

Why the outsides of buildings matter to human health: a global evidence review

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Overview

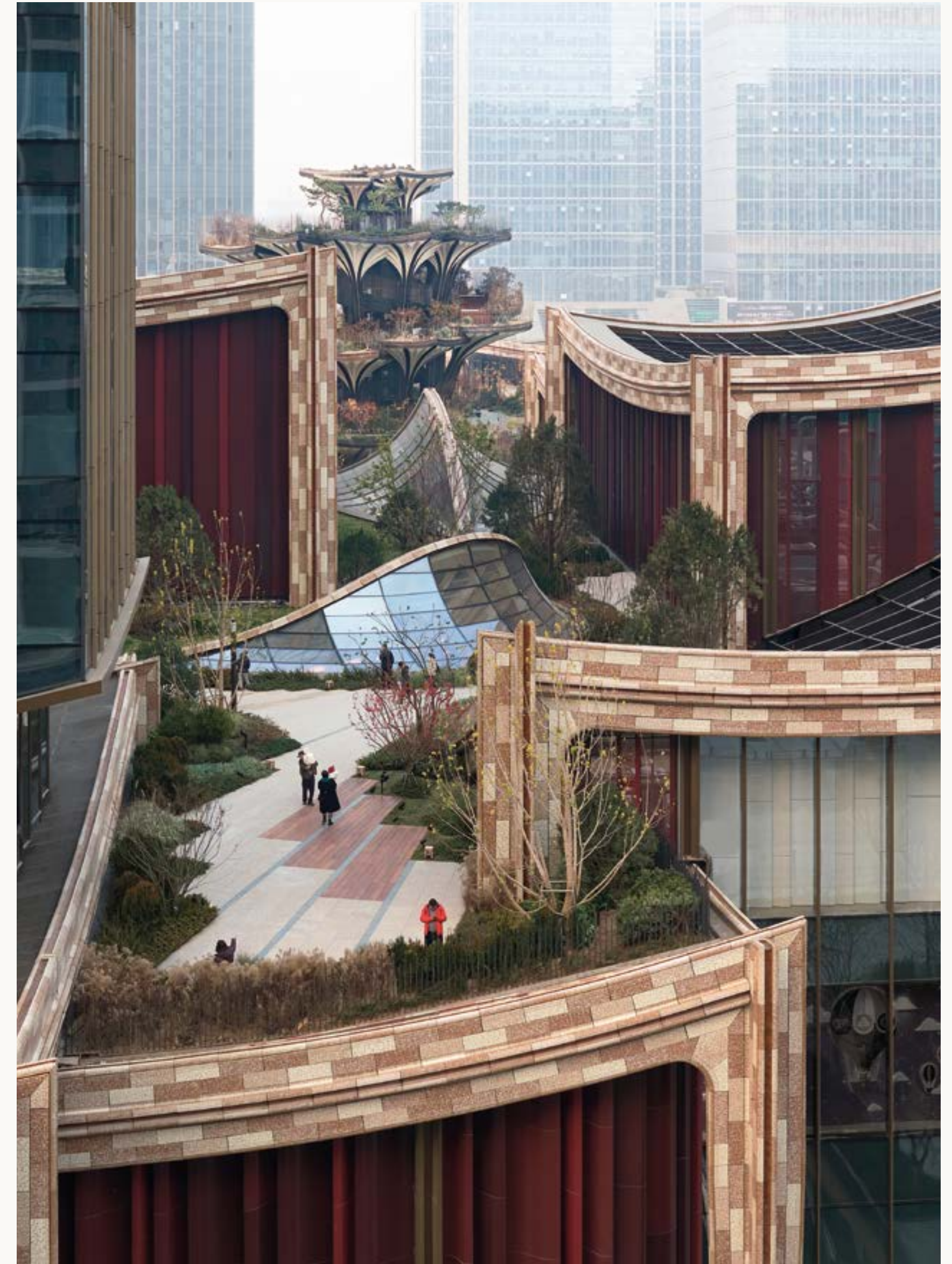
The shape of our cities is shaping us

As more of our world migrates to cities, buildings are shaping far more than the skyline. From the form of façades to the rhythm of streetscapes, a growing body of evidence reveals that the built environment is not just a backdrop to urban life. It is an active force, shaping how people feel, function, and connect.

This report presents findings from a Global Evidence Review: the first of its kind to comprehensively evaluate, integrate and translate findings across a wide range of research on how the external design of buildings affects human health and wellbeing.

Commissioned by Humanise, the review explores why the outsides of buildings matter inside: regulating stress, guiding attention, sparking memory, and influencing mood, physiology, and behaviour in ways we are only beginning to grasp.

Synthesising over 80 recent studies spanning neuroscience, cognitive science, environmental psychology, place-based studies, and urban design, it demonstrates the measurable impact of façades in shaping body, mind and behaviour, with actionable insights to foster design for human needs.





Overview

Creating an evidence base for action

From fragmented findings to thematic insight

Interest in how building exteriors affect human health and wellbeing is growing — but the research remains scattered across disciplines. This review synthesises the emerging science into a unified thematic framework: identifying areas of promise and building systematically from impacts on the brain and body to emotional and social effects. Many of these impacts overlap, so that design features can support more than one of these effects.

1. Building shape and physiological stress

Building proportions, façade enclosure, and glazing patterns affect biomarkers such as heart rate, skin conductance, and stress recovery.

2. Visual complexity and comfort

Monotonous or chaotic façades can tax perception. Façades with organised complexity — symmetry, rhythm, and detail — enhance attention and emotional ease.

3. Natural features and mood

Incorporating natural motifs like greenery, fractal patterns, and organic texture into façades supports psychological restoration and stress reduction.

4. Environmental legibility and spatial orientation

Visually distinct and well-articulated façades aid spatial memory and orientation, particularly in dense or disorienting urban environments.

5. Human-scale and street-level design

Architectural features that meet the body at street level — such as openable windows, texture, and articulation — enhance comfort, safety, and informal social interaction.

6. Place-attachment and belonging

Culturally resonant and emotionally expressive façades support memory, identity, and long-term bonds to place.

7. Lived experience and bodily wellbeing

The felt experience of space — shaped by rhythm, atmosphere, and movement — influences wellbeing beyond what metrics alone can capture.

8. Enriched environments and engagement

Façades that offer texture, symbolic richness, and sensory engagement foster curiosity, emotional engagement, and connection.



Overview

Implications for research, practice, and policy

The review also highlights the potential of neuroarchitecture, an emerging field bringing neuroscience and design into active dialogue. With advancing technology in mobile EEG and biosensors, we can now measure how people experience buildings in real time. Yet these findings have yet to be effectively translated into recommendations for real-world impact.

This review addresses that gap. Not only does it synthesise cutting-edge science — it offers core insights for all those concerned with the health of people and cities: from designers and developers, to investors, city governments, clients and communities.

The goal underpinning it is to rehumanise our built environment through more human buildings: designing not only for health, but also meaning, belonging, and joy - our fundamental human needs.



Introduction

Why the outside matters inside: rethinking building design for human needs

Across the globe, urbanisation is accelerating at an unprecedented pace. For the first time in history, humanity is now predominantly urban — and by 2050, nearly 70% of the global population is expected to live in cities. While urban life offers opportunities for innovation, connection, and economic growth, it is also linked to rising levels of stress, loneliness, and chronic disease. As buildings multiply, rise taller, and cities densify, the overall effect on health and wellbeing is more than a question for architects — it is a collective, public concern.

This Global Evidence Review is the first of its kind to comprehensively evaluate, integrate and translate findings across a wide range of fields on how the external design of buildings affects human health and wellbeing.

Commissioned by Humanise, it challenges a long-standing assumption that the external design of buildings is a superficial concern. It demonstrates instead that features such as form, rhythm, materiality, and texture are biologically and emotionally consequential — active forces shaping brain function, physical health, and civic life.

Synthesising over 80 recent studies across neuroscience, cognitive science, environmental psychology, place-based studies, and urban design, the review reveals how these surfaces function as perceptual and emotional interfaces, regulating stress, guiding attention, sparking memory, and influencing mood, physiology, and behaviour in ways we are only beginning to grasp.

The review also highlights the potential of neuroarchitecture, an emerging field which brings design into dialogue with neuroscience to better understand how people perceive and experience buildings. While technologies such as mobile EEG, eye-tracking, and immersive VR are rapidly advancing our ability to study the experience of buildings, in real time, their insights have yet to meaningfully shape design or planning practice.

This review helps bridge that gap. Organised around a unified thematic framework, it evaluates findings across disciplines to offer a more integrated understanding of how facade design impacts physiological, psychological and social states.

As the science evolves, the implications are clear. Buildings are not neutral forms or functional containers. Their external design directly influences how we feel, navigate, and relate to the world around us.

As cities grow denser and construction accelerates across the world — affecting both people and the planet, the design of the spaces we experience daily are more than an academic concern.

This review not only synthesises the latest scientific evidence. It also offers actionable insights for all those shaping the future of our cities and neighborhoods: architects and designers, developers, planners, city leaders, clients, investors, and communities.

Its goal is simple, but urgent: to humanise our buildings, and positively shape the cities that are shaping us — not only to support health and wellbeing, but to embed an ethics of care in how we build, now and for future generations.



Introduction

The potential of neuroarchitecture

The convergence of neuroscience and architecture marks a pivotal moment in understanding how the built environment shapes human health. Once regarded as purely subjective, emotional and perceptual responses to buildings are now recognised as biologically grounded, rooted in neural mechanisms that influence health, mood, cognition, and behaviour.

Neuroarchitecture offers more than a conceptual reframing; it introduces new methodological tools. Technologies such as eye-tracking, portable EEG, skin conductance sensors, and immersive virtual reality allow researchers to measure — in real time — how architectural features affect attention, emotion, stress regulation, and memory. These approaches move beyond aesthetics as personal preference, revealing how the form, texture, and layout of buildings influence physiological and psychological functioning.

A recent synthesis of 20 studies using biometric and neurophysiological tools found consistent associations between specific façade elements — such as pattern, symmetry, lighting, and openness — and more positive emotional responses. Other research suggests that design features aligned with neural systems for orientation, spatial memory, and emotional regulation tend to evoke greater comfort and ease. Together, these findings suggest that neuroscience can help design environments that actively promote wellbeing.

Despite growing interest, these insights have yet to be widely adopted in mainstream architecture and urban planning. Mental health and aesthetics often remain marginal in design decisions, treated as secondary to technical or economic priorities. This review aims to bridge that gap by synthesising evidence from neuroscience, environmental psychology, and urban planning to illuminate how façades shape everyday experience — both consciously and unconsciously.

This shift signals a broader redefinition of building design: from a purely technical or functional endeavour to a form of care. It invites a more humane approach to building — one that recognises how deeply physical environments shape emotion, physiology, and quality of life. Neuroarchitecture calls for designing not just for form or function, but for feeling — to create environments that support healthier, more emotionally attuned cities.



Introduction

Methodology

A central challenge in this emerging landscape of research and experiment is fragmentation. Findings from neuroscience, neuroaesthetics, neurophenomenology, cognitive science, environmental psychology and urban planning remain largely siloed — limiting both conceptual development and practical application. This review addresses that gap by integrating insights across disciplines into a cohesive thematic framework: a structured approach to assessing how the external design of buildings affects human health and wellbeing.

It also incorporates research from the field of place-attachment, which examines how buildings and neighbourhoods acquire emotional meaning and shape feelings of safety, identity, and belonging. This places human emotion — often peripheral in architectural discourse — at the heart of design evaluation. The approach aligns with a growing international emphasis on place-based development, as reflected in OECD (2025) guidance calling for culturally grounded, context-sensitive design that fosters social cohesion.

Focusing specifically on external building design — including visual character, spatial composition, materials, and sensory effects — this review addresses three guiding questions:

1. What does current research reveal about the relationship between external building design and human health and wellbeing?
2. Through what neurological, physiological, and psychological mechanisms do design features shape experience?
3. Where is the evidence most promising — and where are the gaps or limitations?

The existing evidence base is often limited by small sample sizes, narrow geographic scope, and an emphasis on isolated variables. Often it is disconnected from design, development, and policy practice. In response, this review offers a more integrated and systematic synthesis — intended to support broader public understanding, inform design and planning decisions, and guide future research.

Evidence is synthesised across eight thematic domains:

- Building shape and physiological stress
- Visual complexity and comfort
- Natural features and mood
- Wayfinding and spatial orientation
- Human-scale and street-level design
- Place-attachment and belonging
- Lived experience and bodily wellbeing
- Enriched environments and engagement

In scoping the literature, priority is given to recent peer-reviewed research — primarily from the past five years — by leading international scholars in these fast-developing fields. Special attention was paid to interdisciplinary studies that bridge theory and application. Open-access and publicly available sources were prioritised wherever possible, reflecting a commitment to equitable access to knowledge.

Finally, the review has been shaped by dialogue with eight leading researchers, ensuring the scientific robustness of its synthesis. It aims not only to highlight emerging evidence, but to generate actionable insights for architects, designers, developers, clients, city leaders, and communities — helping to translate research into buildings that actively support human health and wellbeing.



Thematic evidence synthesis

Building a framework for design insight

This synthesis opens with the physiological effects of architectural form, where insights from neuroscience and biometric research converge to show how façades influence the body's stress-response systems. The first theme examines how spatial form — through geometry, scale, and enclosure — can modulate autonomic nervous system activity, grounding the link between external design and human wellbeing in biological processes.

From this foundation, the review follows a progression of interconnected themes, tracing how the design of façades and streetscapes shapes not only stress, but also perception, memory, emotional resonance, and social connection.

The eight sections are not discrete topics but stages in a cumulative inquiry into how external building design shapes human experience. Together, they move from fundamental physiological responses toward more integrative, embodied, meaning-rich dimensions — mirroring current advances in neuroscience, environmental psychology, and design theory.

From neural networks to lived experience, this framework offers a structured lens for understanding how the built environment can either support or undermine health and wellbeing in everyday life.



Thematic Evidence Synthesis

1. Building shape and physiological stress

Design and the nervous system

A growing body of research across neuroscience, neuroarchitecture and environmental psychology shows that building form is not just a backdrop to human activity — it can directly influence how the autonomic nervous system regulates stress. Features such as geometry, enclosure, scale, and material detailing affect the body's baseline state. Stark, repetitive façades — particularly those with excessive height, minimal glazing, or little variation — have been linked to elevated arousal, reduced emotional energy, and other markers of physiological strain. In contrast, façades with visual openness, human-scale proportions, and balanced variation appear to support calmer, more regulated nervous system states.

Researchers are now able to track these effects in real time using tools such as EEG (which records brainwave activity), skin conductance sensors (which measure subtle sweat responses as stress indicators), and immersive virtual reality. These methods reveal that architectural design is not merely a matter of conscious preference — it can have measurable, embodied effects on health.

Evidence synthesis

Interdisciplinary research in neuroarchitecture and environmental psychology has begun to identify specific façade characteristics — such as curvature, spatial openness, and articulation — that influence cognitive, emotional, and physiological responses. Higuera-Trujillo, Llinares, and Macagno's (2021) scoping review maps this emerging field, showing how these variables are increasingly investigated using biometric and immersive technologies, including EEG and virtual reality. While their review synthesises rather than generates empirical findings, it underscores the growing scientific focus on how spatial form interacts with perceptual and neural mechanisms to shape wellbeing.

Complementing this, Kim and Kim (2022) demonstrate that biometric measures — including facial expression analysis and skin conductance — can effectively quantify emotional reactions to spatial environments in immersive conditions. Their study reinforces the value of integrating physiological and behavioural indicators to assess how architectural design influences emotional wellbeing in real time.

Several studies emphasise three recurring design variables: curvature, enclosure, and proportion.

Environments that feel closed in or overly angular — such as those with rigid forms, low ceilings, or minimal openness — are often associated with heightened physiological arousal. In contrast, curved or biophilic forms that echo patterns found in nature tend to correlate with calmer neural responses and reduced visual stress. Kim et al. (2021) used VR and EEG to show that lower ceiling heights and certain window-to-wall ratios were associated with reduced arousal signals, suggesting that specific spatial proportions can directly influence brain state (see also Valentine, 2023).

Immersive VR studies support these findings. Suurenbroek and Spanjar (2023) report that façades with high window-to-wall ratios improved perceived comfort and lowered stress levels, whereas tall, narrow buildings with few windows heightened tension. Similarly, Chamilothoni et al. (2022) found that variations in façade geometry alone — regardless of daylight or room function — can alter heart rate and skin conductance. Earlier studies by the same team (Chamilothoni et al., 2019) found that complex daylight patterns and irregular spatial forms were linked to more positive emotional responses.

Real-world studies further validate these effects.



Srikantharajah and Ellard (2024) found that façades dominated by featureless or reflective glass — with minimal architectural detail or permeability — were associated with higher physiological stress and reduced emotional engagement. Similarly, Ellard (2020) observed that environments marked by visual entropy — a lack of clear visual structure — were linked to weaker physiological regulation and more negative affective responses.

Visual complexity appears to play a key role. Studies by Le et al. (2017) report that overly enclosed or statistically “unnatural” façades — those that don’t reflect the spatial patterns typically found in nature — were associated with visual fatigue and stress-related brain activity. Valentine et al. (2025a) suggest that exposure to repetitive, high-contrast patterns — especially those at a frequency of around three cycles per degree of visual angle — may lead to visual stress, a form of cortical discomfort linked to sensory overload.

Material choices also matter. Chiu et al. (2024) showed that façades made with cold-toned or heavy materials like iron were linked to increased

physiological stress — especially when used in blank or texture-less urban settings. However, not all complexity is calming: excessive brightness or extreme contrast can lead to overstimulation, suggesting that a balance of sensory input is key.

These insights are supported by a comprehensive review by Bower, Tucker, and Enticott (2019), which found that enclosure, lighting, and material articulation consistently produce both subjective feelings of stress and measurable physiological effects. Their findings underline that building form can shape wellbeing in real time.

Longer-term consequences are also being explored. Valentine et al. (2025b) propose that prolonged exposure to visually monotonous environments may increase allostatic load — the cumulative stress burden on the body — by activating the brain’s chronic stress system (the hypothalamic–pituitary–adrenal axis). While longitudinal studies are still emerging, their work suggests that architectural monotony may not only dull experience but contribute to subtle biological strain over time.





Thematic Evidence Synthesis

2. Visual complexity and comfort

From stress response to cognitive ease

Beyond helping regulate stress, architectural design also influences how the brain processes visual information. This section explores how façades that feature organised visual complexity — those that balance variation with visual coherence — can support perceptual ease, attention, and emotional wellbeing.

Neuroscience and environmental psychology suggest that people respond especially well to patterns found in nature and in traditional architecture: symmetry, rhythm, ornament, and variations that repeat in scale (also known as fractal-like structure). These elements appear to match how the brain naturally perceives and processes the world, reducing visual effort and creating a sense of clarity and engagement. Rather than serving a purely decorative function, these features may offer perceptual nourishment — stimulating the brain in a way that feels intuitively satisfying and emotionally grounding.

Evidence synthesis

Multiple studies suggest that façades with moderate visual complexity — characterised by symmetry, proportion, and clear articulation — are linked with easier visual processing and greater aesthetic appeal. These designs activate brain areas related to pattern detection and reward, allowing the viewer to process information fluidly while maintaining interest (Coburn, Vartanian & Chatterjee, 2020; Bower, Tucker & Enticott, 2019).

Eye-tracking studies reveal that people naturally focus more on façades with human-scale detailing, depth, and even face-like characteristics — features that appear to aid both orientation and emotional engagement (Sussman & Hollander, 2015; Simpson, Thwaites & Freeth, 2019). Lavdas and Schirpke (2020) found that façades that echo natural visual statistics — such as repeating patterns, textured surfaces, and fractal variations — tend to elicit stronger aesthetic responses, particularly when the overall layout is spatially coherent. Similarly, Rosas et al. (2023) demonstrate that façades with structured contrast and visual variety consistently attract and hold gaze longer than those that are flat, plain, or chaotic.

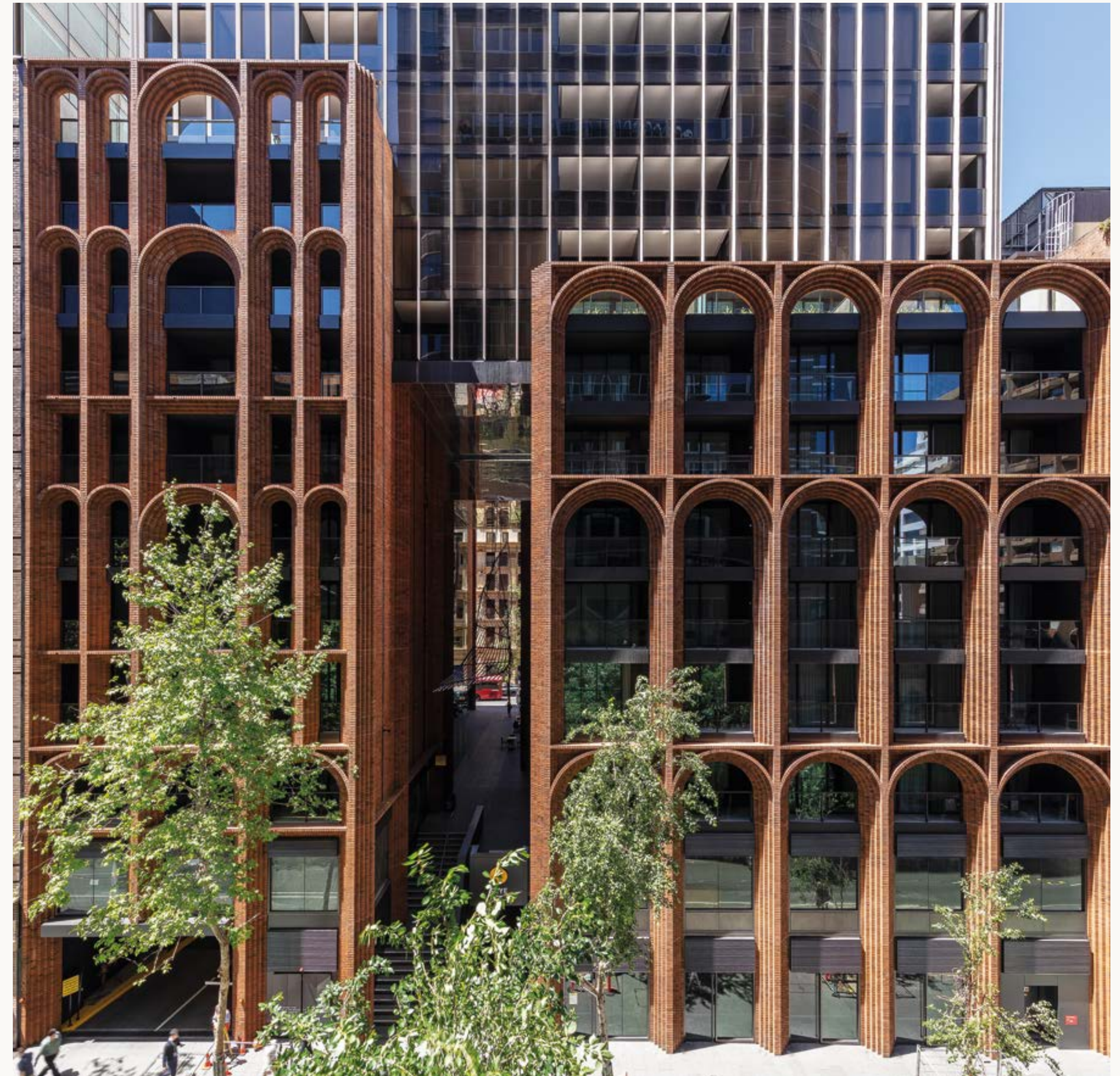
Drawing on Berlyne’s arousal theory (1971), which links moderate stimulation with positive affect, and supported by modern neuroscience, Salingaros (2021) and Mehaffy (2020) propose that visual designs with order and variation hit a cognitive “sweet spot”: enough stimulation to be interesting without becoming overwhelming. Rhythmic patterns, clear proportions, and symmetry are all linked to calmness and mental clarity — suggesting a strong link between visual legibility and emotional ease.

Nanda et al. (2013) argue that architecture and neuroscience share a common perceptual entry point: the visual image. Their work explores how visual properties — especially contours — may elicit rapid emotional responses that shape how we experience form. Drawing on insights from fMRI studies and environmental psychology, they propose that isolating specific visual features could inform emotionally attuned architectural design, connecting aesthetic form with neurobiological function.



Studies in developmental psychology provide further support. McAdams et al. (2025) found that both infants and adults tend to prefer façades with high edge orientation entropy (EOE) — a measure of visual richness structured by directional lines. This suggests that our preference for organised complexity may be hard-wired from early in life, reflecting evolutionary adaptations for making sense of visual environments.

From a physiological perspective, Ruggles (2018) argues that classical design elements — such as ornament, layered detail, and proportion — may activate the body's parasympathetic nervous system, which helps us relax and recover. These features, he suggests, align with both natural forms and architectural traditions that evolved to support human wellbeing.





Thematic Evidence Synthesis

3. Natural features and mood

From visual complexity to nature-inspired coherence

If organised complexity supports easier visual processing, biophilic design takes this further by drawing on our innate affinity for nature. This framework explores how architectural elements inspired by the natural world — such as fractal geometry, green façades, and organic forms — can reduce stress, promote emotional wellbeing, and support cognitive recovery.

Studies in neuroscience, environmental psychology, and design research indicate that even subtle natural cues in the built environment — like curved lines, leaf-like textures, or patterns with high contrast — can stimulate perceptual systems evolved to recognise and feel comforted by natural surroundings. These effects may occur automatically, shaping how we feel and function without conscious effort.

Evidence synthesis

A growing body of empirical research suggests that incorporating natural forms into building façades may support both mental and physical wellbeing. Studies have found that exposure to natural elements — such as greenery, fractal patterns, and organic motifs — is linked to lower cortisol levels and improved emotional states in both real-world and virtual settings (Taylor, 2006). In dense cities, vegetated surfaces and green façades have been associated with faster recovery from stress and improved perceptions of liveability (Elsadek et al., 2019; Yin et al., 2021).

Valentine et al. (2024) report that visual exposure to biophilic façades correlates with reduced delta wave activity — a type of brainwave potentially linked to stress regulation. Though still emerging, such findings suggest that biophilic design may influence deeper neurobiological processes, including those related to inflammation or mental fatigue.

Other studies highlight the impact of perceptual patterning in façades. Chatterjee, Coburn & Weinberger (2021) note that visual features such as natural curvature, openness, and fractal structure engage brain areas involved in emotion, memory, and sensory enjoyment. Coburn et al. (2019) found

that façades reflecting naturalistic visual statistics — such as high edge density and spatial contrast — elicited stronger aesthetic preferences and emotional responses, even without literal representations of nature. Similarly, Weinberger et al. (2021) report that façades with subtle nature references were rated as more comforting and emotionally resonant.

Brielmann et al. (2022) provide physiological support for these findings, showing that fractal geometries rapidly engage attentional systems and can influence emotional tone. These designs appear to help the brain maintain focus and regulate stress, supporting both attentional clarity and emotional balance.



Attention-based research further strengthens these claims. Lavdas, Salingaros & Sussman (2021) used predictive modelling to show how natural elements in architecture guide early visual attention. Lavdas (2024), using wearable eye-tracking in real-world settings, found that greenery and biophilic patterns increased both gaze duration and emotional engagement. Valtchanov and Ellard (2015) add neurovisual evidence that spatial frequencies typical of natural environments are associated with physiological signs of restoration.

These findings reflect two influential environmental psychology theories: Attention Restoration Theory (Kaplan & Kaplan, 1989) proposes that natural settings engage our attention in an effortless way, allowing mental recovery. Stress Recovery Theory (Ulrich, 1983) suggests that natural stimuli evoke rapid emotional responses that help lower stress levels. Both theories highlight how visual features of the environment influence wellbeing, particularly by supporting recovery from mental fatigue or emotional strain.

In addition to emotional benefits, biophilic design may contribute to physical health. Iungman et al. (2023) demonstrate that green infrastructure and vegetation integrated into the built environment can lower urban heat exposure and enhance cardiovascular and mental health, especially in vulnerable populations.





Thematic Evidence Synthesis

4. Wayfinding and spatial orientation

From emotional resonance to spatial orientation

In addition to shaping atmosphere and emotional response, building façades can influence how people navigate, make sense of, and mentally map their environments. This section examines the concept of architectural legibility — how clear visual features, such as distinctive shapes, colours, and ornamentation, help individuals orient themselves in complex urban settings. Especially in unfamiliar or densely built environments, façades that stand out from their surroundings may function as visual landmarks, supporting memory, navigation, and feelings of spatial coherence.

Research suggests that these features do more than aid orientation — they may also engage the brain’s emotional and spatial processing systems, enabling façades to serve as both emotional and cognitive reference points. As people move through cities, the legibility of façades may shape not only how they find their way, but how they connect emotionally to public space.

Evidence synthesis

Façade design can influence spatial cognition by increasing what Kevin Lynch (1960) called the imageability of the urban environment — how easily a place can be remembered and mentally represented. Neurophysiological and behavioural research has since expanded on this concept. Distinctive architectural features, such as contrasting colours, ornamental detail, or unique shapes, can help façades function as memorable visual anchors within the city.

A recent systematic review by Maestre et al. (2025) further reinforces this, finding that environments with high imageability are correlated with better cognitive and psychological health, improved wayfinding, and stronger emotional engagement. The review also highlights imageability’s role in supporting physical activity and social connection — while calling for more standardised, neuroscience-informed methods to evaluate its impact on brain function.

EEG experiments show that encountering such distinctive façades can activate theta-band brain activity in the posterior cortex, a signal associated with spatial memory and navigation (Rounds et al., 2020). Similarly, neuroimaging by Gregorians et al. (2025) reveals that façades with higher visual and spatial complexity activate the prefrontal cortex and hippocampus — areas involved in planning, memory, and spatial awareness. These findings suggest that navigating built environments involves distributed brain systems that encode both emotional value and spatial structure.

Well-articulated façades enhance legibility by providing visual cues that help users orient themselves in dense or confusing urban settings. Conversely, buildings that are overly uniform or repetitive may lack helpful markers, increasing the risk of disorientation — particularly in large developments with few distinguishing features (Chatterjee & Vartanian, 2014). Connected to overly uniform facades, Weisman (1981) introduced the concept of ‘architectural differentiation’ referring to locations and places that look too similar, causing confusion and disorientation.



In real-world behaviour studies, visual attention is frequently directed at street edges — the continuous lines formed by building fronts and boundary walls (Simpson, Thwaites & Freeth, 2019). Emo (2014) complements this, showing that people are drawn to spatial features like long lines of sight, openings to the sky, and defined floor areas, which help structure visual and physical movement.

Importantly, wayfinding is not purely individual — it often involves shared perception and group decision-making. Dalton, Hölscher, and Montello (2019) emphasise that navigation is a social process, influenced by verbal cues, group dynamics, and collective interpretation of the built environment. In this context, well-designed façades can facilitate both personal orientation and social cohesion by making environments more readable and mutually intelligible.

Finally, the role of façade design in navigation may extend beyond practical guidance. Over time, distinctive and familiar architectural features may help foster a sense of place identity, anchoring emotional attachment and supporting a feeling of rootedness in urban space.





Thematic Evidence Synthesis

5. Human-scale and street-level design

From orientation to interaction: the significance of eye-level design

Street-level architecture plays a role in shaping how people feel and behave in public space. Features encountered at eye level — such as permeability, variation, and social cues — can influence emotional comfort, engagement, and perceptions of safety. In both low- and high-rise environments, façades that are animated and human-scaled encourage lingering, support spontaneous social interaction, and reduce physiological stress. Especially in dense urban contexts, well-designed eye-level environments can act as buffers against the psychological strain of verticality, supporting more liveable, inclusive cities.

Evidence synthesis

Façades that incorporate texture, transparency, and visible signs of life have been associated with positive emotional and social responses. Ellard (2020) found that participants tended to exhibit greater physiological arousal and more positive affect when walking past visually engaging façades. In contrast, blank or enclosed frontages were linked to lower skin conductance and increased reports of negative affect, suggesting that openness and material richness may help support emotional regulation (Srikantharajah & Ellard, 2025).

Empirical fieldwork lends further support to these associations. In southern Chile, Zumelzu et al. (2024) observed that vibrant façades and sensory-rich streetscapes — featuring wood, greenery, soft paving, and street trees — were associated with high-arousal positive emotions such as joy and vitality. Conversely, participants described deteriorated pavements, metal fences, and blank walls as evoking discomfort and fear.

These findings extend earlier observational research by Jan Gehl and William Whyte on street life and social behaviour, and are now being explored further using biometric methods, including eye-tracking and physiological monitoring.

Design strategies that prioritise human scale and pedestrian orientation may also be linked to prosocial behaviour and emotional ease. A recent review by Salsabila and Navitas (2024) suggests that inclusive ground-floor design — characterised by walkability, greenery, and sensory variation — may support mental wellbeing by encouraging social interaction, physical activity, and psychological restoration.



Research by Sussman and Chen (2017) indicates that pedestrians tend to focus more on ground-floor articulation than on upper-storey features, underscoring the visual and psychological significance of eye-level design. In dense urban contexts, carefully considered street-level interventions may help reduce perceived stress. Sarkar and Lai (2023) report that façade permeability and material diversity were associated with lower perceptions of crowding, suggesting a potential link between design variation and psychological comfort. In response to such findings, cities such as Amsterdam and Melbourne have introduced planning policies mandating “active frontage” design to promote street-level vitality (Suurenbroek & Spanjar, 2023).

However, not all visual stimuli are experienced positively. Chiu et al. (2024) found that façades constructed from cool-toned, heavy materials such as iron were associated with increased self-reported stress, pointing to the possible role of sensory warmth in emotional response. Similarly, Mazumder, Spiers & Ellard (2020) found that high-rise buildings lacking transparency or visible sky at street level were linked to heightened physiological stress indicators.





6. Place-attachment and belonging

From momentary interaction to belonging

While street-level design shapes immediate emotional and social responses, façades may also contribute to deeper experiences of belonging, identity, and emotional continuity. This section explores how the visual features of architecture — its symbolic cues, material care, and sensory richness — can foster place attachment, the emotional bond between people and their surroundings.

Architectural elements such as porches, balconies, decorative thresholds, and visible signs of human presence may signal cultural meaning, social identity, and care. These features can be particularly significant for individuals who are more closely tied to their immediate environment — such as children, older adults, or those with limited mobility. In this way, façades function not only as protective enclosures but also as expressive interfaces that influence how people feel about the places they inhabit.

Evidence synthesis

Coburn et al. (2020) identify hominess, coherence, and fascination as key perceptual qualities that shape emotional responses to façades. While their study does not focus specifically on decorative details, features like stoops, porches, and thresholds may help create these qualities by providing familiarity, symbolic meaning, and visual interest. These perceptual experiences have been linked to activity in brain regions involved in emotion, memory, and visual processing (Chatterjee, Coburn & Weinberger, 2021).

Chatterjee and Vartanian (2014) suggest that architecture may engage what is called “emotional valuation” by activating neural systems that integrate sensory input with affective and autobiographical memory. In this context, façades that reflect cultural identity, material continuity, or personal meaning may help forge deeper emotional ties.

Weinberger et al. (2021) report that positive emotional responses to architectural environments are more likely when the environment resonates with personal memory or shared identity. This is echoed in recent work by Ariannia, Naseri and Yeganeh (2024), who found that building form and visual quality strongly influence place attachment. Their study of iconic cultural buildings in Iran shows that well-articulated and visually engaging architecture can enhance satisfaction and emotional connection, reinforcing the importance of form in fostering urban belonging. The emotional value of façades in heritage settings has also been extensively documented in Madgin’s studies (Madgin & Lesh, 2021; Madgin et al., 2016), which reveal how emotional attachments shaped by memories, identity, and urban change influence perceptions of historic architecture.



Further evidence from Seoul National University's Urban Planning Laboratory (2021) suggests that façades designed to reflect local culture or enable social interaction may foster social cohesion and inclusive urban identity. These findings point to the importance of contextually sensitive, emotionally resonant architecture.

Recent studies provide additional support. Liao et al. (2021) found that older adults reported greater wellbeing and functional independence in neighbourhoods with well-maintained façades – especially those showing signs of care, texture, and human scale. Nan et. al (2024) similarly found that multisensory and visually rich façades supported emotional connection in people experiencing physical or cognitive decline.



Casa Milà, Barcelona, Spain by Antoni Gaudí (1912). Image: Thomas Ledl



Thematic Evidence Synthesis

7. Lived experience and bodily wellbeing

From cultural resonance to embodied experience

While façades contribute to memory and cultural meaning, they are also experienced physically — through mood, movement, and sensory perception. This section introduces neurophenomenology, an approach that integrates subjective experience with neuroscientific data to explore how architecture is felt as well as seen. Rather than treating buildings as static visual objects, this perspective recognises them as dynamic, multisensory environments — encountered through walking, remembering, and sensing — where emotional experience unfolds in relation to bodily movement and context.

Evidence synthesis

Much of our emotional response to architecture takes place below the level of conscious thought. As Bower, Tucker, and Enticott (2019) observe, these reactions are shaped by immersive, multisensory cues that develop over time — requiring methods that go beyond static images or single-point measurements.

Neurophenomenology addresses this by combining biometric data (like EEG or skin conductance) with first-person descriptions of experience to understand the emotional texture of architectural engagement. Edelstein (2022) similarly argues that design can activate the brain’s deep affective systems, evoking sensations of delight, meaning, and embodied presence.

Ruzzon (2020) suggests that architectural form contributes to atmospheric perception — a subtle but powerful emotional response shaped by memory, movement, and sensory cues. His work shows how design can prompt autobiographical recall and modulate mood, particularly through features like rhythm, texture, and materiality. These insights are supported by neuroimaging studies such as Coburn et al. (2020), which demonstrate that architectural perception engages brain regions involved in memory, emotion, and sensory integration.



Neurophenomenological research also emphasises the temporal dimension of experience. In contrast to aesthetic assessments made in laboratory settings, real-world interactions with façades occur in rhythm and sequence — through changes in light, surface texture, and spatial flow. As Ruzzon notes, such rhythms can evoke emotional responses akin to those triggered by music or narrative, mediated by the body's sensory-motor and emotional systems.

This is reinforced by Djebbara et al. (2019), who used mobile neuroimaging and experience-sampling techniques to show that walking through architectural space simultaneously activates emotional, memory, and motor networks. Ruzzon describes this as “empathic resonance”: a felt alignment between bodily state and spatial form.

To better reflect lived experience, Gregorians et al. (2022) developed a dataset of first person-view videos simulating movement through urban environments. Their results showed that qualities like fascination, coherence, and hominess correlated with emotional states: fascination was linked to arousal, while coherence and hominess were associated with positive emotional valence.

Together, these studies suggest that façades and urban spaces are not just processed visually, but felt through time, movement, and memory. The ecological approach to perception reinforces this view, emphasising the dynamic, action-oriented nature of environmental experience and its intrinsic link to affective response (Heft, 2024). Neurophenomenology provides tools for understanding and designing environments that support wellbeing — by attending not only to visual form, but to the embodied and emotional resonance of architectural experience.





8. Enriched environments and engagement

From embodied experience to active support for wellbeing

If architecture is lived and felt — as neurophenomenology suggests — then façades are not only seen or remembered but encountered in ways that can actively shape wellbeing. This section draws on the concept of enriched environments: settings that offer multisensory, cognitive, and emotional stimulation to support human thriving. Grounded in neuroscience, design psychology, and what is called “salutogenic theory”, this approach views buildings as active contributors to health — not merely by avoiding harm, but by fostering joy, agency, and emotional connection. Central to this is the idea of architectural generosity: façades and streetscapes that go beyond visual function to invite curiosity, comfort, and moments of engagement in daily life.

Evidence synthesis

In neuroscience and psychology, environmental enrichment (EE) refers to conditions that enhance sensory, cognitive, and social stimulation. In animal studies, enriched settings have been shown to reduce stress, promote neuroplasticity, and protect against cognitive decline (van Praag et al., 2000; Nithianantharajah & Hannan, 2006). While caution is needed when applying these findings to human contexts, recent research suggests comparable benefits.

A 2024 pilot study by Khalil and Steemers found that enriched residential environments — characterised by spatial diversity, material richness, and visual complexity — were associated with lower rates of anxiety and depression, as well as enhanced cognitive functioning and emotional wellbeing. Complementary large-scale neuroimaging studies have also reported that environmental complexity — including access to green infrastructure — is associated with differences in brain structure and function, suggesting links to resilience and mental health (Kühn et al., 2017).

Translating these insights into architecture, the concept of design affordance — features that subtly invite interaction, exploration, or ease — becomes central. Bower, Tucker & Enticott (2019) note that emotionally supportive façades often include visual richness, coherent spatial organisation, and cues that promote intuitive use. Building on this, Farrow (2021) argues that architecture can enhance wellbeing by supporting dignity, delight, and autonomy, especially through human-scaled elements and sensitive transitions.

Importantly, these experiential effects may also have a biological basis. Magsamen and Ross (2023), in *Your Brain on Art*, link multisensory, meaning-rich environments to the release of oxytocin and dopamine — neurochemicals associated with trust, pleasure, and resilience — while buffering the effects of stress hormones such as cortisol. While more direct architectural evidence is still emerging, related studies support this link.



Similarly, regenerative design approaches suggest that aesthetic richness — expressed through light, natural materials, and textural contrast — can foster neurochemical conditions that reduce stress and enhance engagement (Mile High CRE, 2019). Together, these findings reinforce the idea that beauty and material care are not simply cultural values, but biologically meaningful aspects of health-supportive environments.

Building on these insights, Ruzzon (2022) introduces the concept of empathic affordance: the capacity of architectural form to align with bodily and emotional states through rhythm, openness, and material quality. Generous façades — those offering light, texture, or spatial invitation — may function as emotional scaffolds, creating environments that support calm, vitality, or intrigue.

These design principles hold particular significance in public, healthcare, and educational settings, where emotional support and social equity are critical. Evidence suggests that richly detailed façades, public art, and dynamic lighting can enhance belonging, positive mood, and attentional focus, especially for individuals navigating vulnerability or marginalisation.

Echoing the work of Coburn et al. (2020) and Briemann et al. (2022), Ruggles (2018) argues that humans are evolutionarily attuned to patterns of symmetry, coherence, and proportion — visual structures that may signal safety and promote emotional stability. In this light, façades are not simply exterior surfaces, but potential contributors to public health and civic wellbeing.





Conclusion

Key insights and core findings

This review has synthesised a rapidly growing body of research — spanning neuroscience, cognitive science, environmental psychology, neuroaesthetics, neurophenomenology, place-based studies, and urban design — to demonstrate that external building design plays a measurable role in shaping human health and wellbeing. Design features once dismissed as superficial or subjective are now recognised as meaningful contributors to a wide range of health and wellbeing indicators, such as physiological regulation, cognitive processing, emotional attachment, and social connection.

Together, these findings show that façades influence not only how neighbourhoods and cities look, but how they are felt, navigated, and remembered. Research suggests that humans are especially responsive to visual structure, biophilic cues, and emotionally legible architectural elements. These features activate neural networks associated with memory, affect, and reward — while monotonous or incoherent façades may contribute to background stress, disorientation, or even social withdrawal.

Many of these responses occur below the level of conscious awareness. Studies using biometric tools — such as EEG, fMRI, eye-tracking, and skin conductance — reveal that people’s reactions to architecture are often pre-conscious and physiological. As Bower, Tucker, and Enticott (2019) note, design influences affective states through both subjective experience and neurophysiological response.

Neurophenomenology deepens this understanding by showing that architecture is not only seen but felt. People engage with façades through motion, atmosphere, memory, and sensory resonance. Buildings are not merely objects in space — they become part of our emotional landscapes: places to dwell, recognise, and belong to.

Enriched environments — those that offer sensory variation, symbolic depth, and opportunities for interaction — are associated with psychological resilience, agency, and social cohesion. The literature on salutogenic and emotionally generous design further underscores that buildings can be crafted not only to minimise harm, but to actively support human thriving.

These findings echo global calls — including the OECD’s 2023 wellbeing framework — to rethink the built environment as part of social and public health infrastructure. As neuroscience continues to evolve, it becomes increasingly clear: architecture should be evaluated not only by how it looks or performs, but by how it makes people feel — and whether it fosters the emotional and physiological conditions for living well.

This review offers a foundation for that future: reimagining buildings not as passive backdrops, but as active agents of health, emotional connection, and collective wellbeing.



Conclusion

Core findings

1. The shape of buildings affects stress levels

Our bodies respond to buildings — often without us realising it. Long, blank walls or monotonous, towering façades can trigger tension and discomfort. In contrast, buildings with human-scale proportions, varied textures, and visible openings tend to promote calm and ease. These effects are not just subjective: studies using VR, EEG, and biometric sensors show measurable changes in heart rate, skin conductance, and arousal. In short, how a building looks and feels on the outside has real, physiological effects on how people feel on the inside.

2. Visually engaging buildings help us think and feel better

Facades with balanced, human-scale details — like symmetry, rhythm, and texture — are easier for our brains to process. This kind of visual richness reduces mental strain, supports emotional ease, and helps us navigate our surroundings more fluently. Eye-tracking and neurological studies show that buildings with structured variation and natural patterns attract our attention, hold it longer, and elicit positive emotional





Conclusion

responses. From infants to adults, people tend to prefer environments with organised complexity — suggesting that our attraction to visually engaging architecture may be both biological and universal.

3. Natural features boost mood and reduce stress

Even brief exposure to natural elements on building façades — like green walls, leaf-like patterns, or organic textures — can help lower stress and improve mood. In dense urban settings, these biophilic features offer a sense of calm, support attention restoration, and reduce mental fatigue. Studies show that natural patterns and materials engage the brain’s sensory and emotional systems in ways that promote wellbeing. By softening the urban experience, nature-integrated design helps people feel more relaxed, clear-headed, and at ease in their environment.

4. Distinctive buildings help people find their way

Façades with clear, recognisable features — such as contrasting materials, ornament, or distinctive entrances — can make buildings easier to identify,

remember, and mentally map. These visual cues support orientation, particularly in unfamiliar or complex environments. Research shows that well-articulated exteriors may function as visual anchors, aiding wayfinding and spatial memory. Over time, distinctive buildings can also contribute to a stronger sense of place by helping people feel more grounded and confident as they navigate the city.

5. Street-level design shapes how we feel and connect

How a building meets the street can influence how people feel — and whether they engage. Façades with features like transparent glazing, textured materials, open entrances, and signs of life tend to be perceived as more welcoming, comfortable, and socially inviting. These human-scale details are linked to greater emotional ease and positive affect, especially in dense urban areas. By contrast, blank or enclosed street edges are often associated with discomfort or disconnection. Ground-floor design plays a subtle but powerful role in shaping how people relate to each other — and to the public realm.

6. Buildings with character create a sense of belonging

Façades that show care — through texture, material warmth, transparency, or visible life — can foster comfort, pride, and emotional connection to place. These features are associated with positive affect and perceptions of welcome, especially in dense or walkable environments. While not all visual cues are experienced equally, studies suggest that human-scale, sensory-rich façades may help people feel more at ease in their surroundings. Over time, expressive architecture may also support community connection and place identity, particularly when it reflects the qualities people value in their everyday environments.

7. We experience buildings through our whole bodies

Architecture is not just seen — it is felt. As we move past a façade, the rhythm of materials, light, and texture can shape how we feel, moment by moment. Research shows that architectural experience engages memory, emotion, and bodily sensation — not just visual processing. Using tools like EEG,

first-person video, and mobile biosensing, recent studies highlight how movement through space activates neural and emotional systems. These findings suggest that the impact of buildings is not static but unfolds over time — through rhythms and cues we perceive with our whole selves.

8. Welcoming design supports wellbeing

Architectural features that invite comfort, curiosity, or ease — through texture, detail, or spatial richness — can support emotional and cognitive wellbeing. Research suggests that environments with visual and material variety may help reduce stress, enhance mood, and promote engagement. These effects are especially important in shared or high-pressure settings, where thoughtful design can offer moments of calm or connection. While the underlying mechanisms are still being explored, emerging studies link enriched, meaning-rich architecture to patterns of attention, affect, and even resilience. In this light, generous design becomes not decorative — but quietly health-supportive.



Conclusion

Designing with intentionality and care

The evidence presented in this review has the potential to transform how we design, invest in, and develop the built environment. If buildings are not neutral containers, but active interfaces that shape physiological, emotional, and social experience, then their design has the potential to influence public health, civic connection, and social equity.

For architects and designers

For those in architectural and design practice, these findings call for a shift in mindset. Too often, buildings have been conceived as functional systems or formal exercises, with façades treated as secondary. But façades are not just surfaces — they are sensory thresholds that shape how people feel, think, and relate.

Designing with intentionality means recognising that features such as visual complexity, rhythm, texture, and human-scale articulation are not aesthetic luxuries, but essential supports for emotional regulation, cognitive clarity, and social connection. Façades should be understood as a medium of communication and care — one that speaks to the body and brain as much as to the eye.

Education must reflect this shift. Architecture students should be introduced to neuroscience, psychology, and public health as core components of their training. Designers must learn not only how to construct buildings, but how those buildings are felt and experienced. Interdisciplinary collaboration — from studio education to professional practice — must become standard.

For developers, planners, investors, city leaders and communities

For developers, investors, civic leaders and communities, the implications are equally significant. External design influences more than branding or curb appeal — it can affect stress, sociability, place identity, and perceptions of safety. The core findings make clear that façades shape how people navigate, interpret, and emotionally respond to the built environment.

Planning and investment decisions should therefore account for the emotional, cognitive, and physiological consequences of design. This includes updating procurement and design review processes to embed wellbeing indicators — and applying them equitably, especially in underserved communities where poor design often compounds other forms of disadvantage. Raising design standards for housing, schools, and infrastructure is not just good practice — it is a matter of equity.

Emerging technologies are making this possible. Spatial analytics, immersive simulations, and environmental sensors can help optimise buildings for wellbeing from the earliest stages of design. This points toward a future in which health is embedded — by design — into the very fabric of cities.



Conclusion

For researchers and interdisciplinary teams

For researchers in neuroscience, design, public health, and social science, the task ahead is one of integration and translation. There is growing consensus — from Salingaros, Sussman, and Chatterjee to Chana et al. (2024) — that architecture must evolve into an evidence-informed discipline grounded in human experience. This requires bridging the gap between lab findings and real-world application.

The research agenda must expand to include education, evaluation, and implementation. Recent work by Hölscher et al. (2025) offers a structured framework for bridging architectural design with user cognition, organised around three pillars: fundamental research on person–environment interaction, reflective analysis of how designers conceptualise users, and translational research to embed empirical insights into practice. Their approach underscores the need for tools and methodologies that make cognitive and affective evidence usable within real-world design workflows.

New design standards — aligned with empirical insights on rhythm, symmetry, coherence, and sensory richness — can help translate knowledge into policy and practice. And as Ruggles (2018) notes, aesthetic deprivation — the absence of perceptual richness or meaning — is itself a form of environmental stress.

Looking ahead, the challenge is not only to generate new data, but to develop shared frameworks that link science, design, and community priorities in practical, actionable ways.

A shared responsibility

Designing for wellbeing demands collaboration across disciplines and sectors. Just as building codes protect physical safety, we now need frameworks that safeguard mental and emotional health.

This perspective affirms the founding vision of Humanise: that architecture should be joyful, meaningful, and profoundly human. We now have the tools to validate what many have long intuited — that the buildings and streetscapes we share shape how we feel, connect, and thrive.

A more human architecture is not a luxury. It is a public responsibility, and a human need.



Conclusion

The promise and challenge of neuroarchitecture

The neuroscience of architecture stands at a pivotal juncture. While early research in the field was largely descriptive — mapping brain activity onto broad aesthetic categories — advances in technology and methodology are enabling more experimental, data-rich, and context-sensitive approaches. This evolution holds significant promise for advancing evidence-based design, particularly in relation to health and wellbeing in the built environment.

New tools are transforming the research landscape. Mobile EEG, functional near-infrared spectroscopy (fNIRS), immersive virtual reality (VR), eye-tracking, and ecological momentary assessment (EMA) now make it possible to capture real-time physiological and emotional responses to buildings in everyday settings. These methods allow researchers to ask more nuanced questions:

- How do specific façade features affect emotional arousal or cognitive load?
- What brain activity is associated with feelings of comfort, coherence, or safety?
- Can we identify repeatable design features that support mental restoration or reduce stress?

Artificial intelligence is also reshaping the field. lungman et al. (2023) used machine learning to detect how certain window patterns elicit positive emotional responses. Valentine et al. (2025a) developed a system that uses generative AI and mathematical analysis to estimate visual stress from façades, helping identify potential discomfort early in the design process. While these approaches are still emerging, they point to a future where computational tools could guide more health-conscious design decisions.

Yet key limitations remain. One of the most pressing challenges is the lack of shared conceptual models. While frameworks such as the aesthetic triad and concepts like empathic affordance offer useful starting points, neuroarchitecture still lacks the theoretical consistency needed to synthesise findings across neuroscience, psychology, and architectural practice. Additionally, as Bower, Tucker and Endicott (2019) emphasise, many of our responses to architecture occur at a pre-conscious level — indicating the need to combine biometric measurement with reporting subjective experience.

Experimental constraints further limit insight. Much existing research is still conducted in laboratory settings using static images on screens. These methods do not fully reflect the multisensory, embodied nature of how people experience architecture in real life. Although mobile neuroimaging and immersive tools are beginning to bridge this gap, real-world and longitudinal studies remain rare.

In response, researchers are increasingly calling for “neuroarchitecture in the wild.” This approach uses wearable sensors, field-based tracking, and in-the-moment experience sampling to evaluate how people feel and behave in built environments. As de Paiva and Jedon (2019) note, individuals are often unaware of how design features influence their emotions or stress. Without grounded, ecological research, many effects of architecture on health and behaviour may be missed.

The field also needs shared methods and measurement standards. To improve comparability across studies, researchers must agree on how to describe and test architectural features. Standardised metrics — such as façade permeability, edge orientation entropy, or geometric articulation — would help unify evidence and make findings more useful for design practice.

Finally, research must remain sensitive to cultural context. While some physiological responses — such as preference for symmetry or natural elements — appear to be broadly shared, emotional reactions to architecture are shaped by culture, memory, and place. What feels calming or meaningful in one context may not be in another. Caution is needed to avoid assuming that all findings are universally applicable.

Realising the promise of neuroarchitecture will require deeper collaboration. This includes stronger partnerships between architects, designers, planners, scientists, health experts, and communities. It also demands methodological innovation, cultural humility, and ethical foresight.

Only by grounding architectural design in the realities of how people feel, perceive, and thrive can we create built environments that truly support public health, inclusion, and collective wellbeing.



Recommendations

From insight to action

For developers, investors, clients, city leaders and communities

1. Recognise the health impact of building exteriors

Acknowledge that façades and streetscapes can influence emotional wellbeing, stress, and social behaviour — and embed these insights into urban design, policy, and planning frameworks.

2. Design for visual richness, human scale, and openness

Encourage building exteriors that feel welcoming and alive — through varied materials, open entrances, and eye-level detail — because these elements support trust, comfort, and public life.

3. Address design inequality as a health issue

Uplifting environments should not be a privilege. Poor or monotonous design in underserved communities must be recognised and addressed as a matter of equity and wellbeing.

4. Use emerging tools to measure impact before you build

Leverage technologies like VR, mobile eye-tracking, and biometric simulations to understand how buildings will feel in use — reducing risk and improving outcomes from the start.

5. Invest in external building design

The sensory and visual quality of buildings isn’t decorative — it’s essential. Design that supports emotional wellbeing and social connection delivers lasting value to people and places.

Design insights for architects and designers

Create visually rich but coherent façades	Use rhythm, symmetry, and texture to make buildings more engaging and easier for the brain to process — supporting comfort, attention, and long-term appeal.
Design at human scale	Façades that include open entryways, windows, and detail at eye level feel more approachable, encouraging trust, interaction, and a stronger street presence.
Bring nature into the façade	Incorporate natural patterns, curves, and materials to reduce stress and foster a sense of calm — even in dense, urban environments.
Make buildings easy to read and navigate	Help people find their way with clear entrances and memorable exterior features that act as visual anchors in the urban landscape.



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