# Biophilic Architecture: Using Cognitive Science Principles to Understand Impact On Well-Being

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## ABSTRACT

Biophilic architecture is an approach that seeks to connect users more closely with nature by utilizing natural elements and landscape features in buildings. Its aim is to increase well-being, health, and mood using the built environment that surrounds us. Similarly, and often used in tandem, biomorphic architecture refers to an approach that seeks to connect users more closely with nature by using features that mimic it. Despite these goals, little research in cognitive science, the study of the mind, has explored the underlying cognitive reactions specifically induced by biophilic architecture. Here, I have compiled neuroscientific, architectural, and psychological research to study the effects of biophilic architecture on mood, stress, and general health outcomes, and suggest further areas of study for future research. Early findings suggest green spaces and biophilic architecture are extremely effective in lowering stress, increasing happiness, and improving overall physiological health.

## Introduction

### Pruitt-Igoe and the Psychological Impact of Architecture

**Figure 1.** Aerial view of the Pruitt-Igoe Housing Project in 1956, by Joe Wolf. License: Attribution-NoDerivs (CC BY-ND 2.0).

In 1954, the Pruitt-Igoe public housing project in St. Louis, Missouri, first opened its doors. Built during the height of Modernism, its thirty-three 11-story towers (as seen in Fig. 1) made it one of the largest public developments in the nation (Marshall, 2015). When creating the project, architect Minoru Yamasaki originally envisioned the complex as a mixture of two-story houses and widely spaced 11-story slab blocks with playgrounds and a 'green river' running throughout. However, due to federal housing regulations and cutting costs, the final product doubled in density of units per acre, eliminated the variation in building heights and two-story housing, and eliminated the green river (Gyure, 2019). This follows the common features of Modernist architecture, which has minimal or no ornamentation and tends to have form follow function, emphasizing horizontal lines, flat roofs, and efficiency (RIBA, n.d.), often appearing impersonal or even sterile. Despite its uniformity and lack of organic forms and greenspaces, the Pruitt-Igoe project was initially seen as an "oasis" compared to the previous housing complexes (de Paiva, 2018). However, over time the quality of life declined severely. Less than two decades later the abandoned, deteriorating, and crime-infested housing was demolished. While Pruitt-Igoe's failure has been attributed to the declining population and financial problems within the housing authority, critics, such as architect and city planner Oscar Newman (1935-2004), known for his defensible space theory, have also attributed it to the shortcomings of institutional, Modernist architecture, which some believe created enough of a hostile environment that the entire project failed (Donnelly, 2010). The discourse over what truly attributed to the failure of this housing project raises questions about the degree of influence architecture has on our well-being and behavior.

In a general response to the pitfalls and cognitive effects of institutional and "hostile" styles of architecture, in recent years, the concept of biological and nature-inspired architecture has gained prominence. It is imperative to explore architectural paradigms like biomorphic design that prioritize human psychological and physiological needs, to ensure a project failure like this doesn't happen again. Perhaps if Yamasaki's original greenspace and visually varied housing had been implemented, the project would have seen a different outcome.

Biophilia refers to the innate tendency that humans have to see connections with nature and other life-like processes (Wilson, 1984). The Biophilia Hypothesis, proposed by Edward Wilson in his 1984 book, therefore, posits that given that humans evolved in the natural world, our brains are wired or "programmed" to respond positively to nature. Biophilic design, and specifically biophilic architecture, is based on this hypothesis, with the idea that by imitating nature, architecture will have positive effects on humans. Therefore, the cognitive responses of occupants in these built environments can be studied to determine how effective this approach is psychologically and emotionally. In this paper, I am going to suggest that, based on cognitive science principles, biophilic architecture is very effective in improving human well-being, which has been studied through surveys and tightly controlled experimental manipulations. I include data from a 2021 study to provide evidence for this effectiveness. However, through this review, I have also identified that research regarding biophilic and biomorphic forms and their cognitive effect has been severely limited, despite the Biophilia Hypothesis being almost 50 years old. For instance, a lot of prior work has been limited to laboratory settings making the results less transferable to real-world conditions. The purpose of this review is therefore to highlight possibilities for future investigations of this promising approach to human-centric architecture. I present suggestions for future research, namely that individuals should be placed in biophilic architectural environments and have their neural activity measured in tandem with subject responses. Therefore further research should be done specifically regarding architecture that emulates organic forms, using an embodied cognition framework.

## Background and Approaches

### Biomorphic and Biophilic Architecture

As evidenced by the Pruitt-Igoe case study above, architectural buildings are the result of a complex decision-making process that translates socio-cultural objectives into spatial architectural forms (van der Voordt et al., 1997). Thus, when an architectural space does not align with the objectives of its users, it creates an incongruence that negatively impacts occupants and their functional abilities. This is why it is crucial to design architecture that meets all of an occupant's needs.

Biophilia means an affinity for nature or living things. As such, biophilic architecture is an approach that seeks to connect occupants more closely to nature. Similarly, biomorphic architecture is a style that seeks to emulate and express natural forms and patterns. The two approaches are not exclusive and are often used in tandem. For the purpose of this paper, I will be using the overarching term of biophilic architecture to encompass both labels under one major approach to architecture, which is one that has the purpose of connecting the occupants more closely with nature. Though these approaches have been present for centuries, there has been a global resurgence in interest in the benefits of this style. Humans have adapted to the natural environment for the majority of our time on earth, but in recent times the rapid growth of urbanization has severely diminished human contact with natural forms. In fact, by 2030, 60% of the population will live in urban environments, which could have potentially massive effects on humans (Joye, 2006). This rise of modern biophilic architecture is likely in response to our need for natural stimulation in our environments. Common features of this overarching approach include natural elements; such as trees and plants, traditional ornaments depicting nature, stylized abstractions of natural forms, and more abstract structural features; any geometric feature that evokes organicity or naturalness, such as high degrees of curvature or fractal design (Joye, 2006). Examples of these features can be seen in Figures 2-4 below.

**Figure 2.** The Portico of Charity, el Temple Expiatori de la Sagrada Família, Barcelona, Catalunya by Elias Rovielo. Licensed under Attribution-NonCommercial-ShareAlike (CC BY-NC-SA 2.0). As seen in Figure 2, this is an example of traditional ornamentation, containing biomorphic sculptures and forms.

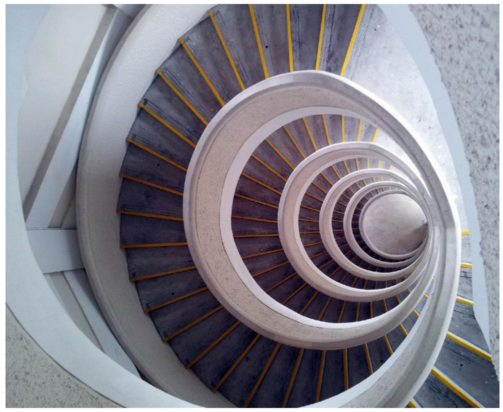

**Figure 3.** Spiral Staircase. An example of a structure that uses high degrees of curvature to emulate organic forms.

**Figure 4.** Grin Grin Park in Fukuoka, Japan, by Scarlet Green. License: Attribution (CC BY 2.0). This biophilic park is an example of using both natural forms and abstractions of natural forms.

Even though this is the goal of this paradigm of architecture, the cognitive ramifications of these types of environments remain understudied. In this paper, I aim to apply and review how the application of a cognitive science approach can help us better understand the success of this type of architecture. I begin by defining cognitive sciences and the current state of the field before presenting some data supporting the potential cognitive effects of using biophilic architecture.

## Cognitive Science and its Application in Architecture

Cognitive science is the interdisciplinary study of the mind and its processes. It draws from aspects of psychology, neuroscience, philosophy, linguistics, computer science, artificial intelligence, and anthropology. It describes the human mind as primarily an information processing center. This field covers a wide array of topics, including the study of attention, language, reasoning, emotion, bodily processes, memory, and perception. Cognitive scientists believe that a complete understanding of the mind and brain can only be attained by studying it on multiple levels; this includes the neural, the representational, and the computational. Because of this, computational models ideally work hand in hand with psychological experimentation. However, there are several distinct theoretical approaches to knowledge representation, which each propose their own set of cognitive processes that explain behavior. Essentially, the goal of cognitive science is to understand how the mind behaves, and by understanding how our minds (and in turn, bodies) respond to biophilic design choices, we can create spaces that are more supportive of our well-being and productivity.

## Embodied Cognition

One such distinct theoretical approach to knowledge representation is embodied cognition. Embodied cognition is an approach within cognitive science that emphasizes how an organism's interaction with its environment shapes and develops its cognitive processes. It argues that cognition emerges from real-time interactions and sensorimotor experiences between organisms and their surroundings, and that cognitive processes are not in isolation from the environment (Wilson & Foglia, 2021). The theory suggests that these interactions are the foundation for the formation of categories, concepts, and even higher-level cognitive functions. Relatedly, psychologist Kurt Lewin (1890-1947) created the equation $B = f(P, E)$, to illustrate that behavior is a function between the *person* (a unique individual with their own memories and genetics) and the *environment* (both physical and social) (Burnes, 2020). This approach effectively parallels the goals of biophilic architecture, which is to impact human behavior and cognitive functions by manipulating the environment, making it a compelling framework to use. Despite these obvious parallels, the relationships between embodied cognition and biophilic architecture have been understudied (see the Recommendations section for more suggestions for how to use this approach).

## Psychological Preference for Natural Designs - Fractals

Although these approaches have a relatively short history, something we do know is that humans have a psychological preference for natural designs. For instance, much work has focused on fractals. The term fractal is used to describe fractured shapes that possess repeating patterns when viewed at increasingly smaller magnifications (Hagerhall et al., 2004). Fractals are often observed in nature. The fractal dimension, D, ranging from the values between 1 and 2, is a parameter that can be used to describe fractal shapes and how completely fractals embed themselves into normal Euclidean space. Because of the natural presence of fractals in nature, many researchers have studied whether humans have a preference for "fractalness", and the effect of fractals in urban environments. Studies have found that the most preferred D values were in the same range of 1.3-1.5, regardless of the fractals' origin (nature such as trees and mountains, computer-generated fractals, or human fractals in Jackson Pollock's paintings) ( Spehar et al.,2003; Taylor et al., 2005). These results indicate that mimicking elements of nature, such as fractals, will have the same effect on the brain, regardless of origin. Additionally, the fractal dimension D can be a predictor of human preference (see Fig. 5). It has also been found that viewing these fractal patterns with D values between 1.3 and 1.5, tends to reduce physiological stress (Taylor, 2006). A 2018 study on psychological responses to natural patterns in architecture found that the variable of Scaling (Edge Density and Fractal Dimension) was a strong predictor of human preference for both architectural interiors and exteriors (Coburn et al., 2019). Architectural scenes with more fractal and natural qualities are preferred, on average, over scenes that appear artificial (Coburn et al., 2019). Another study on reducing physiological stress using fractal architecture and art found, using fractal analysis, that viewing fractals produces the desired physiological response (Taylor, 2006). The research presented in this study suggests that fractal architecture (an element of biomorphic design) is more practical for cities than directly incorporating nature, as the biophilia hypothesis suggests. Importantly, an entire field has been dedicated to understanding neural responses to this type of architecture.

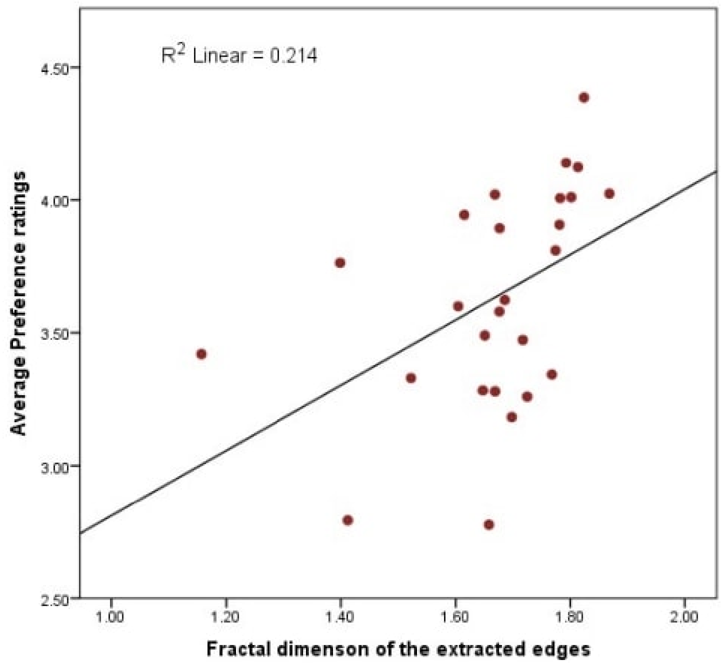


**Figure 5.** Graph of Fractal dimension of extracted edges of landscape photographs vs. Average preference ratings of participants. This figure is adapted from Investigating Landscape Preference Using Fractal Geometry (Patuano, 2019), showing a positive correlation between the extracted fractal dimension of landscapes and average human preference, suggesting that this can be a predictor of preference. Licensed under CC BY-ND.

## Neuroarchitecture

Traditional approaches to architecture have focused on 'designerly ways of knowing', or rather problem-solving strategies specific to designers which are distinct from traditional scientific methods (Cross, 2001). There also exist design principles that provide basic guidelines for architects, built on the cumulative knowledge and experience of professionals in many disciplines. They are defined as identifiable objective qualities of design elements. However, these processes are often subjective and can introduce biases in decision-making, potentially leading to designs that do not adequately address the cognitive-emotional needs of users (Higuera-Trujillo et al., 2021). While many design theorists agree that design should not be confused for a science, nor that design theory should be based on inappropriate paradigms of logic (Cross, 1982), it can be understood that design is a process of pattern synthesis and architectural spaces have direct cognitive-emotional impacts on occupants. Thus, our understanding of design can be improved through "scientific" (i.e. reliable, systemic) investigation (Cross, 2001). For this reason, a relatively new discipline has emerged within architecture, which utilizes neuroscience to address the cognitive-emotional aspect of architecture, not just the aesthetic or physical dimensions. Neuroscience is the study of the nervous system, typically through scientific procedures such as imaging the brain. As such, the application of neuroscience to architecture is labeled "neuroarchitecture" (Metzger, 2018) Despite being a new field of research, neuroarchitecture has the potential to revolutionize the way we design our built environment. By understanding how the brain responds to different architectural elements, we can create spaces that are more supportive of human well-being and cognition.

## Existent Work in the Field of Neuroarchitecture

The main approaches to studying neuroarchitecture include environmental psychology, and the evidence-based design (EBD) approach. One of the advantages of using environmental psychology is its use of evaluation instruments, such as the models of Küller, which describe the affective-emotional states elicited by the experience of space (Küller, 1972). These models have been able to be used to quantify how certain environmental experiences affect emotional states, such as the perceived importance of different design variables. A more practical tool within environmental psychology is the EBD approach, which bases decisions about the built environment on credible past research (Higuera-Trujillo et al., 2021).

Reducing stress and improving overall well-being are two prominent outcomes that have been studied. Research has shown that EBD can reduce pain and stress (Ulrich et al., 2006, pp. 37–61), such as a study of patient recovery in a suburban Pennsylvania hospital between 1972-1981 (Ulrich, 1984). Patients with windows facing natural scenes had shorter stays and took fewer painkillers than those facing monotonous brick walls, supporting the principle within EBD that natural elements have positive, therapeutic effects on occupants. This makes EBD a reliable approach for predicting how design will impact users and adjusting it accordingly. See Figure 6 for additional evidence of the effects of EBD studies.

| Design Variable | Effect |
|---|---|
| Ceiling height | High ceilings inspire freedom, low ceilings calm [177]. |
| | High ceilings generate greater creativity and feelings of comfort [178]. |
| | Ceiling height positively affects wayfinding [179] |
| Presence of vegetation | Vegetation reduces stress and anxiety [4]. |
| | In parks, pleasure increases based on tree density, and arousal with weed density [180]. |
| | Biophilia hypothesis: preference for natural forms [181,182]. |
| | Attention restoration theory: natural environments are restorative. Their restorative characteristics are "fascination," "being away," "coherence," and "compatibility" [183]. |
| Complexity | Preference for moderate levels of complexity, similar to a savannah environment [184]. |
| | Prospect-refuge: preference for natural and built environments, which offer visual control of the environment and places to hide [185–187]. |
| Illumination | Colour temperature and illuminance are interrelated with comfort [188]. |
| | Natural light reduces hospital stays [189]. |
| | Light and form are interrelated: walls and ceilings influence the perception of brightness. A room appears larger when it receives more indirect light [190]. |
| | Mood valence and cognitive performance alter based on light parameters: colour temperature with a less negative effect on mood, improved cognitive performance, the combination of colour temperature, and illuminance with better evaluation in mood, improved cognitive performance [191]. |
| | Emotional states affect the perception of brightness [192]. |
| Colour | Extracted at an early stage of visual processing [193] |
| | Wide variety of effects on aesthetic preferences [194]. |
| | Hue and saturation are related to the emotional state [195]. |
| | Warm tones have higher arousal values, and colder tones are lower [196]. |
| Use | The use to which a space is put influences its psychological evaluation [197]. |
| Coherence | In natural settings, the coherence of a setting with wooden furniture is significantly greater than a setting with metal furniture, but significantly less than a setting without furniture [198]. |

**Figure 6.** List of effects generated by variables or aspects of architectural design frequently studied in the environmental psychology and EBD approach. The above image was adapted from Higuera-Trujillo and colleagues. Licensed under CC BY 4.0.

## Brain Regions for Unconscious Processing of the Environment and Mood

At a broader level, as in the theories of embodied cognition (see section above), cognition and well-being are highly influenced by our surrounding physical space. Thus, the brain regions that have been shown to be involved in the processing of architecture include not only sensory regions such as the visual cortex and the somatosensory cortex, but also higher-level processing regions like the prefrontal cortex (P.F.C.; for planning and emotional regulation), the hippocampus (for navigation), the amygdala (for emotion processing), and the insula (for interoception and self-awareness). Studies have found that decision-making is actually much more influenced by impulsive, instinctive, and affective thinking rather than logic and rationality (de Paiva, 2018), relying on brain regions like the P.F.C. and basal ganglia. In particular, lots of work has considered how the brain may be *unconsciously* taking in architectural elements. One system for doing this is our default mode network of the brain, which is involved in mind wandering and introspection. This can be directly contrasted to the frontoparietal network of the brain, including the P.F.C., which is involved in focused attention and is majorly involved in decision-making. Workplaces should support both types of processing so it would be important to design spaces that promote mind wandering to boost creativity (i.e., spaces that are quiet or with plenty of light) and spaces that promote focus and attention to improve productivity (i.e., spaces that have limited distractions).

Of course, a lot of this processing relates to our mood. "Mood," or rather, positive and negative affect, has a direct impact on our mental and physical health, as can be observed in mental illnesses such as depression and anxiety, and in general in our overall cognitive performance. A majority of neuroarchitecture studies discussed below consider mood to be the most relevant outcome when considering the benefits of biophilic architecture. Associations, in cognitive science, are how thoughts advance from one representation to another. Our understanding of the process of mood regulation is limited, but there is strong evidence to show that a positive mood results in broad, associative thinking that activates related concepts, while narrow associative thinking (in other words, rumination) is associated with a negative mood (Bar, 2009). As such, experiences that result in spontaneous and new thoughts should alleviate negative moods. Possible benefits have been given to explain this, such as the evolutionary benefits of accurate predictions and the ability to interact with novel situations, which go hand in hand with the physiological release of neuropeptides, which modulate cognitive functions like mood and learning (Bar, 2009). As reviewed in Affective Processing in Non-invasive Brain Stimulation Over Prefrontal Cortex (Liu et al., 2017), one of the major neural structures involved in mood and emotional regulation is, again, the prefrontal cortex, which, when stimulated, can alleviate symptoms of depression in subjects. For example, a 2014 study found that people working in offices with natural light were shown to have reduced symptoms related to depression and poor well-being, such as poor sleep quality, compared to those in windowless offices (Boubekri et al., 2014). Other relevant brain regions include systems like the hippocampus and the amygdala.

Notably, while we know that these structures are involved in processing mood and attention more generally, more evidence is needed regarding how they respond to different architectural elements (see discussion of recommendations below). We recommend potential studies that can be done to gather more insight into these systems.

## Psychological Preference for Natural Forms and their Effect on Mood - Greenspaces

A lot of the prior work investigating mood has focused on greenspaces, or areas reserved for the natural environment, which are common in biophilic architecture when trying to give occupants an opportunity to closely interact with nature due to their ability to lower stress, increase happiness, and even increase physical health. Greenspaces have been shown to improve mood and alleviate depression in various different environments, including workplaces and non-commercial areas (Brengman et al., 2012). I was interested in directly testing these benefits in relation to mood, so I used publicly available data from 2021 to analyze how natural environments affect positive affect and stress.

## Methods

The present analysis employed Python libraries and tools to conduct an analysis of publicly available data sourced from a study on affect and cognition in natural and commercial semi-public spaces done by researchers (Schertz and colleagues) from the University of Chicago, Huron University College, and the University of Minnesota. The experiment was conducted in the Garfield Park Conservatory (https://garfieldconservatory.org) and Water Tower Place Mall in Chicago (https://www.shopwatertower.com/en.html). 86 participants (mean age 21.60 years, SD = 3.78 years, Range 18-39) were analyzed from the dataset. In the questionnaires (surveys 0-3) participants were asked questions about their most recent thought and its valence, and to assess thought valence, they reported how much the thought aligned with certain adjectives, the ones utilized in this analysis being "spontaneous," (see Fig. 9) and "stressful" (see Fig. 8) (Schertz et al., 2022). The participants' positive affect was measured by asking how much they felt the following four emotions: energetic, grateful, in awe, and optimistic (Schertz et al., 2022). The data was imported and subjected to descriptive analysis using Python to generate graphs and visual representations. I looked at condition/level differences (urban/commercial and natural) on variables of interest (Positive Affect, Stressful Thought, and Spontaneous Thought). All participant reports of Positive Affect, Stressful Thought, and Spontaneous Thought in response to the baseline questionnaire and 3 ambulatory questionnaires in the mall and conservatory environments were compiled to create three boxplots comparing the survey time to the specific affect/thought content variable. The data analyzed can be found here: https://osf.io/npwrj/.

## Results

According to the study, researchers studied differences in affect and cognition using participant responses and Bayesian multi-level models before, during, and after exposure to a nature conservatory as well as a large mall. I used their data to provide support that greenspaces, compared to strictly urban environments, increase positive affect (see Fig. 7), reduce stressful thought (see Fig. 8), and promote spontaneous thought (see Fig. 9) . My results confirm their results and also support the theory that environments that integrate nature increase well-being through positive affect, and improve cognitive performance and mood by countering rumination.

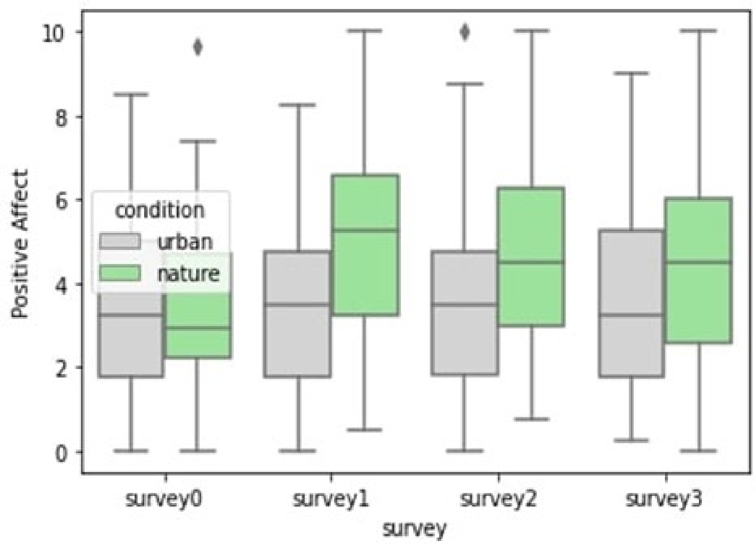


**Figure 7.** Survey type, from baseline affect (survey0), during exposure (survey1 and survey2), and after exposure (survey3), against Positive Affect value. Refer to the study discussed in the text for details of the measurements and the relevant y-axis scale. I found that positive affect increases the most relative to baseline during exposure (comparing surveys 1 and 2 to survey 0). This was only seen in natural environments and not in urban environments.

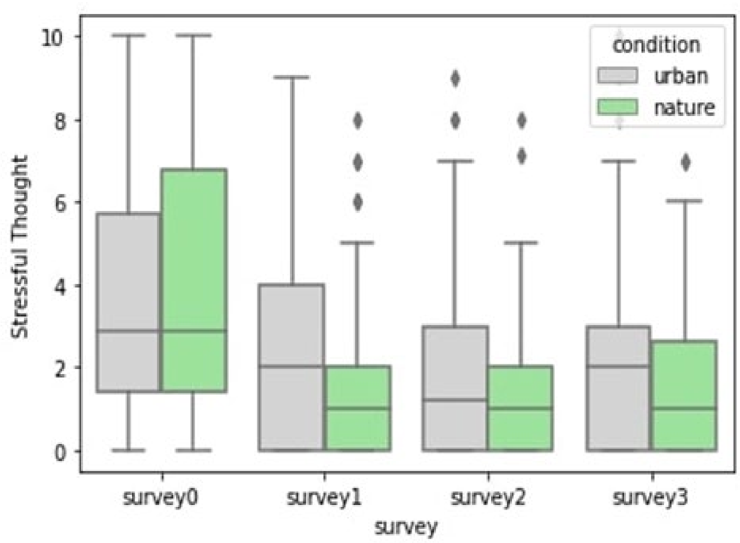


**Figure 8.** Survey type, from baseline stressful thought (survey0), during exposure (survey1 and survey2), and after exposure (survey3), against Stressful Thought value. Refer to the study discussed in the text for details of the measurements and the relevant y-axis scale. No differences were seen in stressful thought at time point 0. The data indicates that stressful thought was reduced relative to survey 1 in the natural compared to the urban environment.

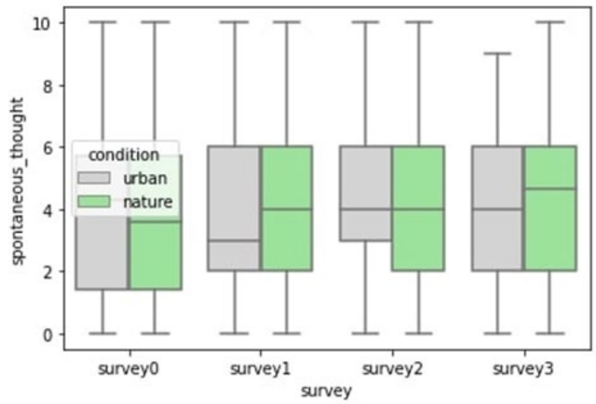


**Figure 9.** Survey type, from baseline spontaneous thought (survey0), during exposure (survey1 and survey2), and after exposure (survey3), against spontaneous thought value. Refer to the study discussed in the text for details of the measurements and the relevant y-axis scale. Data indicates that the amount of spontaneous thought differed between the urban and natural environment at time points 1 and 3.

## Conclusion

A cognitive science approach is necessary for understanding the effectiveness of biophilic architecture. These findings are significant for public health, as elements of biophilic and biomorphic architecture such as greenspaces and the mimicking of natural forms have been shown to cause responses in humans that improve their well-being and cognitive function (see Figures 7-9; and discussion of fractals). While some argue that it is unfair to test design within the field of architecture with the scientific method, the data shows that it is worthwhile to look into evidence-based design and these public health benefits. Based on the examples presented in this review, biophilic architecture has the potential to significantly improve our mood. Biophilic architecture appears to be a promising and practical solution for an increasingly urbanized world.

## Recommendations

Although there is evidence that biophilic architecture should have vast impacts on both people's preferences and general mood, there still remains a lot that is unexplored. Namely, few studies have taken a fully robust, empirical approach– most have either been purely descriptive or testing these questions "in the lab," outside of the important context of the actual buildings. Further, the statistics are often descriptive, such as reporting a mean, as opposed to comparing groups. This makes it difficult to compare results across different studies. In addition, few studies have approached research in biophilic architecture with an embodied cognition framework.

Within the literature, there exist many studies that utilize surveys and occupant responses, which are subjective, but few measure physiological responses such as skin conductivity or the activation of certain brain regions. While a cognitive science approach does include the psychological aspect of the architecture's effects, which is observed behavior, it also encompasses the neuroscientific aspect and the processes in which brains operate.

Furthermore, the limitations of existing empirical experiments are that many observe human responses to naturalness, e.g., fractalness, in natural landscapes or solely organic natural forms. Or, participants look at images of environments instead of actually experiencing them. While ecologically valid experiments regarding greenspaces have been conducted, it is necessary to consider them within urban environments as well where they are integrated into the built environment, as opposed to vegetation on its own. In addition, this means many inferences must be made, such as applying findings on natural or computer-generated fractals to fractals in architecture and using greenspace data on natural forms to infer the effects of imitations of natural forms. As such, there is a need for ecologically valid experiments that place participants within the built environment to most accurately assess biophilic architecture's effects. This is also where an embodied cognition approach would be relevant in studying how the occupants experience their environment. One tool to look into is virtual reality (V.R.), which can offer any variation of immersive and interactive representations of the environment, and more so than images.

Perhaps future work can test individuals looking at different architectural elements and see how neural activity in crucial regions involved in mood and attention (P.F.C.; amygdala) responds differently based on the degree of biophilia in the images. While this approach would give us insights into the neural structures involved, they still would not be as ecologically valid as testing these differences in buildings. Thus, future work should also take an approach similar to educational psychology and test individuals with mobile EEG in biophilic environments. This would allow researchers to see how neural activity responds differently as individuals are navigating across environments. One intermediary approach could be to set up virtual reality biophilic environments in order to look at subcortical brain regions (as imaged by a functional MRI) while preserving some elements of the natural experiences of navigating through these environments.

Another experiment I propose is to take a group of individuals, record their baseline stress and positive and negative affect (through a trait questionnaire), and place them in a building with biophilic architecture, compared to a regular building that does not include biophilic elements. Their stress and affect will be tracked over a week in each building, and measured both behaviorally through recorded thought associations and responses, as well as objectively through skin conductivity and EEG, and will be compared at the group level if the reported mood differs across people based on the architecture that they occupied.

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