Patterns in Architecture and How it Affects Our Brain

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Abstract- This study investigates the complex connections between human emotions and cognition and architectural designs. It explores how patterns like symmetry, rhythm, and repetition affect the human mind by fusing ideas from design, psychology, and neuroscience. The study evaluates participants' reactions to different architectural styles using controlled trials and psychophysiological data in an effort to identify minute impacts on emotional and cognitive states. The study attempts to identify patterns in brain activity, attentional focus, and emotional responses using a combination of quantitative and qualitative studies, statistical techniques, and theme interpretation. It is anticipated that the results would provide insightful information for architects, making it easier to create spaces that support emotional balance and cognitive health. Ultimately, the research contributes to a deeper understanding of how architectural elements influence human experiences, guiding the development of spaces that positively resonate with our cognitive and emotional states.

Key Words: Patterns, symmetry, rhythm, harmony, psychology

1. INTRODUCTION

The complex interactions between architectural patterns and the human brain are examined in this study, which looks at the effects of design features including symmetry, repetition, rhythm, and harmony on both mental and affective reactions. The goal of the research, which is based on a multidisciplinary approach integrating psychology, neurology, and architecture, is to identify the processes by which these patterns affect human thought. The constructed environment, which is sometimes referred to as a canvas, serves as a medium for directing a neuronal symphony that influences our feelings, ideas, and actions in ways that go beyond aesthetics.

Architectural patterns are strong communicators that influence human cognitive processes, not only decorative elements. A visual language is created by the repetition of components, which also helps to establish rhythm and guide the viewer's eye. A preference for order is sparked by symmetry, which has balance and proportion, and harmony in design adds to a room's overall coherence and comfort. These recurring themes, which are extensively embedded in architectural discourse, align with the brain's innate ability to identify and interpret visual cues in order to survive.

This study aims to improve architectural design by integrating ideas from psychology, neuroscience, and other disciplines in order to maximise emotional well-being and cognitive performance in built spaces. The aim is to promote harmonious cohabitation between people and their environment by investigating the relationship between architectural patterns and the human brain. The project aims to inspire a new design paradigm that produces environments that are compelling, interesting, and rewarding by emphasising patterns as dynamic tools. In addition to adding appeal and interest, patterns in design assist to produce rhythm, balance, and harmony. They also represent cultural importance and foster identity. They aid in stress reduction, efficient space organisation, and improved

sustainability and environmental performance. Understanding the significance of patterns enables architects to design unique, emotionally engaging rooms that are consistent with company identity.

2. Navigating the Cognitive Landscape of Architectural Patterns

Patterns and the Cognitive Landscape:

The potential of architectural patterns to impact the cognitive landscape is what gives them their power. A key component of design, repetition induces a cognitive dance in the brain that gives informational rhythm and predictability. Another powerful element is symmetry, which appeals to the brain's predilection for order and balance and frequently elicits pleasant feelings. When disparate components are integrated, harmony is created, which has a favorable effect on mental health by fostering a holistic perspective.

Neuroscientific Insights:

Utilizing neuroscientific tools like functional Magnetic Resonance Imaging (fMRI) and Electroencephalography (EEG). While fMRI provides spatial insights into brain activation, EEG captures the temporal dynamics, revealing the rapid interplay of neural responses. Beyond the visual cortex, studies suggest that exposure to aesthetically pleasing architectural elements activates the brain's reward centers, releasing neurotransmitters associated with pleasure and positive emotions.

Psychological Understanding:

Architectural patterns not only engage cognitive processes but also contribute to emotional resonance within a space. Emotional responses to patterns are explored through psychological instruments, including surveys and questionnaires, assessing factors such as aesthetic preference, emotional valence, and perceived comfort. The psychological concept of biophilia suggests that designs mimicking natural patterns may tap into an innate affinity for nature, potentially reducing stress levels.

3. Historical Perspective on Patterns in Architecture

Throughout history, patterns have been used by structures as a kind of coded communication. Consider how the ancient Greeks, Egyptians, and Mesopotamians all employed patterns to narrate tales about their leaders, religions, and spiritual connections. Consider the Mesopotamians, who constructed enormous ziggurats covered with recurring patterns to represent their views on the universe's order. Then there are the stunning Greek temples, whose elaborate designs and expertly balanced columns were like a hymn honoring elegance and harmony. Time travel to the Islamic world, where complex geometric patterns glistened on mosques and palaces, narrating stories of God's limitless nature. Architects such as Leonardo da Vinci and Gian Lorenzo Bernini were artists in their own right, using patterns into their designs to create stunning rooms even in the Renaissance and Baroque periods. Not to be overlooked are the modernists of the 20th century, who simplified things yet managed to use patterns to great effect in their sleek, minimalist structures. Thus, patterns have always been a tool for architecture to communicate with people and tell tales, whether it be in contemporary skyscrapers or ancient temples.

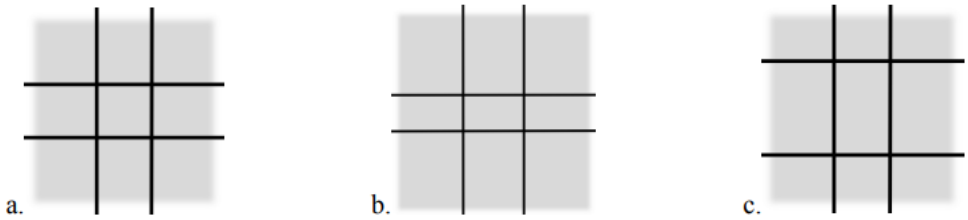
4. Understanding How We See Patterns

Our minds are continuously trying to interpret what we perceive as we look around us. Pattern perception enters the picture here. Similar to an innate system, it aids in the recognition and comprehension of recurrent patterns in colours, forms, and designs. Gestalt psychology is a field of study that focuses on how our minds automatically arrange items into patterns, such as pairing similar objects together or completing blank spaces to form a picture. Significant roles are also played by our attention, memory, and prior experiences. For instance, when a pattern catches our attention or reminds us of something we've seen previously, we usually notice it. Furthermore, our

feelings might affect the patterns that draw our attention. Architects and designers use all this knowledge to create spaces that feel just right, using patterns to make places that are both visually appealing and emotionally engaging.

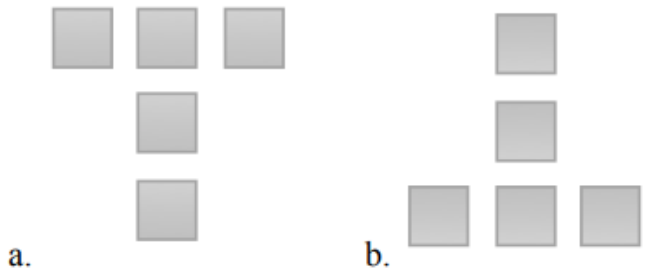
Nine Square Pattern

There is more to architecture and design than merely mimicking the natural world to evoke strong emotions in us. The patterns that they employ are also quite significant. Architect Don Ruggles discovered he preferred certain structures over others after touring the globe and seeing a variety of locations. He saw that all of the ones he thought were lovely shared the usage of a design known as the Nine Square. This pattern is still very important in architecture even if it is not new. The Nine Square design has been utilized by many cultures throughout history, each giving it a unique significance. It was seen as cosmologically significant in ancient Asia, and as a perfect and primal shape in the Middle East. It was also commonly employed throughout the Renaissance and Neoclassical eras. The fundamental Nine Square design is a 3 × 3 grid with an outside zone encircling the inner square. But since people are inherently drawn to patterns, the Nine Square may be adapted in a variety of ways to accomplish the same goal. Not only are the squares important, but also the way the area is partitioned to make them. The lines can be rearranged to be separated more, less, or even eliminated entirely. A Nine Square can also be nestled inside a bigger one.



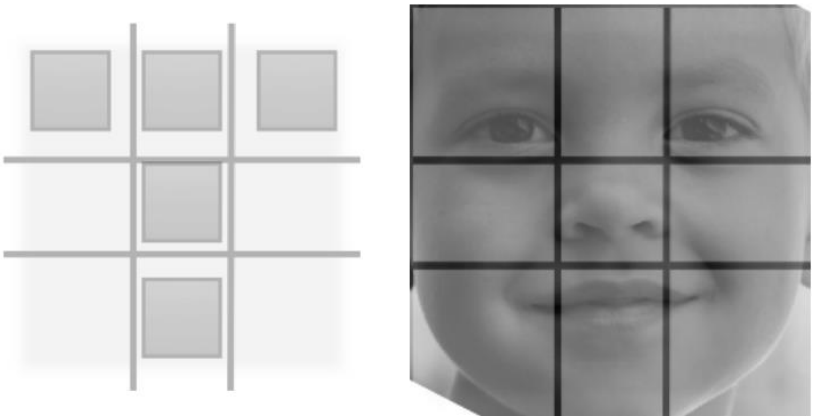
The Nine Square pattern has been used on city plans, building exteriors, and floor layouts in addition to architecture. The Nine Square is used in many famous buildings, including the Parthenon in Greece, the Pantheon in Rome, and the Taj Mahal in India. The enduring attraction of the Nine Square design is demonstrated by these structures, which have stayed strong for centuries due to their timeless beauty. Frank Lloyd Wright's Falling Water home and the Apple Store in New York City are two more modern examples. The pattern's extensive use implies that it's not merely a passing fad but rather something that speaks to a fundamental aspect of human psychology.

The Nine Square's resemblance to the structure of the human face is another factor contributing to its appeal in architecture. Because facial recognition requires a large amount of mental power, it is essential for survival. We analyse the characteristics of the face, the distance between them, and the structure of the face as a whole. Clinical research has revealed patterns, such the face inversion effect and the part-whole effect, that facilitate face recognition. face suggesting patterns are preferred even by babies, demonstrating the intrinsic value of face recognition in human cognition.



The shape of a T made up of various square to vaguely resemble facial structure. Inverting the T lessens its resemblance to facial structure.

Babies favored forms that resembled upright faces to ones that looked upside down, according to studies on shapes that resemble facial characteristics. It's interesting to note that the Nine Square closely matches the design of the human face, particularly the vertical "T" form. Imagine that the nose is in the middle square, the mouth is at the bottom centre square, the left eye is in the top left square, and the right eye is in the top right square. This resemblance implies that the Nine Square pattern may appeal to us more because it may use our natural capacity to recognize faces.



The similarities between the basic facial structure and the Nine Square.
Example of the human facial structure and the Nine Square. Background
Image from 2643525, by Tiluria, 2015, https://pixabay.com/en/portrait-child-face-boyhuman-2643525/. Copyright 2015 by Tiluria. Note: Reference lines for the Nine Square
in Figure 8 are not part of the original photograph. They were added to emphasize the
similarity of the human face and the Nine Square pattern.

The Nine Square's striking similarity to the human face suggests that when we look at certain architectural forms and patterns, we might subconsciously see faces. This could be why certain buildings give us feelings of pleasure and evoke strong physiological reactions.

5. Architectural Patterns and Their Typologies

Similar to the building blocks that architects employ to construct stunning and useful places are architectural patterns. Consider them as distinct architectural elements that provide interest and individuality to structures. There are many different kinds of patterns, including forms (such triangles, squares, and circles), embellishments (like flowers or swirls), and textures (like wood grain or bricks). Certain patterns have a specific significance, such as symbols or signs that convey tales about a culture or historical period, while others recur again, creating a feeling of rhythm and movement. Architects select patterns with great care to ensure that structures feel correct, look nice, and blend in with their environment. Thus, the next time you see a structure, notice the patterns—it's like witnessing the creative hand of the architect come to life!

5.1 Symmetry

Empirical studies continuously demonstrate the importance of symmetry in shaping our aesthetic preferences and perceptions of beauty in a variety of contexts, such as branding, architecture, and the arts. Studies show that symmetrical designs are typically chosen over asymmetrical ones, demonstrating the intrinsic attraction of symmetry to people. Symmetry is favoured even by babies, demonstrating its inherent attractiveness. Symmetry evokes sentiments of pleasure and delight and is linked to pleasant affect and subjective beauty. That being said, various people with varying degrees of skill may have varied preferences for symmetry. Asymmetrical and simpler designs

are frequently appreciated by art specialists, whilst non-experts typically like symmetrical and complicated stimuli. Despite this variance, symmetry is nonetheless a basic feature of visual perception and is associated with ideas of sophistication, harmony, and stability. Overall, the widespread preference for symmetry suggests its universal appeal and its ability to evoke positive emotional responses in viewers.

5.2 Lines and Shapes

Humans have distinct reactions to different lines and shapes, which often form visual patterns. For instance, horizontal and vertical lines are generally preferred over diagonal ones because they're easier for our brains to process. Upward diagonal lines, sloping from lower left to upper right, tend to evoke higher activity levels, while descending diagonals, from upper left to lower right, are associated with relaxation. In terms of shapes, people tend to favor curved contours over sharp angles. Curved designs are perceived as more pleasing and harmonious across various cultures. Studies also show that concave lines are often rated more positively than convex ones. Additionally, individuals generally associate curved shapes with sweetness, calmness, and femininity, while angular shapes are linked to sourness, excitement, and masculinity. Moreover, the preference for angular or curved shapes can vary depending on cultural background and personal traits. Overall, these findings suggest that our responses to lines and shapes are deeply rooted and can influence our perceptions and emotions in various contexts.

5.3 Harmony, Balance, and Rhythm

Kumar took a close look at timeless aesthetic concepts like harmony and balance in 2016. He found that humans have a keen eye for balance in visual designs. According to Kumar, people tend to find compositions that are balanced more appealing than those that are intentionally unbalanced. Whether in art or design, harmony plays a key role in enhancing attractiveness. Similarly, Lehrer, in his review of art principles in 2009, pointed out that beauty is closely linked to order. He emphasized the importance of elements like repetition, rhythm, and orderliness, suggesting that these qualities contribute significantly to what we perceive as beautiful.

In architecture, pattern is often described as rhythm because it guides the eye smoothly from one focal point to another, like strolling through different parts of a room or a house. It's not just about getting attention; it also adds to the beauty of the place. Architects talk about four kinds of rhythm:

1. **Alternation:** This is like a dance between contrasting pairs, repeating back and forth to create an engaging pattern.
2. **Progression:** It's like a journey where elements in the pattern either grow bigger or smaller, giving a sense of movement and change.
3. **Repetition:** Just like a catchy tune, a single element is repeated over and over again, bringing a sense of harmony and consistency.
4. **Transition**: Using lines like pathways, the eye smoothly moves from one spot to another, ensuring a seamless visual experience throughout the space.

We find buildings that incorporate certain aesthetically pleasing patterns or rhythm to be more beautiful because our brains are conditioned by evolution to associate those patterns with safety, security, well-being and survival.

5.4 Colors Together

Ou (2015) points out that certain color combinations are more pleasing to the eye than others. Colors with similar hues or saturation levels tend to appear harmonious, while small differences in lightness between colors can enhance their harmony. Interestingly, colors that only differ in lightness also create harmonious combinations. Additionally, Jeon, Han, and Nam (2020) studied how people's preferences for colors vary. They found that individuals with

interdependent personalities, who value harmony and relational similarity, tend to prefer analogous color combinations (colors next to each other on the color wheel). Conversely, those with independent personalities see objects as more discrete and are less concerned with color harmony. Serra, Gouaich, and Manav (2022) assessed preferred surface color combinations and discovered that people generally prefer hues that are closer on the color wheel, with similar backgrounds being more important than accent colors. They also found that observers preferred compositions with low chromaticness and a certain level of contrast in blackness between background colors and accent colors. Overall, these studies emphasize the importance of color harmony and similarity in creating aesthetically pleasing combinations.

6. Neurological Responses to Architectural Patterns

When we look at architectural patterns, our brains react in interesting ways that scientists can study using special tools like fMRI and EEG. These tools help researchers see which parts of the brain light up when we see different patterns. It turns out that seeing beautiful architectural designs can make us feel happy because it activates parts of our brain associated with pleasure. These patterns don't just affect our eyes—they can also change how we feel and think. So, architects can use this knowledge to create spaces that not only look nice but also make us feel good inside.

7. Biophilic Design and Natural Patterns

Imagine walking into a building and feeling like you're surrounded by nature. That's what biophilic design is all about—bringing the outdoors inside to make us feel happier and healthier. Architects use things like natural light, plants, and flowing water to create spaces that feel like a breath of fresh air. These designs aren't just pretty to look at; they actually help us relax and feel more connected to nature. So, next time you step into a building and feel a sense of calm, you might just be experiencing the magic of biophilic design!

Many of history's most celebrated buildings draw inspiration from nature, reflecting the beauty and harmony found in the natural world. One such iconic structure is La Sagrada Familia, a breathtaking cathedral designed by Antoni Gaudí, nestled in Barcelona, Spain. Its construction commenced in 1882 and continues to this day, with an expected completion date in 2026 due to its intricate details and grandeur.

Gaudí's vision for La Sagrada Familia was deeply rooted in nature, particularly the lush forests that surround us. Upon entering the cathedral, visitors are enveloped by towering pillars, reaching an impressive height of 78 feet. These pillars branch out at their summits, mirroring the graceful intertwining of tree branches in a forest canopy, creating a mesmerizing spectacle that evokes a sense of awe and reverence.

A photo of the tree-like pillars that fill La Sagrada Familia. From Inside Sagrada Familia, by Trey Ratcliff, 2017, https://www.flickr.com/photos/stuckincustoms /34317112306/in/photostream/ Copyright 2017 by Trey Ratcliff.

The Eden Project

in Cornwall, England, consists of several transparent domes that house a wide variety of plants. The architect Nicholas Grimshaw found his inspiration from bubbles, making it easy for the translucent domes to effortlessly coexist with the surrounding nature.

The bubble-like domes of The Eden Project, shown here as part of an artistic installation, was inspired by the form of bubbles. From Field of Light, by Bruce Munro, 2017, http://www.brucemunro.co.uk/exhibitions/eden-project-st-austell-cornwalluk/ . Copyright 2017 by Bruce Munro.

All three of these buildings are renowned for their stunning beauty. One significant reason why we find these structures so captivating is how our brains interpret the sensory input they receive, connecting it with patterns that have historically been advantageous for our survival in nature. However, because this pattern recognition occurs on a subconscious level, most people are unaware of the underlying neuropsychological and physiological processes influencing their perception of beauty. This innate reaction can occur even when the resemblance of a building to the natural environment is not immediately apparent, demonstrating the profound impact of our evolutionary heritage on our aesthetic preferences.

8. Cultural Considerations in Pattern Perception

Patterns mean different things to different people, depending on where they come from. What looks beautiful or meaningful in one culture might not have the same impact in another. For instance, a pattern that represents good luck in one place might mean something completely different somewhere else. Architects need to be aware of these cultural differences to make sure their designs are appreciated and understood by everyone. So, when creating spaces, they take into account the diverse backgrounds and perspectives of the people who will use them.

9. Practical Applications and Design Guidelines

Architects and designers use what they've learned about patterns and people's feelings to make buildings that are just right. They pick patterns that make us feel good and help us think clearly. These experts have all sorts of tips, like choosing patterns that fit the size of the room and making sure they match the culture of the people who will use the space. They also think about things like how the light hits the patterns and what materials to use. By following these tips, they create buildings that make us happy and comfortable.

10. Future Directions and Research Implications

Looking ahead, there's still lots to learn about how patterns in buildings affect us. Scientists want to see how living and working in spaces with certain patterns over time can change the way we think and feel. They also want to team up with different experts, like architects and psychologists, to learn even more about how patterns influence us. And who knows? Maybe they'll even come up with cool new ways to use technology to design buildings that make us feel great. By keeping up this research, they'll keep making buildings that are better for all of us to live and work in.

11. Conclusion

In conclusion, the research on patterns in architecture and their influence on the human brain reveals significant insights into the design of built environments. Patterns play a crucial role in shaping cognitive function, emotional well-being, and overall human experience within architectural spaces. By understanding how patterns impact the brain, architects and designers can create environments that optimize mental health and enhance quality of life for occupants. This underscores the importance of integrating evidence-based design principles into architectural practice. Moving forward, there is a clear need for continued research in this field to further advance our understanding and application of patterns in architecture. By embracing evidence-based design principles, architects can continue to innovate and create spaces that positively impact individuals and communities alike.

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