance the biophilic experience at Pinnacle at Duxton. Reflecting pools, cascading fountains, and water walls contribute to the sensory richness of the space. The sound of flowing water, combined with the lush green surroundings, creates a tranquil ambiance that transcends the urban clamor, offering residents a serene retreat within the city.

The communal spaces within the complex are thoughtfully infused with biophilic elements, fostering social interaction and community engagement. Rooftop gardens, pocket parks, and seating areas surrounded by greenery become communal havens where residents can connect with both nature and each other. These shared spaces go beyond mere aesthetics, acting as catalysts for a sense of belonging and well-being among the diverse inhabitants of Pinnacle at Duxton.

Beyond the aesthetic allure, Pinnacle at Duxton's biophilic design is rooted in a commitment to sustainability. The incorporation of green roofs and walls contributes to energy efficiency, insulation, and stormwater management. The ecological consciousness embedded in the design aligns with Singapore's broader vision of creating a sustainable and resilient urban environment.

Residents of Pinnacle at Duxton are not only surrounded by nature but are active participants in its cultivation. The presence of community gardens allows residents to engage in gardening activities, fostering a hands-on connection with the natural world. This participatory aspect of biophilic design contributes to a sense of ownership and pride among residents, further enhancing the positive impact on their well-being.

In conclusion, Pinnacle at Duxton stands as a biophilic marvel, redefining high-density living in the urban context of Singapore. The intentional integration of nature into the architectural fabric transcends mere aesthetics, offering a holistic and transformative living experience. As cities around the world grapple with the challenges of urbanization, Pinnacle at Duxton serves as an exemplar of how biophilic design can elevate the quality of life for residents, creating sustainable and harmonious urban environments.

In the heart of Manhattan's dynamic urban fabric, Via 57 West stands as a testament to innovative biophilic design, seamlessly blending nature and architecture. This residential complex, designed by Bjarke Ingels Group (BIG), redefines high-density living in New York City through its distinctive tetrahedron shape and intentional integration of biophilic elements.

At the core of Via 57 West's biophilic design is the iconic courtyard, a verdant oasis nestled within the angular structure. This central space, adorned with lush greenery, water features, and seating areas, serves as a communal retreat from the bustling city below. The courtyard's design mimics natural landscapes, offering residents a respite reminiscent of a tranquil park within the urban jungle. The building's unique shape allows for optimal exposure to natural light and expansive views of the Hudson River. Floor-to-ceiling windows and terraces in

each apartment maximize access to daylight and offer residents a connection to the surrounding environment. This deliberate effort to enhance natural light not only contributes to energy efficiency but also elevates the overall well-being of residents.

Biophilic design at Via 57 West extends beyond the courtyard to the selection of materials and architectural elements. The use of natural materials, such as wood and stone, creates a tactile connection to the environment. The building's exterior features a cascading system of terraces, each adorned with greenery, promoting vertical biodiversity and fostering a sense of continuity with nature across the building's facade.

Water, a fundamental element of biophilic design, is artfully incorporated throughout Via 57 West. Reflecting pools and water features enhance the sensory experience, providing a soothing auditory backdrop to the urban environment. The sound of flowing water coupled with the visual spectacle of aquatic elements creates a multisensory ambiance, contributing to stress reduction and an enhanced sense of well-being. Communal spaces within Via 57 West are carefully designed to encourage social interaction and connection with nature. Rooftop gardens and communal lounges adorned with plants serve as extensions of the courtyard, creating a cohesive biophilic experience throughout the building. These shared spaces become hubs of community life, where residents can relax, socialize, and immerse themselves in the natural surroundings.

Via 57 West exemplifies the principles of biophilic design not only in its physical features but also in its commitment to sustainability. The building incorporates green roofs, rainwater harvesting, and energy-efficient systems, aligning with the broader ecological ethos of modern urban living.

Via 57 West stands as a biophilic jewel in the Manhattan skyline, redefining the possibilities of high-density living. Its innovative design transcends the conventional boundaries of urban architecture, offering residents a harmonious synthesis of nature and city life. In an era where the importance of sustainable and human-centric design is paramount, Via 57 West serves as a beacon, showcasing the transformative potential of biophilic principles in the heart of one of the world's busiest cities.

## 9. Conclusion

In conclusion, this research advances our understanding of the intricate relationship between biophilic design and stress reduction in high-density living environments. The synthesis of theoretical frameworks, case studies, and empirical evidence underscores the potential of biophilic interventions to act as a salve for the urban soul. As cities continue to evolve and grapple with the complexities of urbanization, the principles of biophilic design provide a beacon of hope—a pathway to creating urban environments that not only accommodate the density

of populations but also nurture the well-being of individuals. The transformative potential of biophilic design serves as a testament to the enduring connection between humanity and the natural world, even within the bustling heart of urban landscapes.

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