Exploring the Influence of Neuroarchitecture on Human Behavior and Well-being

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Abstract—Neuroarchitecture explores the powerful connection between the design choices made in a building and how those choices impact our well-being. This impact can be felt on multiple levels, influencing our physical health, mental state, emotions, and even our social interactions. This research delves into systematic review of recent neuroarchitecture research. And also explore the historical evidence on how architecture has been used to influence emotions throughout history. This journey through time will provide valuable insights into how design has shaped human experience for centuries. The study encompasses how design elements like light, color,acoustics, material, scale, layout and volume affect user's behavior, emotions, and well-being. On this basis, creating collective information on how architectural elements affect our human emotions. This research helps to understand how to design buildings that actively promote a better quality of life and also going through the limitation in its effectiveness on different users and consistency.

Keywords— Architecture, emotion, human wellbeing, cognitive wellness, behavior, brain.

I. INTRODUCTION

What if architecture had a further effect than the buildings it creates? This is where and when neuroarchitecture begins. It is a new discipline that explores how elements of design are used to influence our mental state, mood and overall health. It's like creating spaces that can speak to our subconscious in order to improve thinking skills, increase work efficiency and elate emotions. This exploration will focus on the fine balance between designs made for human beings and the human mind. What scientific study reveals about particular building aspects linked to cognitive processing, emotional stability or stress reduction will be presented in this section. Although the term "neuroarchitecture" is relatively modern, the underlying principles have existed for centuries. Architects responsible for iconic structures like the Sagrada Família in Barcelona, Spain, or the Notre Dame Cathedral in Paris, France, may not have had access to contemporary neuroscience research, but their designs undoubtedly aimed to evoke profound cognitive responses related to spirituality and transcendence.

Consider Antoni Gaudí, the architect of the Sagrada Família. His unconventional approach to design, characterized by intricate organic forms and intricate details, was deeply rooted in his understanding of nature and his desire to create spaces that inspired awe and reverence. While Gaudí may not have articulated his intentions in terms of neuroscience, his use of light, space, and symbolism was undoubtedly intended to elicit emotional and cognitive responses from those who experienced his architecture. Similarly, the architects of the Notre Dame Cathedral, and countless other religious structures throughout history, were keenly aware of the psychological impact of their designs. From the soaring heights of the nave to the intricate stained glass windows depicting biblical scenes, every element of these buildings was carefully crafted to create an atmosphere conducive to contemplation, prayer, and spiritual experience.("Neuroarchitecture: When the Mind Meets the Built Form" 2023)

A. Concept of Neuroarchitecture

Neuroscience is a multidisciplinary field that encompasses various principles and concepts related to the structure and function of the nervous system. Neuroarchitecture is an emerging field that explores the interplay between designed spaces in the built environment and their impact on human behavior and well-being by the stimulation of the respective nerves. It essentially uses neuroscience principles to inform the design of spaces to achieve specific goals, such as:

Stimulating the thinking process and focus, creating a calming and healing environment, designing layout and features that reduce anxiety and stress, increased productivity and engagement for a better workflow.

B. Core Principle

Neuroarchitecture uses scientific knowledge about perception, attention, memory, and emotions to understand how various design elements – like lighting, color, volume, scale, spatial organization, and materials – affect us. Understanding how the brain responds to different stimuli.

C. ETHICAL CONSIDERATION

It's crucial to acknowledge the ethical considerations when manipulating behavior through design. Neuroarchitecture should be used ethically and responsibly, considering transparency, respect for autonomy and avoid manipulation

II. HISTORY

In ancient civilizations evidence suggests that civilizations like Greeks and Egyptians understood the impact of space on human experience, incorporating principles like symmetry, natural light, and symbolism into their architecture. While the term "neuroarchitecture" itself is a recent invention, ancient civilizations undeniably incorporated principles similar to its core concepts without necessarily having a scientific understanding of the underlying neurological mechanisms. They observed the impacts of their surroundings and used these observations to design structures that influenced behavior and well-being.

This intuitive understanding of the connection between space and human experience serves as a valuable starting point for our modern scientific exploration. By analyzing these historical examples and combining them with contemporary research, we can gain a deeper understanding of how design shapes our thoughts, emotions, and behaviors. This knowledge can then be used to inform the design of future environments that actively promote not only physical well-being but also mental and emotional health, fostering a deeper connection between ourselves and the spaces we inhabit..

A. EMPHASIZE ON NATURAL ELEMENTS

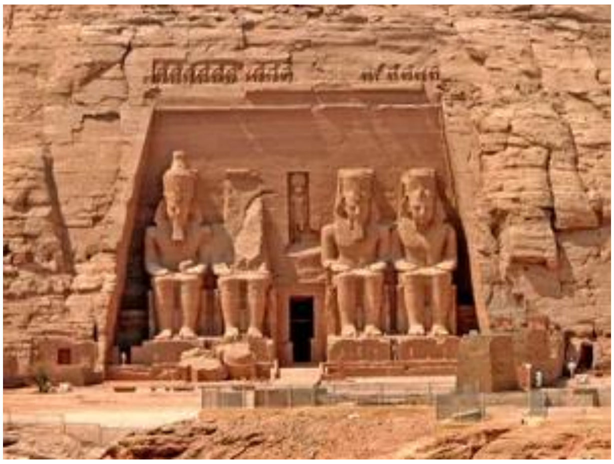

figure 1 *Great temple of Ramses II*
image courtesy : Encyclopædia Britannica

Ancient Egyptians temples often incorporated natural light and ventilation, potentially promoting feelings of peace and connection to the divine (Zelazko, n.d.). The most remarkable monument of Ramses II figure 1, the great builder, is undoubtedly the temple dedicated to the sun gods Amon-Re and Re-Horakhte at Abu Simbel. Although excavated from the living rock, the structure generally follows the plan of the usual Egyptian temple. Four colossal seated statues emerge from the cliff face: two on either side of the entrance to the main temple (Zelazko, n.d.). Those four carved statues are of Ramses II (Pharaoh), Ra (Sun God) and Amun (King of the Gods) only the statue of Ptah (The God of darkness) remains in the shadow. This phenomenon occurs on two days of the year, one on the anniversary of his ascension to the throne (t February 22) and the other on his birthday (October 22) (Sandorini 2017). The first rays of the morning sun penetrate the whole length of the temple and illuminate the shrine in its innermost sanctuary.

figure 2 *Machu Picchu*
image courtesy : upload.wikimedia.org

The Inca Empire built their cities on mountaintops for example Machu Picchu (figure 2), maximizing exposure to sunlight and fresh air, which could have improved mood and alertness (Wallenfeldt, n.d.).

figure 3 *Asclepieia*
Image courtesy : Just Go Greece

The Asclepieia (figure 3) healing temples built in Ancient Greece are another example of neuroarchitecture. Their therapeutic landscapes were strategically designed to help healing and well-being, considering architectural factors such as the natural setting, the built environment, sense of place, and symbolic landscape. It is typically located in scenic and peaceful settings away from the bustle of city life. This natural environment could have promoted relaxation, reduced stress, and supported overall well-being. Asclepieia often emphasized a holistic approach to health, incorporating aspects beyond just treating physical symptoms. Purification rituals could have reduced anxiety and stress, while dream incubation, where individuals slept in the temple hoping for divine intervention, might have provided comfort and a sense of hope. This belief could have triggered the placebo effect, a phenomenon where the expectation of healing can contribute to positive outcomes ("Neuroarchitecture: When the Mind Meets the Built Form" 2023).

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B. Use of Geometric Patterns and Symmetry

Figure 4 *Parthenon*
Image courtesy : Steve Swayne

Greek and Roman architecture buildings often employed geometric proportions and symmetrical layouts, believed to create a sense of harmony and order, potentially promoting feelings of calm and clarity. The iconic temple the Parthenon (figure 4), dedicated to Athena, goddess of wisdom and patron of Athens, stands majestically on top of the Acropolis, a sacred complex overlooking the city. The 17 Doric columns on either side and the eight at each end create both a sense of harmonious proportion and a dynamic visual and horizontal movement. The building exemplifies the Doric order and the rectangular plan of Greek temples, which emphasized a flow of movement and light between the temple's interior and the surrounding space, while the movement of the columns, rising out of the earth, to the entablature that rings the building, draws the eye heavenward to the carved reliefs and statues that, originally, brightly painted, crowned the temple (Seiferle 2018).

figure 5 *Pantheon*
Image courtesy: Roberta Dragan

The circular temple faces the street with a monumental portico, employing eight Corinthian columns at the front with double rows of four columns behind, to create an imposing entrance. The facade, evoking the octastyle of the Athenian Parthenon (figure 5), also emphasized that Rome was the heir of the classical tradition. The large granite columns rise to an entablature with an inscription reading "Marcus Agrippa, son of Lucius, made [this] when consul for the third time." Though Agrippa's temple, built during the reign of the Emperor Augustus (27 BCE-14 CE), burned down, the Emperor The building's innovative and distinctive feature was its concrete dome; with a height and diameter of 142 feet, still, the world's largest dome made of unreinforced concrete. The interior was equally innovative, as the dome rose above a circular interior chamber, illuminated by an oculus opening to the sky in the center of the coffered dome, creating a sense of both an imperial and divine space (Seiferle 2018).

figure 6 *Mayan pyramid*
Image courtesy : afterdark-entertainment.com

Their intricate geometric designs, multi-level elevated platforms, massive step- pyramids (Figure 6) and astronomical alignments might have served religious purposes while also creating a sense of awe and wonder, impacting emotional states (Cartwright 2015).

C. Symbolic Elements and Ritualistic Spaces

figure 7 *Pyramids of Giza*
Image courtesy : wallpapers.com

Egyptian pyramids with their colossal size and intricate passageways likely fostered awe and reverence, supporting their religious and spiritual functions. The pyramids were not just monumental structures but also held profound religious and symbolic significance for ancient Egyptians. Neuroscience studies indicate that exposure to symbols and rituals associated with one's belief system can activate brain regions involved in processing emotions and reinforcing cultural identity. The belief in an afterlife and the role of the pyramids as tombs for the pharaohs would have imbued these structures with deep emotional and spiritual significance for the ancient Egyptians. Neuroscience tells us that experiencing awe can lead to increased activity in brain regions associated with reward, pleasure, and motivation. This sense of awe could have fostered a deep emotional connection to the monuments and to the pharaohs who commissioned them.

figure 8 *Stonehenge*
Image courtesy : English Heritage

The complexes of monuments at Stonehenge (figure 8) and Avebury provide an exceptional insight into the funerary and ceremonial practices in Britain in the Neolithic and Bronze Age. Together with their settings and associated sites, they form landscapes without parallel. The design, position and interrelationship of the monuments and sites are evidence of a wealthy and highly organized prehistoric society able to impose its concepts on the environment. An outstanding example is the alignment of the Stonehenge Avenue (probably a processional route) and Stonehenge stone circle on the axis of the midsummer sunrise and midwinter sunset, indicating their ceremonial and astronomical character. At Avebury the length and size of some of the features such as the West Kennet Avenue, which connects the Henge to the Sanctuary over 2 km away, are further evidence of this. The precise astronomical alignments of this monument suggest its use for religious rituals and gatherings, potentially influencing emotional states and social cohesion. (“Stonehenge, Avebury and Associated Sites”, n.d.).

D. SPATIAL ORGANIZATION AND SOCIAL INTERACTION

The Roman Forum (figure 9) was the central hub of political, religious, and social activity in ancient Rome. Its spatial organization played a crucial role in shaping the emotions and experiences of people during that period. It is situated in the heart of Rome, the Forum was easily accessible to all citizens. Its central location made it a focal point for various activities, drawing people from all walks of life. Surrounded by grand temples, basilicas, government buildings, and monuments, the Forum conveyed a sense of power, authority, and civic pride. The impressive architecture would have instilled awe and reverence in visitors, contributing to a sense of respect for the institutions and values they represented. The Forum served as a social gathering space where people came together to interact, exchange goods and ideas, and participate in public events. The bustling atmosphere would have fostered a sense of community and belonging among the Roman populace. The Forum was laid out along a monumental axis, with important buildings and monuments aligned to create a sense of visual harmony and order. This axial arrangement would have imparted a sense of direction and purpose to visitors, guiding their movement through the space and enhancing their emotional experience (Cartwright 2018).

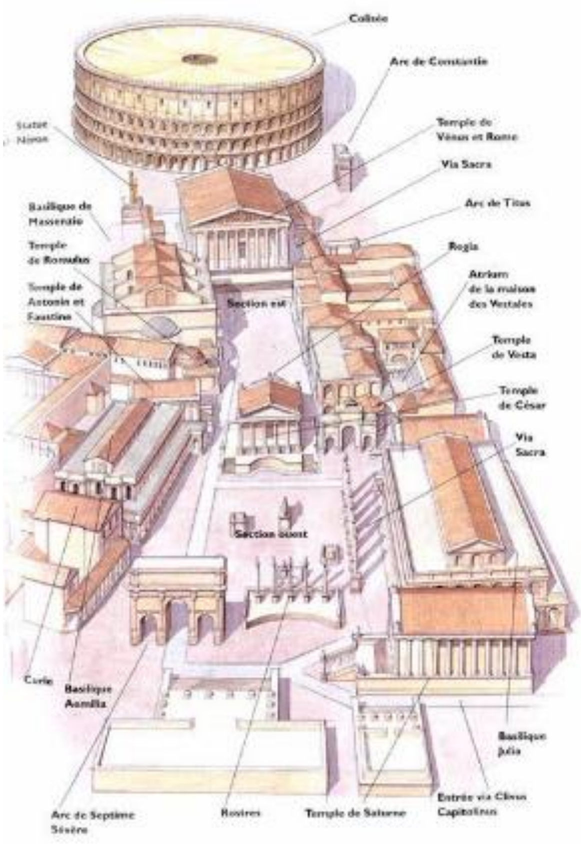

figure 9 *Roman Forum*
Image courtesy : www.worldbyisa.com

III. FUNDAMENTAL APPROACHES TO THE COGNITIVE-EMOTIONAL ASPECT OF ARCHITECTURE

Studying how architecture affects our thoughts and feelings has been a key focus for researchers over time. By understanding these basic principles, we can better grasp how neuroscience is applied in architecture today. This section outlines three main approaches:

a.Geometric approach

b.How we experience space.

c.Impact of philosophy and psychology on design.

These approaches are all connected and help us understand architecture's influence on our emotions and cognition. (Higuera-Trujillo, Llinares, and Macagno 2021,8)

A. GEOMETRIC APPROACH

Throughout history, architects have looked at how the human body and architecture relate to each other in two main ways: theomorphism and anthropomorphism. Theomorphism, seen in ancient Greek buildings like the Parthenon, uses geometric proportions to create emotional effects. Similarly, later architects like Palladio and Le Corbusier used mathematical rules to achieve similar effects. Anthropomorphism, seen in ancient Roman temples and later in the Renaissance and Baroque periods, uses human body symmetry in building design. Both approaches have been combined over time, with architects like Alberti trying to make spaces feel more human using geometric principles. This idea continued with Rationalism, which focused on practical architecture for everyday needs, seen in the works of Klimt, Bataille, Zevi, Smithson, Niemeyer, and Mollino. (Higuera-Trujillo, Llinares, and Macagno 2021, 9)

Many of these geometric ideas still appear today. Some, like the nine-square pattern and the golden section, have been proven to be aesthetically pleasing through experiments, even using virtual reality and neuroscience. New methods are also being developed to quantify geometric properties and understand how they affect emotions. For example, isovist analysis looks at how much space you can see from a certain point, while artificial intelligence helps categorize architectural features. There's also mathematical-geometric analysis of architectural images, measuring things like edge density, fractal dimension, entropy, and color metrics. So, the geometric approach to architecture is still going strong. (Higuera-Trujillo, Llinares, and Macagno 2021, 10).

B. How we experience spaces

In neuroarchitecture, the experience of a space is analyzed through the perspective of neuroscience, which delves into how the brain processes sensory input and perceives the environment. Our interaction with a space begins with sensory perception, as our brains interpret information from sight, sound, touch, smell, and taste. Neuroarchitecture considers how architectural elements such as lighting, color, texture, acoustics, and fragrance influence our sensory experience and evoke emotional responses.

Spatial cognition is another key aspect of how we experience a space. Our brains process spatial information to understand our location within a space, navigate our surroundings, and form mental maps of our environment. Neuroarchitecture explores how architectural layouts, circulation patterns, and wayfinding cues impact spatial cognition and ease of navigation within a space.

Emotional responses to architecture are also deeply rooted in neuroscience. Design features such as proportions, symmetry, scale, and aesthetics can elicit a range of emotional reactions by activating specific neural pathways associated with reward, pleasure, arousal, or stress. Neuroarchitecture investigates how these design elements influence emotional states and contribute to the overall atmosphere of a space.

Cognitive load, or the mental effort required to process environmental stimuli, is another consideration in neuroarchitecture. Design interventions that reduce cognitive load, such as clear sightlines, intuitive layouts, and minimalistic aesthetics, can enhance cognitive function, focus,

Table 1 *principle of design and its effect on human.*

and well-being. Neuroarchitecture examines how these design strategies optimize cognitive performance and user experience.

Biophilic design principles, which integrate elements of nature into the built environment, are also explored in neuroarchitecture. Exposure to natural elements such as sunlight, greenery, water, and natural materials has been shown to positively impact cognitive function, mood, and physiological responses. Neuroarchitecture investigates how biophilic design elements promote stress reduction, restoration, and overall well-being.

Ultimately, neuroarchitecture seeks to optimize the user experience by designing spaces that support cognitive function, emotional well-being, and overall quality of life. By understanding the neural mechanisms underlying human perception and behavior, architects can create environments that resonate with users on a neurobiological level, fostering comfort, engagement, and a sense of belonging. (Higuera-Trujillo, Llinares, and Macagno 2021, 10)

C. The impact of philosophy and psychology on design

Principles	*Trend*
Balance	*When a design looks even and stable, it helps us feel calm and satisfied.*
Harmony	*Designs that look consistent and put-together are easier for our brains to understand.*
Contrast	*When things stand out in a design, like bright colors or big letters, our brains pay attention.*
Emphasize	*Designs that highlight important parts help our brains focus on what's most important.*
Proportion	*When things in a design look the right size compared to each other, it's easier for our brains to understand their relationship.*
Hierarchy	*Clear order in a design helps our brains know what to look at first, second, and so on.*
Rhythm	*Patterns and repeating elements in a design make it easier for our brains to follow along.*
Movement	*When parts of a design move or point in a certain direction, it catches our attention and keeps us engaged.*
Proximity	*Grouping similar things together in a design helps our brains see how they're connected.*

The impact of philosophy and psychology on design is vast and influential, providing the conceptual and methodological framework for designers to create meaningful and user-centered products and environments. Philosophy, encompassing aesthetics, ethics, metaphysics, and epistemology, shapes design principles and approaches by exploring concepts of beauty, morality, reality, and knowledge. Philosophical inquiries inform design decisions related to visual composition, ethical considerations, conceptual approaches, and research methodologies, guiding designers in crafting designs that are not only aesthetically pleasing but also socially responsible and intellectually rigorous.

Psychology, delves into human behavior, cognition, and emotion, offering insights into how users perceive, interact with, and respond to designed environments and products. Understanding psychological principles is crucial for creating intuitive interfaces, emotionally engaging experiences, and environments that promote well-being and productivity. Psychological research informs design decisions aimed at optimizing the user experience, eliciting specific emotional responses, and enhancing cognitive ergonomics. By integrating philosophical insights with psychological understanding, designers can create designs that resonate with users on intellectual, emotional, and experiential levels, fostering meaningful interactions and enhancing quality of life.

IV. RELATIONSHIP BETWEEN ARCHITECTURE AND HUMAN EMOTION

People's perceptions of the built environment go beyond just what they can see and touch. They use their feelings and emotions, like feeling safe, calm, or excited, to describe how they relate to a place. When people are in a certain environment, both their short-term emotions and long-term feelings are affected. Studies have shown that things like the size, layout, and shape of a building or space can trigger people's emotions. This highlights how the design of our surroundings can influence how we feel. This demonstrates the power of the built environment in changing humans' emotions or affect. After experiencing these emotions, people evaluate the environment as either good or bad based on how it affects them, both in objective and subjective ways. (Assem, Khodeir, and Fathy 2023, 3)

V. EFFECT OF NEUROARCHITECTURE ON HUMAN WELLBEING

Using Neuroarchitecture, researchers can address four key aspects of human well-being: (1)physical health, (2) emotional well-being, (3) intellectual stimulation, and (4) social interaction within spaces (figure 10). This is possible because there's a connection between these aspects of well-being and the core elements of Neuroarchitecture: the body's physiology, emotions, psychological responses, and cognitive processes. Studies have shown that exposure to certain elements in indoor environments can impact people, whether in virtual simulations or real-world settings. A compilation of architectural design elements that affect people through Neuroarchitecture has been made, detailing their effects.

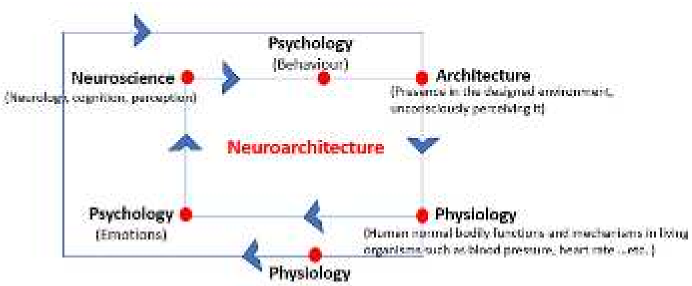

figure 10 *The cyclic relationship between the pillars of Neuroarchitecture.*

Source: (Assem, Khodeir, and Fathy 2023, 5)

During an architectural experience, changes in the body can occur with or without a person being aware of them. For example, fluctuations in blood flow in certain areas of the brain have been linked to shifts in emotions, showing that emotions can affect physical health by influencing the immune system's response. Evidence also suggests that emotions can directly impact brain activity in areas related to attention, memory, motivation, mood, and decision-making. This means that changes in behavior can improve learning, psychology, well-being, and speed up recovery. Studies conducted in educational and healthcare settings have explored these effects. (Assem, Khodeir, and Fathy 2023, 5)

Additionally, research has shown that pleasant environments have a more positive effect on brain stimulation compared to unpleasant ones. Brain imaging studies have demonstrated that exposure to positive environmental stimuli activates different parts of the brain than exposure to negative stimuli. Moreover, differences have been observed between the brain activity of men and women in response to both positive and negative stimuli. However, certain parts of the brain, such as the Occipital and Limbic lobes responsible for visual perception and emotional responses, were found to be activated in both men and women in all cases. (Assem, Khodeir, and Fathy 2023, 7)

VI. FINDINGS

Architecture element	Effect of architecture elements on the 4 pillars of Human wellbeing
Low Ceiling Height	Low evaluation of beauty, stimulates item-specific processing; calmness, causes negative emotions; causes exit decisions
High Ceiling Height	arouse greater creativity, stimulates primarily rational processing, and areas involved in visual and spatial perception.; freedom; positively affects wayfinding. Found more attractive.
Wide	Not experimentally measured in many studies, Wider classrooms are linked with poorer attention, memory, and performance; lower arousal of emotions
Narrow	enhances attention and memory
Smells	Not covered well in the studies. However, Emotional: spaces with slightly scented plants were the most preferred for human comfort
Sounds: quietness/ noise	Fairly quiet spaces improve attention and quiet ones improve perception; Noise causes feelings of stress; Sounds of nature causes stress reduction; music decreases diastolic blood pressure
Lack of Vegetation	Generates feelings of stress, oppression, arousal; more arousal measured by EDA; Negative effects on estimating distance
Vegetation/ Natural Environment in pictures/ simulations or reality	reduces stress and anxiety, pleasure increases based on tree density, and arousal with weed density, restorative; ‘‘fascination,” ‘‘being away,” ‘‘coherence,” and ‘‘compatibility”, emotional states affect the perception of brightness.Simulations activated spatial cognition and space expansion; positive effects on views of nature; lower pain intensities & pain distress. Natural forms are always preferred.
Textures:Natural Materials (wood)	decreased heart rate and sweat response without conscious perception of individuals, adjusted vision in the near-distance especially after working and improved performance for people with myopia eye condition; coherence is greater, square wooden spaces are better for focusing and saving information; more relaxed and comfortable; carpet material brings satisfaction in patient corridor
Unnatural materials (metal)	Coherence is less than with natural materials, better attention in interiors made of steel, concrete, or glass.
Natural Lighting	decreases cortisol and stress levels, less patients stays in hospitals; good natural lighting is correlated with better brain functional abilities needed for writing; reduces stress
Artificial lighting	Light above 7500 K raises blood pressure; White light regulates sleep rhythms; White regulates mood, blue light speeds up post-stress relaxation, indirect light lets participants feel cooler & more pleasant in comparison to direct light, LED lighting feels ‘‘attractive, comfortable, cutting-edge”; Artificial Ambient Light reduces feeling of pain; ‘‘Clear-efficient, intense-brilliant & uniform lighting” improves vision and perceiving optical information, ‘‘Clear-efficient, Uniform and Surprising-amazing lighting” arouses attention, LED lighting is more stimulating than fluorescent. Behavioural:‘‘warm-cozy and non-intense brilliant lighting” facilitates reflection discussions.

Architecture element	Effect of architecture elements on the 4 pillars of Human wellbeing
Symmetrical	arouses emotions, decreases satisfaction and excitement
Asymmetrical	provides higher cognition, arouses emotions
Curvilinear	Improved memory in a square or cylinder area made of concrete, conical, glass spaces activate visual and spatial perception, curved contours aroused higher fear response in contrast to sharp angled contours. More attractive & preferred by non-design expert subjects
Sharp-angled	More attractive & preferred by expert subjects
Color temperature (cool/warm):	Cold-hued colors (between yellowish green and Purple) improve attention and memory, cool temperatures cause less arousal than warm (regarding sleeping), but enhance attention more; warm temperatures enhance memory more.Warm are preferred by adults, & cool by children.
Contrast	Improved memory in spaces with high contrasting colors
Bright Colors	Higher attention and problem solving with purple, followed by blue, green, yellow & red, moderately bright/bright colors improve perception; White color with bright highlights encourages better performance in learning Bright colors cause positive emotions e.g., red, but not all colors were experimentally confirmed using digital devices; green causes satisfaction & comfort; color of light has emotional effects; color of sunlight has positive effects
Dark Colors of brown wood	Least production of human perspiration in completely dark brown wooden rooms
Furnished environments	Increased heart rate and larger brain theta power across frontal parts for high presence of furniture /Open office; more physical activity; less stress, flexible furniture causes more stress reduction; Flexible furniture design is correlated with better brain functional abilities for performance in math
Non– Furniture	Less coherence than with furniture
Linear Shapes (2D geometry)	Low arousal and pleasure; sharp contours activate Amygdala in the brain more than curved ones, simple linear shapes are better for student's performance while learning. Did not affect exit decision from space
Curved Shapes (2D geometry)	Contours in hospital interiors & exteriors activated Amygdala greater than sharp, irregular windows activate attention; cause approach (rather than avoidance) behaviors;decreased heart rate with irregular windows 3 authors agreed it is more preferred over sharp

Table 2 *A summary of neuro-architectural design elements and their impact on human wellbeing*

source : (M et al. 2022) (Higuera-Trujillo, Llinares, and Macagno 2021) (Shemesh A et al. 2017) (Gongora M. 2019) (Barrett P et al. 2017) (Assem, Khodeir, and Fathy 2023,6-7)

VII. DISCUSSION

Designing spaces that work for everyone can be challenging. From the scoping review of neuroarchitecture and its preceding methodologies, four key elements pertaining to the integration of neuroscience into architecture emerged: (1) constraints of existing approaches, (2) challenges in addressing the cognitive-emotional aspect of architectural design, (3) proposed solutions to these challenges, and (4) the inherent limitations of this endeavor.

A. *LIMITATIONS OF THE APPROACHES ON THE STUDY OF COGNITIVE-EMOTION THROUGH ARCHITECTURE*

Studying the cognitive-emotional aspect of architecture is complex, but new approaches are emerging to address the limitations of existing methods and to gather data supporting design proposals. However, both old and new methods have their drawbacks. Old methods are often limited by their focus on specific environmental stimuli and evaluation systems. New methods aim to overcome these limitations by integrating virtual reality and neuroscience, drawing from aesthetics and art. Yet, art and architecture, while related, are not interchangeable. Thus, caution is needed when applying findings from other fields to architecture. Limitations arise at three levels: ontological, epistemological, and methodological. Ontologically, there are constraints regarding the breadth of perceptual experiences, including the focus on unimodal stimuli and the subjective nature of beauty and pleasure. Epistemologically, challenges arise in explaining experiences solely through physiological terms and accounting for various influencing factors. Methodologically, issues stem from the diversity of stimuli and presentation methods, leading to conflicts in procedures and technical restrictions with recording technologies. These limitations hinder the development of a universally accepted methodology and impede the translation of research findings into practical architectural guidelines.

B. *PROBLEMS IN ADDRESSING COGNITIVE-EMOTION THROUGH ARCHITECTURE*

Apart from the discussed limitations that apply broadly to art and aesthetics, there are specific limitations concerning architecture. Two main limitations stand out: First, architecture cannot be equated with artistic-aesthetic experiences, as it serves broader human needs. Second, architecture entails a continuous experience, influenced by transitions between spaces and the architectural narrative. Moreover, peripheral vision plays a crucial role, and architecture engages all sensory modalities, extending beyond mere visual perception. These limitations hinder the fragmentation of the cognitive-emotional dimension of architecture, often leading to reliance on case studies. It's essential to cautiously extrapolate findings from neuroscience to architecture. While achieving universal solutions, architecture may be difficult due to individual differences and environmental factors, common architectural design guidelines can still be developed based on innate similarities in human brains.

C. *CHALLENGES FACED BY NEUROARCHITECTURE AND ITS APPLICATION IN REAL LIFE*

Until now, there hasn't been a comprehensive study on the emotional and cognitive aspects of architecture. However, the emerging field of neuroarchitecture shows promise in creating architectural spaces that cater to these dimensions without oversimplifying relaxation. This approach aligns well with modern priorities like sustainability and social inclusion. Examples range from hospitals designed to promote healing to classrooms enhancing cognitive processes and workplaces fostering collaboration. Yet, challenges remain, especially in designing for diverse groups and addressing specific needs like dementia care. However, it's essential to recognize that humans are more than just neurological beings, and architecture is also guided by intuitive design principles. Bridging the gap between science and design requires collaboration between scientists and architects to develop comprehensive tools for architectural design.

D. *LIMITATIONS*

The information gathered from different studies were inconsistent. The emotional experience which is a very subjective matter differs person to person. While research provides general trends, how individuals respond to specific design elements can vary greatly due to differences in personality, culture, past experiences, and even genetics. The wide scope of the study involves many different fields, which can make it hard to cover everything thoroughly. Even though we looked at a variety of approaches, there could still be valuable sources we didn't find, like documents not widely published in traditional sources, known as "gray literature."

VIII. CONCLUSION

This review thoroughly explored how researchers have investigated the field, who has been involved, and what methods are used to measure emotions and brain activity. It explained the essence of neuroarchitecture in ancient period and the term "Neuroarchitecture" and how it relates to neuroscience, emotions, cognition, perception, behavior, and physical changes in the body. However, there was inconsistency in data analysis methods used in the studies reviewed. To improve results, more extensive experimental designs and larger sample sizes are recommended. A summary table was created to highlight progress in understanding how neuroarchitecture affects humans emotionally, psychologically, and physiologically, showing positive effects on human well-being. It suggests creating design guidelines based on these effects. This review can benefit architects, neuroarchitecture researchers, policymakers, and practitioners in the built environment.

Understanding users is essential in designing spaces, because different people have different needs, preferences, and behaviors. By studying users thoroughly, designers can tailor solutions that effectively meet their requirements and enhance their experiences.

As neuroarchitecture grows and adopts evidence based practices, designers can create spaces that make people feel good and are good for the environment. By using insights from neuroscience, they can make places that help people think better, feel happier, and stay healthy, while also being mindful of nature. This means designing spaces that suit different people's needs and preferences, leading to environments that support overall well-being and sustainability.

Neuroarchitecture is quickly becoming popular. It's a mix of different areas like science, technology, health, and the arts. By combining these fields, we can move forward in architecture and design, focusing on people's well-being and happiness as we shape the future.

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