Reconnection

Exploring emotional architecture in a dense environment and the call of nature.

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Abstract:
Human beings respond to architectural spaces cognitively and emotionally. Research has shown that emotional feedback affects human health and well-being. A relative lack of natural environments characterizes cities, and there is growing concern that busy urban lifestyles are contributing to a disconnection from the world. This disconnection is reflected in both the quality and quantity of experiences humans have with nature. Connection with nature has been shown repeatedly by multiple studies to benefit human well-being and predict pro-environmental behaviours. This research focuses on the current state of scientific knowledge regarding how humans respond emotionally to buildings. In this paper emotional architecture, the concept of creating designs that elicit emotions resulting in positive user experiences (mainly focused on the user's body and mind), is examined as a tool for stimulating human scale in cities improving mental health and well-being. The goal is to develop a practical design toolbox that architects can use to integrate appropriate design principles on a project-by-project basis. Designing for multiple sensory experiences through emotions and nature is crucial. This can be achieved by using the following design parameters: Views of nature, spatial complexity, multi-sensory, presence of water, climate and user comfort.

Keywords: *emotional architecture, well-being, nature, emotions, multi-sensory*

1. Introduction

Humans spend over 90 % of their lives in buildings. Architecture shapes their mind and body daily and influences how humans feel and behave (Coburn et al., 2020).
It is projected that by 2050, most of the humans will live in cities. Despite advancements in technology, urban design lacks a human touch. This has led to an increase in social isolation, burnout and feelings of being overwhelmed. However, it is becoming more apparent that designing buildings and urban spaces with emotion in mind is crucial (Heatherwick, 2023a).

At the core of human experience lies emotions from what they see, hear, touch, smell, and taste (Malhotra, 2022). Since emotions play an important role in logical decision-making, perception, learning, and other functions and affect the physiological and psychological state of human beings, it is necessary to pay attention to the effect of architectural space on human emotions. (Zamani et al., 2022) It can be shown through scientific studies in psychology, cognitive science and neuroscience that buildings can elicit strong emotional responses in humans. Dalton

Over the last thirty years, there have been significant advancements in understanding how the brain functions. Thanks to new methods, scientists are now able to detect even the slightest events, such as the firing of a single neuron in the brain. (Although techniques such as fMRI and EEG can only describe aggregate levels of brain activity and not the single neuron level). As a result, researchers have begun exploring which design features of architecture elicit emotional responses from humans and which areas of the brain are involved in this process. Emotional responses are a crucial factor in human perception, and while psychology is commonly associated with emotions, architecture and design also play a significant role in shaping our perceptions (Dalton, 2023).

Cities will soon start to recognize the importance of emotional value in architecture and design. Furthermore, architects and designers will begin to understand how the aesthetics and diversity of buildings can deeply impact our emotions, lift our spirits and stimulate connection (Heatherwick, 2023a). A relative lack of natural environments characterizes cities, and there is growing concern that

busy urban lifestyles are contributing to a disconnection from the world. This disconnection is reflected in both the quality and quantity of experiences humans have with nature. Connection with nature has been shown repeatedly by multiple studies to benefit human well-being and predict pro-environmental behaviours. Humans are socially oriented beings, that need healthy inter- and intrapersonal connections to experience psychological wellbeing. A sense of belonging and connectedness is required to experience an overarching meaning in life. To belong implies experiencing relatedness and connections with people, society, and nature (Uhlmann et al., 2018).

However, the connection between humans and nature is changing. At this moment modern life is a 24/7 society where humans are always busy, reachable and employable (Kesebir & Kesebir, 2017). Finding ways to reconnect with nature is crucial as it requires human attention and care, especially with the urgent threat of global warming leading to more extreme weather conditions such as heat waves, droughts, storms and extreme climates (Montgomery, 2014). By 2023, there will be a growing awareness among humans about the interconnectivity between creating beloved spaces and preserving the environment. A deep appreciation for the surrounding environment will be key in designing streets and buildings that are full of details, innovative solutions, and three-dimensionality. These human-centred spaces will be valued and enjoyed by residents and visitors alike for generations to come (Heatherwick, 2023a).

This paper examines in more detail the current state of scientific knowledge regarding how humans respond emotionally to buildings. In this paper emotional architecture, the concept of creating designs that elicit emotions resulting in positive user experiences (mainly focused on the user's body and mind), is examined as a tool for stimulating human scale in cities.
Architects can deliver a message and create awareness that nature is worth paying attention to and using emotions in architecture can stimulate well-being in cities. The overall aim of this paper is to create awareness of the complexity of the relationship between architecture and emotions. And to create a guideline/ strategy for creating a building with the tools of emotional architecture. The challenge is that while there is a lot of information about design principles that can evoke an emotion in users, there are very few design principles for the use of emotional architecture.
So, the question that emerges is "What can strengthen emotional architecture, - with a focus on natural aspects- and what are the related design principles?".
To answer the main research question, the following sub-questions are asked:

- What is emotional architecture?
- Can emotional architecture be used for architecture?
- Can spaces evoke emotion?
- What types of design characteristics could stimulate positive emotion in a built environment?
- On what scale are architectural interventions necessary that increase the sense of the human scale?

2. Methodology:

2.1 Methods/ paper outline:

The paper is divided into six parts. The first part uses a qualitative literature study on emotional architecture and emotions (psychology) for a better understanding of the concept. In Emotions in Architecture part two there will be a deeper discussion on how emotions work in the architectural world. In part three Design characteristics, this section will translate existing theories/ literature into design parameters. By introducing a case study on how emotional experience has a significant role in architecture, there is still limited research on the emotional connection between design principles and experience. Thus, it's worth examining various architectural projects, including pavilions, museums, exhibition spaces, mixed-use buildings, and temporary exhibition centres. These projects provide symbolic meaning to architectural spaces and offer different ways of understanding spatial experience. The selected projects will be analysed on how the created architectural space improved the quality of mental health, well-being, and emotional connections. Part four called the Human scale will look more into the scales of the built environment. Part five Emotional connection with nature, this part, with the help of literature, will look if there is an emotional connection with nature and how this can be done in a design. In the final part Conclusion and Discussion, the thematic research question will be answered

with the help of the sub-questions. Furthermore, the limits of the method and suggestions for further research will be discussed.

3. Emotional architecture

"Architecture is the art of reconciliation between ourselves and the world, and this mediation takes place through the senses."- Juhani Pallasmaa architect –

3.1.1 Emotions

Emotions are strong feelings directed towards a particular object, often accompanied by physiological and behavioural changes as defined by the dictionary (*Emotion*, 2024).
Emotions were previously misunderstood and perceived as obstacles to rational thinking. However, recent research has revealed that evolutionarily advanced animals tend to display greater emotional complexity. Emotions are now recognized as crucial to human life, influencing thoughts, behaviours, and decision-making. Neurochemicals play a crucial role in modifying perception, decision-making, and behaviour, significantly impacting cognitive functioning (Norman, 2004).

Pieter Desmet's chapter on product emotion (2008) provides background and a foundation for the model and sources of product emotions. Russell (1980; Russell, 2003) introduced 'core-affect' by combining the affect dimension with physiological arousal in a two-dimensional model. Core-affect is a blend of these two dimensions, represented on a circular structure where valence (unpleasant to pleasant) is on the horizontal axis and arousal (calm to excitement) is on the vertical axis. The figure displays emotions felt in response to consumer products adapted by Pieter Desmet. Core affect is an individual's primary emotional state that can range from neutral to extreme intensity. It can be short or long-lasting and can be triggered by a specific stimulus or not. Intensity can determine if it's the focus or just part of the background. For example, momentary mood can also cause a core effect (Desmet, 2008).

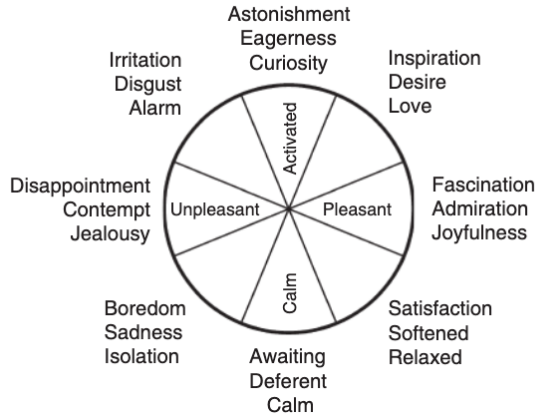


Figure1: Circumplex model of core affect with product-relevant emotions (Desmet, 2002 adapted from Russell, 1980)

3.1.2 Emotional architecture

Emotional architecture is a poetic act that engages both body and mind. Being in a space means not just experiencing its form, but also its unique dialogues. As the user enters, the space enters them. It's a merging of object and subject (Malhotra, 2022).

Mathias Goeritz and Luis Barragán were two architects who redefined emotional architecture and emphasized that it should move its inhabitants. After the establishment of the museum El Eco, Goeritz published a manifesto titled "Emotional Architecture". In this manifesto, Goeritz argued that modern architecture should strive to create the same emotional impact as the architecture of previous eras, such as the pyramids, Greek temples, and Roman or Gothic cathedrals, which were known to evoke powerful emotions. Goeritz believed that only by eliciting genuine emotions could architecture be considered art. This manifesto emphasized the ability of architecture to move the soul, and emotional

architecture reintroduced the temporality of human experience in the conception of a building (Pelletier, 2008).

Two theories of emotional architecture are introduced in more literature about emotional architecture. Professor Don Norman wrote the first theory on emotional architecture. Norman wrote a book about emotional design: why we love (or hate) everyday things. This book states a central concept for stressing the crucial role of emotions in the human ability to understand the world. Norman introduced a principle of three levels of processing for how humans emotionally react to visual experiences: visceral, behavioural, and reflective. See the figure.

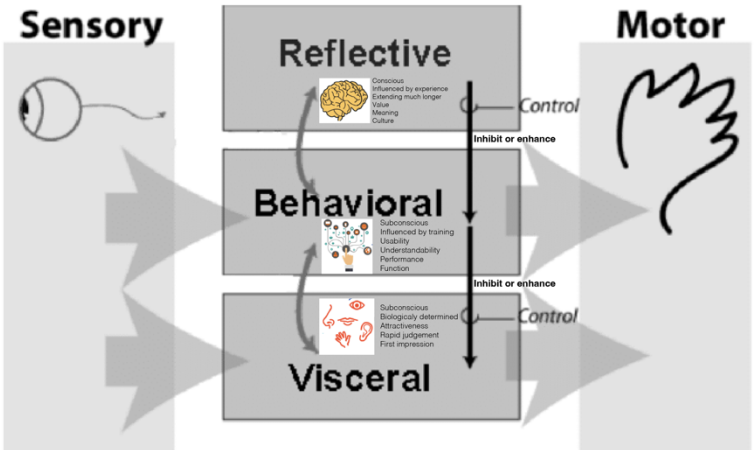


Figure 2: Emotional design model (by the author, after (Zhou et al., 2020) and (Norman, 2004).)

The first level of human perception is the visceral level, which is the pre-consciousness stage where initial impressions are formed based on a product's appearance, touch, and feel. The behavioural level of a product is all about the user's experience with it. However, experience can be broken down into three main aspects: function, performance, and usability. Function refers to what activities the product supports and its intended purpose. Performance is about how well the product carries out those functions. Usability, on the other hand, describes how easy it is for the user to understand how the product works and how to operate it. The highest levels of consciousness, emotions, and cognition are observed at the reflective level where a comprehensive impact of both thoughts and emotions is experienced. This level is characterized by a heightened sense of awareness and introspection. It is only through reflective thinking that one can delve deeper into their thoughts, feelings, and experiences, thereby gaining a more profound understanding of oneself and the world around them (Norman, 2004).

In addition, Pieter Desmet presents an emotional design strategy. This basic model of emotions consists of three key variables: appraisal, concerns, and stimulus, which are responsible for the elicitation of human emotions. The figure illustrates the emotional response from an appraisal process in which the architecture is connected to human concerns and stimulus (Ahmad Fadzil, 2015). According to Desmet, Norman's theory clarifies and illustrates the role of cognition in the process of product emotion and provides humans with a basis for explaining why and how products elicit emotional responses (Desmet, 2008).

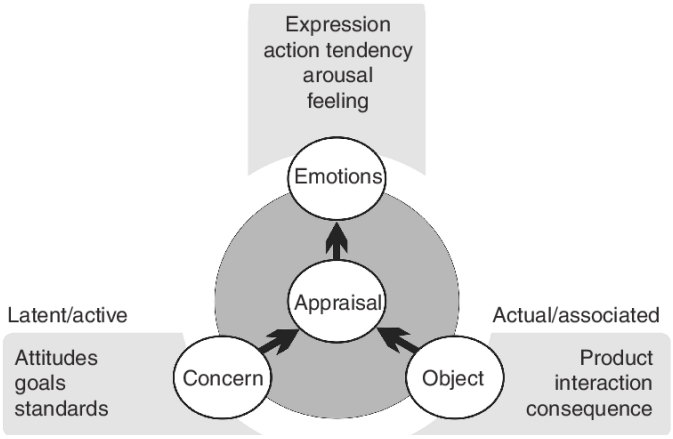


Figure 3: The basic model of emotions in architecture (adapted from Desmet, 2002)

Appraisal involves automatic evaluation of a stimulus' significance for one's well-being. Emotion always assesses how an object may harm or benefit a person. From an evolutionary perspective, sensation and perception aim to aid adaptation that can enhance a species' chances of survival. This implies that every emotion is linked to a concern. An environment will only trigger an emotion if it corresponds to or differs from a concern. However, the challenge in comprehending concerns is that the number and variety of human concerns are infinite. Humans experience stimulus when their surroundings change, whether it be an event, something spoken, or an encounter in a space. This has the potential to elicit an emotional response (Ahmad Fadzil, 2015).

Emotions can result in conscious feelings or behavioural intentions. Emotional experiences are usually short-lived and unconscious. When linked to a specific environment, they may lead to a desire to stay or revisit that place. Long-term feelings not linked to a specific environment are called moods (Schreuder et al., 2016).

3.2 Emotions in architecture:

At the core of human experience lies human emotions, which are present in every aspect of their lives - from what they see, hear, touch, smell, and taste. Their perceptions are shaped by their emotional responses, and while psychology is often associated with emotions, architecture and design also play a significant role (Malhotra, 2022). The principal role of architecture is to trigger emotions. Emotional architecture engages the user's body and mind. They are experiencing its spaces, form and surfaces. A space enters the user as the user enters the space. The exchange and merger of the space (object) and the user (subject) is fundamental to the experience (*I.2.b. Emotional Architecture: When Emotions Take Over - Issuu*, n.d.).

The built environment is an essential part of a person's life, from open spaces to homes, commercial buildings, monuments, and public structures. It represents the humans who use it, and there is a strong connection between the built environment and the emotions of users interacting with the space. For example, natural, green, open, and aesthetically pleasing landscapes, as well as well-designed spaces, evoke a sense of awe in users and promote feelings of relaxation, happiness, connection, and engagement. Conversely, poorly designed, sterile, concrete, and dense environments have been shown to increase stress levels in users, leading to feelings of boredom, irritation, claustrophobia, or even depression (Malhotra, 2022).

Awe is an emotion described as wonder and surprise often experienced in nature, religion, spirituality, art, music, and architecture. It encourages cooperation and reduces self-focus, leading to sharing collaboration, and collective action. Awe fosters a sense of connection to others and promotes well-being. It increases creativity, openness to learning, and the preference for experiential products (Ke & Yoon, 2020).

Juhani Pallasmaa writes in the book: *The Eyes of the Skin: Architecture and the Senses (*1996/2012) mostly about, architecture as a multi-sensory experience, where the eye, ear, nose, skin, tongue,

skeleton, and muscle measure space, matter and scale. Sensory experiences are integrated into the body, and body image or schema is the centre of integration according to psychoanalytic theory. Human bodies and movements are in constant interaction with the environment, and the perception of the body and image of the world turn into a single existential experience. Architecture is an extension of nature into the man-made realm, and it provides the ground for perception and understanding of the world. Architecture also gives a conceptual and material structure to societal institutions and daily life. Architecture strengthens one's sense of being in the world and their experience of self. Humans identify themselves with space, place, and moment, and these dimensions become the ingredients of their existence (Pallasmaa, 1996/2012).

3.2.1 Spaces and Emotions

Architecture acts as a connection between nature and the human-made world. It helps humans understand themselves and the world by experiencing and perceiving architectural forms through their senses. Sight, hearing, touch, smell, and taste are all essential in experiencing architecture. These interactions give spaces and places meaning (Li, 2019).

A space refers to the structural and geometrical qualities of a physical environment, while a place is characterized by the lived experiences, interactions and usage of that space. A sense of place is a concept that describes the human connection with the physical environment in which they operate (Lentini & Decortis, 2010).

The human body has a natural ability to perceive the environment around it. Humans can detect subtle changes in patterns and proportions. As a result, the body receives physical information from its surroundings that can influence psychological behaviour when living, working, studying, or playing within the built environment. The relationship between humans and their physical environments can have complex psychological and behavioural effects. However, the impact becomes clearer when considering individual elements, spaces, and places. If a building were a body, its spirit would consist of light and shadow, materials, colour, water, and structure. These elements are comparable to muscle, skin, blood, and bones. The built environment comprises various elements such as materials, colours, and ambient environments like water, sound, and temperature, which are experienced through the senses of the body. Moreover, the experiences humans have in spaces are based on human inventions such as scale, vertical or horizontal orientation, straight or curved lines, order or disorder, symmetry, asymmetry, and mobility. These concepts are intangible but play a vital role in how humans perceive and experience the built environment (Li, 2019).

Humans experience a space through their entire body, perceiving it physically, sensorially, and emotionally. The body acts as a sensory apparatus to measure a space, other humans, and surrounding objects, creating a unique spatial and emotional experience; that is specific to place, time and materials (Lee, 2022).

3.3 Design characteristics: A review Case study

The emotional experience plays a significant role in subjectively understanding architecture, but there is still limited research on the emotional connection between design principles and experience. Thus, it's worth examining various architectural projects, including pavilions, museums, exhibition spaces, mixed-use buildings, and temporary exhibition centres. These projects provide symbolic meaning to architectural spaces and offer different ways of understanding spatial experience. They are also known to have a link to emotional experience. In this case study, the selected projects will be analysed on how the created architectural space improved the quality of emotional experience, mental health and well-being.

3.3.1 Jewish Museum

The Jewish Museum in Berlin was designed by Studio Libeskind and opened in 1999. The building's form is inspired by an abstracted Jewish Star of David, and it provides visitors with an experience that reflects the Jewish identity lost during World War II. The museum extension's three routes present the Jewish experience through German history, emigration, and the Holocaust. The interior spaces are complex, and the promenade leads through galleries, empty spaces, and dead ends, creating a unique and thought-provoking experience (Pavka, 2010).


Figure 4: Jewish museum exterior and interior (Photographs by Denis Esakov)

3.3.2 Opera House

The Harbin Opera House, designed by MAD Architects, was built in 2015 and reflects the city's local identity, art, and culture. The building's exterior design references the surrounding landscape, with a curvilinear façade made of smooth white aluminium panels. The grand lobby features large glass walls that visually connect the interior with the exterior plaza. The grand theatre provides world-class acoustics and is clad in warm wood. The building offers an open, exterior performance space that serves as an observation platform for visitors to survey the panoramic views of Harbin's skyline and the surrounding wetlands. Inspired by nature, MAD's architecture goes beyond the traditional opera house typology and is both theatrical in its performance of narrative spaces and its context within the landscape deepening the emotional connection of the public with the environment (Castro, 2023).


Figure 5: Opera house exterior and interior (Photograph by Adam Mørk and Hufton + Crow)

3.3.3 Opera Park Cobe

In 2023, Cobe, an architecture studio, designed a new park on a former industrial island in Copenhagen's inner harbour. The Park consists of six gardens from different parts of the world, a greenhouse, and an atrium at its centre. The central greenhouse is designed as an organically shaped glass structure with a hovering roof, intended to surprise and delight visitors as they navigate the landscape. Rainwater is collected from the roof and channelled into underground water reservoirs used for greenhouse irrigation. The park's pathways are permeable, and excess rainwater is collected in rain beds for infiltration and evaporation. The landscaped bridge and greenhouse's green roofs capture and delay the release of rainwater to the site while also serving as a food source for the park's fauna. Solar panels on the roof provide power to the underground parking facility, the park, and the greenhouse. The park's chosen materials are robust and fully recyclable, while the abundance of trees and plantings shield against strong winds coming from the harbour and the sea increasing the level of comfort for park users (Pintos, 2023).


Figure 6: Opera park exterior and interior (Photographs by Francisco Tirado)

3.3.4 Luma Gehry Partners

The Luma Arles Arts Tower, designed by Frank Gehry in 2021, is almost finished in southern France. The tower, which covers an area of 15,000 square meters, will serve as a space for seminars, exhibitions, research facilities, an auditorium, and a café for the arts centre. Swiss collector Maja Hoffmann established the arts centre in 2004. The tower's facade is made up of 11,000 stainless steel panels arranged irregularly, with numerous protruding glass window boxes. The angular tower stands on a cylindrical glass base. LUMA Arles also includes six large-scale industrial buildings with five of them being restored by the New York-based German architect Annabelle Selldorf for presentations, installations, exhibitions, and artists' residences (Ravenscroft, 2021).


Figure 7: Luma exterior and interior (Photographs by Iwan Baan)

3.3.5 Austria Pavilion team Breathe Austria

For the Milan EXPO 2015, “Feeding the Planet, Energy for Life”, the Austrian contribution breathe.austria draws attention to an essential nutrient: air. It functions as a prototype to address possible future interactions between the natural environment and urban strategies by demonstrating the potential of hybrid systems that integrate nature and technology. The central element is a dense forest brought together with technical elements to create a breathing microclimate. With this oxygen- and carbon-producing core, the pavilion becomes an “air generating station”.

Despite the spatial constraints, breathe.austria succeeds in creating a unique climate zone within the pavilion: a pleasantly cool, fresh atmosphere that invites guests to linger. The effective interplay between nature and technology cools the interior space and supplants conventional air conditioning. The pavilion serves as a breathing “photosynthesis collector” that contributes to global oxygen production. The Austrian pavilion is a sensual, experiential site that connects the seemingly irreconcilable – technology and natural diversity – while being climatically active (Aguilar, 2019).


Figure 8: Austria Pavilion exterior and interior (Photographs by Daniele Madia)

3.3.6 Naiipa Art Complex

Naiipa, designed by Stu/D/O Architects in 2016, is a mixed-use project consisting of an Art Gallery, Sound Recording Studio, Dance Studio, Restaurants, Coffee Shops, and Office Spaces. From the beginning, the goal has been to create architecture that seamlessly co-exists with the trees, providing a peaceful and inspiring art community for both its occupants and visitors. Building A was designed to be an elongated 2-story horizontal building, allowing sunlight to reach the existing Pink Trumpet Tree, creating an atmospheric courtyard for the building's occupants. To contrast the horizontal form of Building A, Building B is a vertically orientated 4-story building. The two main masses are then connected by multi-level sculptural terraces that intertwine between the existing trees. The two main buildings are constructed with typical concrete structures to maintain the structural integrity of the function areas. The shift in structural system is due to the building's proximity to the greenery, by using a steel structure, the risk of contamination is reduced. In addition, the steel structure provides more flexibility in navigating the construction around the expanding tree branches. Once inside, the inner architectural façade and the floating "Bird Nest" Gallery cladded in reflective glass seem to dissolve and disappear amongst the trees. It is this effect of being surrounded by trees that evokes the feeling of truly being Naiipa (Literally means 'Deep in the Forest') (Caballero, 2022).

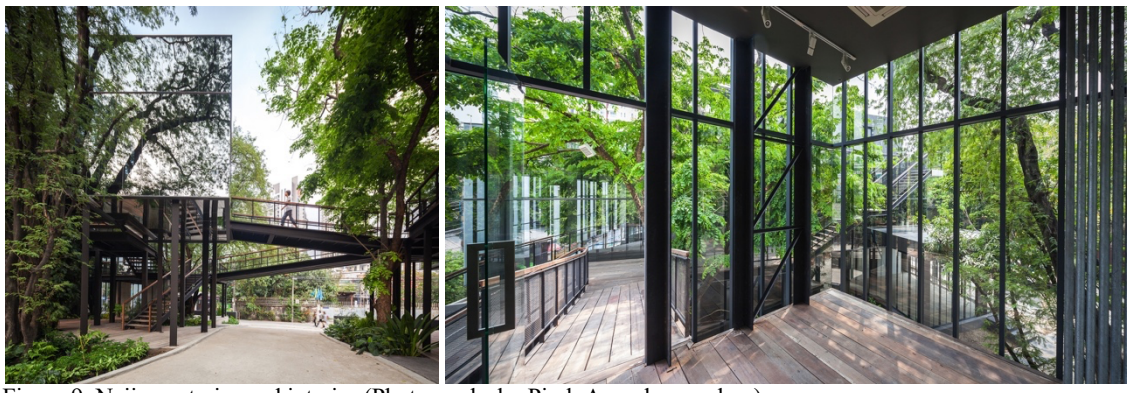


Figure 9: Naiipa exterior and interior (Photographs by Pirak Anurakyawachon)

3.4 Human scale:

Understanding architectural scale involves unconsciously measuring a building with one's body and projecting one's body scheme into the space being observed (Pallasmaa, 1996/2012).

In the book "Humanise" (2023b), Thomas Heatherwick introduces the "Humanise Rule". According to this rule, a building should capture and hold the attention of humans for the duration of time it takes to pass by it. To achieve this, the rule sets that a building must be interesting from three different distances: city distance, street distance, and door distance. City distance refers to around 40 meters from the building where the entire building can be seen. Humans can observe the building's shape, colour, and 3D properties. Humans can experience emotions while observing a building from this perspective. Street distance is looking at a building from across the street and it becomes harder to take

in the whole structure. The roof is probably not visible, but more details are starting to reveal themselves. If the building is human-made, there is likely to be complexity and interest in the patterns that exist on its surface. Humans will also observe more of its three-dimensionality, texture, and personality. The building should have enough visual interest to trigger curiosity and make humans want to look at it again. Door distance is where buildings that are crafted with attention to detail and quality materials can captivate with their presence. An intricate structure can reward attention, for example, looking at the building more closely, the more can be discovered. Patterns might be noticed and even little stories about the makers and users, as well as the time and culture in which it was built. As Heatherwick says, it's worth taking the time to examine and experience great buildings up close (Heatherwick, 2023b).

3.5 Emotional connection with nature

“When humans think about reintroducing nature into their cities, their first instinct is often to plant more trees and create more green spaces. However, MAD Architects suggests that humans can go a step further by integrating the subtleties of nature into their daily lives, not just to stimulate their senses, but to reconnect them with nature. This doesn't necessarily mean that more trees and greenery are needed. Even small elements, such as more water surfaces, can remind humans of nature and help them feel more connected to their environment. It's all about creating a composition that harmonises with the natural surroundings and evokes an atmosphere or feeling that resonates with humans and helps them feel more connected to the city. Ultimately, humans need to have a clear vision for the future of their cities, where they can enjoy living together, instead of just working and existing in the same space. There is a need to create a city that feels like it belongs to its inhabitants, where humans can truly thrive."(reSITE, 2020).

Biophilic design is a design that can reconnect humans with nature. Biophilic design can include reducing stress and improving human well-being. Biophilic design can be organized into three categories Nature in the space, Natural Analogues and Nature of the Space (see appendix). These categories have been divided into fourteen patterns which support stress reduction, cognitive performance, emotion and mood enhancement and the human body. The first category Nature in Space focuses on the immediate, physical and ephemeral existence of nature in a space or place. The strongest Nature in Space experience is achieved by creating meaningful, direct connections with these natural elements, especially through diversity, movement and multi-sensory interactions. This category consists of seven biophilic design patterns:

- Visual connection with nature.
- Non-visual connection with nature.
- Non-rhythmic sensory stimuli.
- Thermal and Airflow variability.
- Presence of water.
- Dynamic and diffuse light.
- Connection with natural systems (Browning et al., 2014).

The second category, Natural Analogues, consists of three patterns of biophilic design:

- Biomorphic Forms and Patterns.
- Material connection with nature.
- Complexity and order.

Natural Analogues focuses on organic, non-living and indirect evocations of nature. The strongest Natural Analogue experiences are achieved by offering a wealth of information in an organised and sometimes evolving way (Browning et al., 2014).

Lastly, the Nature of the space category. Nature of the Space focuses on spatial configurations in nature. This includes man's innate and learned desire. The strongest experiences with the nature of space are achieved by creating deliberate and engaging spatial configurations, mixed with patterns of nature in space and natural analogues. This category consists of four biophilic design patterns:

- Prospect.

- Refuge.
- Mystery.
- Risk/ Peril (Browning et al., 2014).

4. Results:

From the literature study and case study came a lot of information and results leading to a positive emotional experience in architectural space improved quality of mental health, well-being, and emotional connections. The following chapter will discuss the results of studies conducted in this paper.

4.1 Analyzing Case Study

The case studies that have been reviewed highlight the crucial link between the sensory body and materiality, underscoring how the experience of a space can impact our emotions. To enhance the quality of the space experiences, three key elements have been identified: stimulating the body through movement and senses, utilizing materiality to foster awareness of the sensual aspects of the space, and establishing emotional connections that can be shaped both individually and socially.

However, the research has demonstrated that these three aspects are interconnected, and a comprehensive, multi-sensory approach is necessary to create a truly immersive experience. Incorporating local materials and techniques can help connect architecture to its context, reinforcing cultural identity and enabling designers to leverage local knowledge and site-specific conditions. Additionally, even abstract designs can offer a spatial experience by engaging our senses of smell, hearing, and touch, thereby evoking an emotional connection. In short, an emotional experience in an interior space is a multifaceted experience encompassing the physical, sensory, cultural, and mental dimensions. Based on the analysis of the case studies, the architectural projects that possess these characteristics demonstrate (see Figures 10 and 11).

Case study projects:

	Jewish museum	Opera house	Opera Park	Luma	Austria Pavilion	Naiipa
Type	Museum	Opera/ Cultural centre	Pavilion/ park	Exhibition centre	Temporary Exhibition centre	Art complex/ mixed use
Location	Berlin, Germany	Harbin, China	Copenhagen, Denmark	Arles, France	Milan, Italy	Bangkok, Thailand
The Body	Physical movement Senses: Hearing, tactility, seeing	Movements Senses: Seeing, hearing, tactility	Movements Senses: seeing, hearing, smell, tactility	Movements Senses: seeing, tactility	Movements Senses: seeing, smell, hearing, tactility	Movements Senses: seeing, tactility, smell
Materiality	Concrete, plants, titanium/ zinc, dark	Wood, aluminum, glass, light, water	Greenery, water, flowers, wood, glass,	Glass, steel, water, light, wood	Greenery, water, wood,	Greenery, steel, glass, light, concrete, wood
Colour	Grey, dark, white, red	warm brown, white, light, grey	warm light brown, green, white, green	light, white, grey, brown	dark, green, natural	green, grey, brown, white
Emotion	• Emptiness • Calm • Darkness	• Cultural connection • awe • zen	• relaxtion • serenity • Health	• Awe	• Health • Calm • curiosity	• Health • Calm • Cultural connection
Spatial Experience	Physical representation of history's complexity. Journey through history, identity and humanity	Invinting layout, connection indoor and outdoor with landscape. Flow.	Green oasis, recreational escape from dense city.	Entrance as a large park. spiral layout with visual movements and connections	Demonstrates importance of communicating the interaction between technology and natural environment. Sensory journey	Treehouse like building. Spatial layout around trees, connected by multi level terraces and stairs.

Figure 10: The case study project. By the author, 2024 (after Lee 2022)

	Symmetry	Water	Light Shadow	Colour	Shape curved	Materials	View of nature	Sound	Climate	Experience	Scale	Spatial design	Repetition	Senses	Culture	Local
JW			○	○		○				○	○	○	○	○		
OH	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
OP	○	○	○	○	○	○	○		○	○	○	○	○	○	○	○
L	○	○	○	○	○	○	○	○		○	○	○	○	○		
AP	○	○	○	○		○	○	○	○	○	○	○	○	○		
N	○		○	○		○	○		○	○	○	○	○	○	○	○

JW: Jewish Museum, OH: Opera House, OP: Opera Park, L: Luma, AP: Austria Pavilion, N: Naiipa

Figure 11: Comparing the case study project. By the author, 2024 (after Lee 2022)

4.2 Case study: Design characteristics for emotional architecture

The text mentioned above discusses the various design features of emotional architecture in this chapter this will be discussed in more detail. Architecture can enhance the user's experience on two levels, namely the cognitive and emotional levels. The cognition level involves the user's processing and evaluation of perceived information, while the emotional level is the adaptive reaction to the perceived information. These interactions are interrelated, and human emotions respond to design elements like water, light, colour, form, style, materials, sound, and details. These elements can evoke emotions in users and create a connection with them. In addition to evoking emotions, a design can also enforce emotions. To stimulate and direct a specific emotional response in users, the user experience of a space must be enhanced. To simulate a user's activities and behavioural patterns in a space, a variety of stimuli can be used. This involves moulding and stimulating the space in various ways based on the user's experience (Malhotra, 2022).

Ruth Dalton established in *The Science Behind Our Emotional Connection to Architecture* (2023) a list of design features, supported by neuroscience research, that appear to produce strong positive emotions in humans. After an experiment conducted by Alexander Coburn and colleagues (2020) about psychological and neural responses to architectural interiors Coburn and colleagues termed three groups: coherence, hominess and fascination. Lara Gregorians and colleagues looked in further detail at these three groups. They added the terms unusualness and spatial complexity.

Architecture can positively impact well-being by incorporating views of nature and green spaces, which promote calmness. If a space contains curves people are more likely to judge the space as beautiful. A positive emotional response in humans is if a building has a space for social interaction. In the figure, these design elements are listed and are shown how they connect.

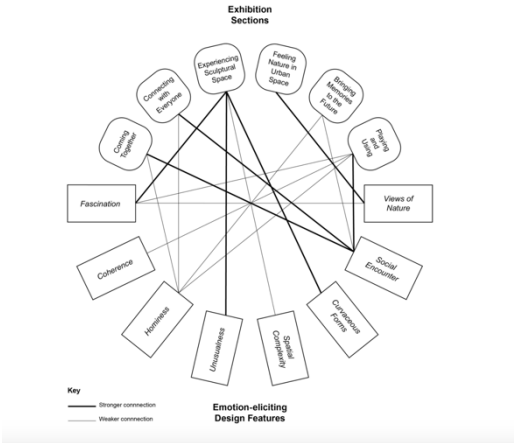


Figure 12: Emotion- eliciting design features (Dalton, 2023)

Other elements to create an emotional connection with users:

- Connection spaces and emotions
- Biophilic design
- Colour psychology
- Spatial layout and functionality
- Light (shadow) and acoustics (users comfort)
- Aesthetics and beauty
- Scale and proportion
- Use materials and texture
- Form and shape.

4.3 Case study according to Desmet

In the first part of this paper, a qualitative literature study on emotional architecture, emotions (psychology) and how emotions work in the architectural world was done.

There was a lot of research about the influence of emotions on humans and the framework focused on the theories of Don Norman and Pieter Desmet. Pieter Desmet interpreted Don Norman’s theory

towards a newer design strategy. To determine if the chosen case study projects generate an emotional response the design strategy was used.
The results are as follows:

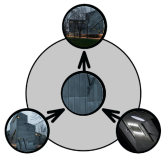
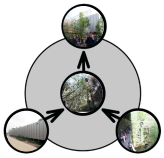
Jewish Museum	Opera house	Opera Park	Luma	Austria Pavilion	Naiipa
					
Emotion: • Emptiness • Calm • Darkness	Emotion: • Cultural connection • awe • zen	Emotion: • relaxtion • serenity • Health	Emotion: • Awe	Emotion: • Health • Calm • curiosity	Emotion: • Health • Calm • Cultural connection

Figure 13. *Analysing case study projects with Desmet's strategy.* By author, 2024 (after Ahmad Fadzil, 2015).

4.4 Toolbox

The purpose of this design guide is to offer architects advice on constructing projects that have a strong emotional impact. In the realm of design, a toolbox serves to gauge the significance of various components in eliciting an emotional response. Specifically, the toolbox comprises two fundamental pillars: Design Characteristics, which closely examine the proportion and dimensions of the built environment, and Emotional Connection with Nature, as shown in Figure 14. Together, these elements form the foundation of the toolbox for creating a meaningful emotional experience.

Toolbox

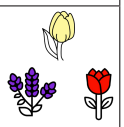
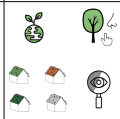
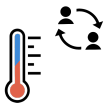
Elements Scale	Biophilic Design	Spatial complexity	Forms and Shapes	Body (user experience/ comfort)	Mind (multi sensory experience)	Aesthetics and "Beauty"	Materials and texture	Colour psychology
City (Landscape)								
Street (Transtion landscape to building)					 Visual			
Door (Urban Oasis)					 Senses			
Strong connection with emotions	xx	xx	xx	xx	xx	x	x	xx
Strong connection well-being/ mental health	xx	x	x	xx	x	x	x	x

Figure 14: Design toolbox (by the author)

5. Conclusion and discussion

This thesis investigates emotional architecture, the concept of creating designs that elicit emotions resulting in positive user experiences (mainly focused on the user's body and mind) and is examined as a tool for stimulating human scale in cities, supporting well-being and mental health.
Each chapter is linked to a subthematic research question. The thematic research question: "What can strengthen emotional architecture, - with a focus on natural aspects- and what are the related design principles?" will be answered by discussing the conclusions for each sub-thematic research question.

Chapter 3.1.2 Emotional Architecture; *What is emotional architecture?*
Emotional architecture is a poetic act that engages both body and mind (Malhotra, 2022).
Mathias Goeritz and Luis Barragán were two architects who redefined emotional architecture and emphasized that it should move its inhabitants. After the establishment of the museum El Eco, Goeritz published a manifesto titled "Emotional Architecture". In this manifesto, Goeritz argued that modern architecture should strive to create the same emotional impact as the architecture of previous eras, which was known to evoke powerful emotions. This manifesto emphasized the ability of architecture to move the soul, and emotional architecture reintroduced the temporality of human experience in the conception of a building (Pelletier, 2008).

Chapter 3.2 Emotions in Architecture; *Can emotional architecture be used for architecture?*
The principal role of architecture is to trigger emotions. Emotional architecture engages the user's body and mind (*I.2.b. Emotional Architecture: When Emotions Take Over - Issuu*, n.d.). The built environment is an essential part of a person's life, from open spaces to homes, commercial buildings, monuments, and public structures. It represents the humans who use it, and there is a strong connection between the built environment and the emotions of users interacting with the space (Malhotra, 2022). Architecture is an extension of nature into the man-made realm, and it provides the ground for perception and understanding of the world. Architecture also gives a conceptual and material structure to societal institutions and daily life. Architecture strengthens one's sense of being in the world and their experience of self. Humans identify themselves with space, place, and moment, and these dimensions become the ingredients of their existence (Pallasmaa, 1996/2012).

Chapter 3.2.1 Spaces and Emotions; *Can spaces evoke emotion?*
Humans experience a space through their entire body, perceiving it physically, sensorially, and emotionally. The body acts as a sensory apparatus to measure a space, other humans, and surrounding objects, creating a unique spatial and emotional experience; that is specific to place, time and materials (Lee, 2022). If a building were a body, its spirit would consist of light and shadow, materials, colour, water, and structure. These elements are comparable to muscle, skin, blood, and bones. The built environment comprises various elements such as materials, colours, and ambient environments like water, sound, and temperature, which are experienced through the senses of the body. Moreover, the experiences humans have in spaces are based on human inventions such as scale, vertical or horizontal orientation, straight or curved lines, order or disorder, symmetry, asymmetry, and mobility. These concepts are intangible but play a vital role in how humans perceive and experience the built environment (Li, 2019).

Chapter 3.3 Design characteristics: A review Case study; *What types of design characteristics could stimulate positive emotion in a built environment?*
The text mentioned above discusses the various design features of emotional architecture. The interactions are interrelated, and human emotions respond to design elements like water, light, colour, form, style, materials, sound, and details. These elements can evoke emotions in users and create a connection with them. In addition to evoking emotions, a design can also enforce emotions. To stimulate and direct a specific emotional response in users, the user experience of a space must be enhanced. To simulate a user's activities and behavioural patterns in a space, a variety of stimuli can be used. This involves moulding and stimulating the space in various ways based on the user's experience (Malhotra, 2022). For instance, the design elements to create an emotional connection with users:

- Connection spaces and emotions

- Biophilic design
- Colour psychology
- Spatial layout and functionality
- Light (shadow) and acoustics (users comfort)
- Aesthetics and beauty
- Scale and proportion
- Use materials and texture
- Form and shape.

Biophilic design is a design that can reconnect humans with nature. Biophilic design can include reducing stress and improving human well-being. Biophilic design can be organized into three categories Nature in the space, Natural Analogues and Nature of the Space (see appendix). These categories have been divided into fourteen patterns which support stress reduction, cognitive performance, emotion and mood enhancement and the human body. The first category Nature in Space focuses on the immediate, physical and ephemeral existence of nature in a space or place. The strongest Nature in Space experience is achieved by creating meaningful, direct connections with these natural elements, especially through diversity, movement and multi-sensory interactions.

Chapter 3.4 Human Scale; *On what scale are architectural interventions necessary that increase the sense of the human scale?*
The rule sets that a building must be interesting from three different distances: city distance, street distance, and door distance. City distance refers to around 40 meters from the building where the entire building can be seen. Humans can observe the building's shape, colour, and 3D properties. Humans can experience emotions while observing a building from this perspective. Street distance is looking at a building from across the street and it becomes harder to take in the whole structure. If the building is human-made, there is likely to be complexity and interest in the patterns that exist on its surface. Humans will also observe more of its three-dimensionality, texture, and personality. The building should have enough visual interest to trigger curiosity and make humans want to look at it again. Door distance is where buildings that are crafted with attention to detail and quality materials can captivate with their presence. Patterns might be noticed and even little stories about the makers and users, as well as the time and culture in which it was built (Heatherwick, 2023b).

In conclusion: *"What can strengthen emotional architecture, - with a focus on natural aspects- and what are the related design principles?"*

The related design principles can strengthen the body (users' comfort/ experience) and the mind (multi-sensory design) thus therefore emotional architecture. The design toolbox consists of eight elements: Biophilic design, spatial complexity, forms and shapes, body, mind, aesthetics and "beauty", materials and texture and colour psychology. Translating design elements focused on emotional connection and mental health/ well-being in different human scale levels.
After analysing these eight elements, the main criteria appear to be: designing multi-sensory spaces and high-quality user experience with a design that can reconnect humans with nature.
These criteria are translated into the following design parameters: Levels transitioning city, street, and door, including water storage, views of natural elements and tools, Local materials and techniques, and multi-sensory design stimulated by biophilic design and materials.

Finally, when applying the design toolbox, it is essential to put it alongside the plan of requirements and location, before designing for the body and mind.
The limit of the methods used is that architects have not sufficiently tested the use of this design toolbox to prove that this guide gives promising results in the design process. Therefore, a suggestion for further research is to investigate how architects experience the design toolbox within the design process. Furthermore, research about emotions is always developing, also research studies of the effect of architectural spaces on the brain (with the right measuring tools) are improving with

time. The related design principles also need further improvements and tests of the results on the brain (neuroscience).
In the coming decades, 70% of the world's population is expected to live in cities. As a result of this shift, the need for designs to (re)connect people to a natural experience becomes increasingly important (Browning et al., 2014). Furthermore, architects and designers will begin to understand how the aesthetics and diversity of buildings can deeply impact our emotions, lift our spirits and stimulate these reconnections (Heatherwick, 2023a).

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Appendix

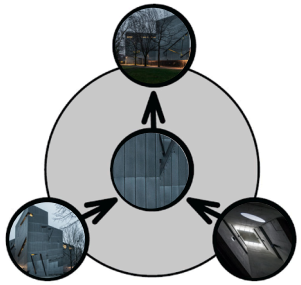
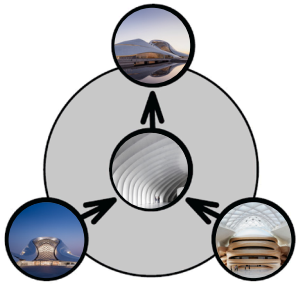
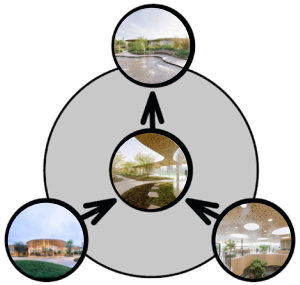
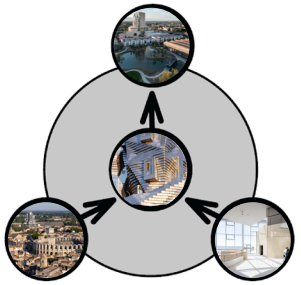
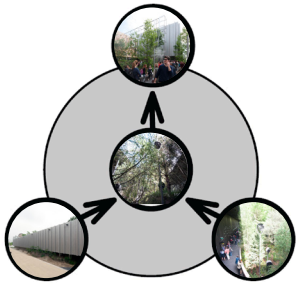
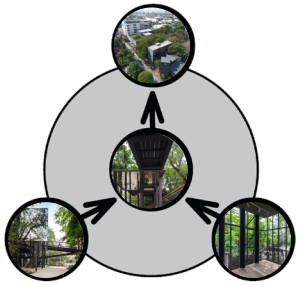
Case study projects:

	Jewish museum	Opera house	Opera Park	Luma	Austria Pavilion	Naiipa
Type	Museum	Opera/ Cultural centre	Pavilion/ park	Exhibition centre	Temporary Exhibition centre	Art complex/ mixed use
Location	Berlin, Germany	Harbin, China	Copenhagen, Denmark	Arles, France	Milan, Italy	Bangkok, Thailand
The Body	Physical movement Senses: Hearing, tactility, seeing	Movements Senses: Seeing, hearing, tactility	Movements Senses: seeing, hearing, smell, tactility	Movements Senses: seeing, tactility	Movements Senses: seeing, smell, hearing, tactility	Movements Senses: seeing, tactility, smell
Materiality	Concrete, plants, titanium/ zinc, dark	Wood, aluminum, glass, light, water	Greenery, water, flowers, wood, glass,	Glass, steel, water, light, wood	Greenery, water, wood,	Greenery, steel, glass, light, concrete, wood
Colour	Grey, dark, white, red	warm brown, white, light, grey	warm light brown, green, white, green	light, white, grey, brown	dark, green, natural	green, grey, brown, white
Emotion	• Emptiness • Calm • Darkness	• Cultural connection • awe • zen	• relaxtion • serenity • Health	• Awe	• Health • Calm • curiosity	• Health • Calm • Cultural connection
Spatial Experience	Physical representation of history's complexity. Journey through history, identty and humanity	Invinting layout, connection indoor and outdoor with landscape. Flow.	Green oasis, recreational escape from dense city.	Entrance as a large park. spiral layout with visual movements and connections	Demonstrates importance of communicating the interaction between technology and natural environment. Sensory journey	Treehouse like building. Spatial layout around trees, connected by multi level terraces and stairs.

Case study projects comparing:

	Symmetry	Water	Light Shadow	Colour	Shape curved	Materials	View of nature	Sound	Climate	Experience	Scale	Spatial design	Repetition	Senses	Culture	Local
JW			○	○		○				○	○	○	○	○		
OH	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
OP	○	○	○	○	○	○	○		○	○	○	○	○	○	○	○
L	○	○	○	○	○	○	○	○		○	○	○	○	○		
AP	○	○	○	○		○	○	○	○	○	○	○	○	○		
N	○		○	○		○	○		○	○	○	○	○	○	○	○

JW: Jewish Museum, OH: Opera House, OP: Opera Park, L: Luma, AP: Austria Pavilion, N: Naiipa

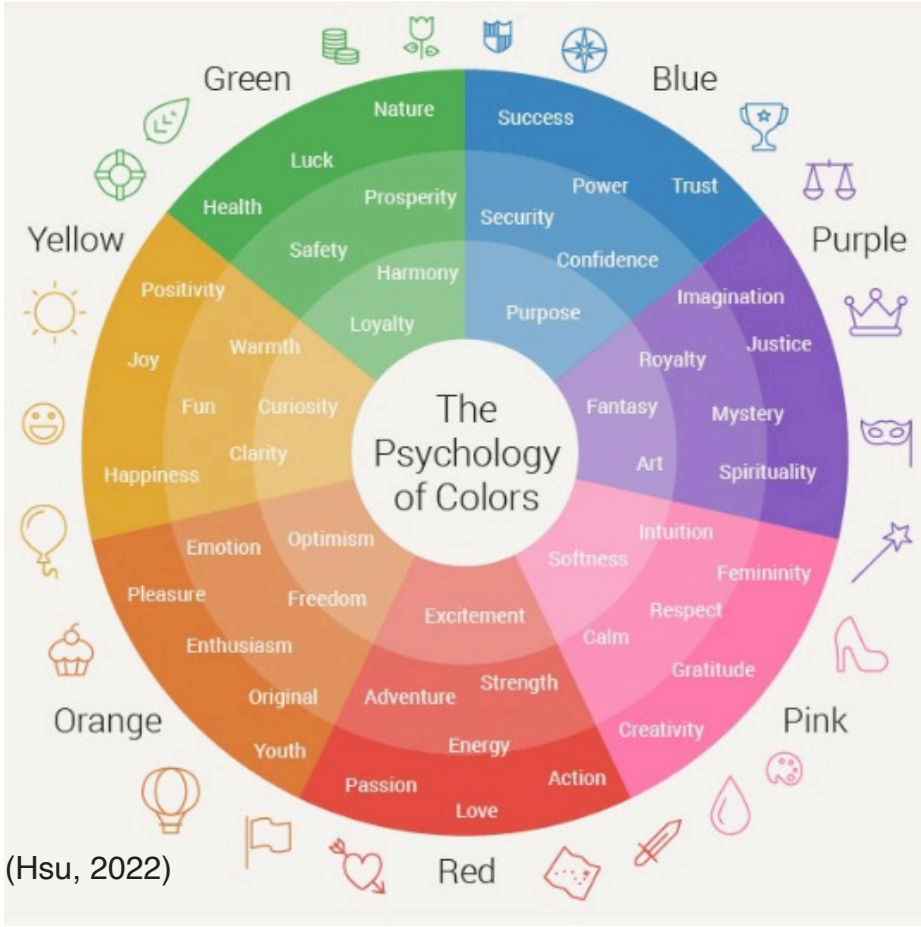
Jewish Museum	Opera house	Opera Park	Luma	Austria Pavilion	Naiipa
					
Emotion: • Emptiness • Calm • Darkness	Emotion: • Cultural connection • awe • zen	Emotion: • relaxtion • serenity • Health	Emotion: • Awe	Emotion: • Health • Calm • curiosity	Emotion: • Health • Calm • Cultural connection

Colour	Effect
Red	Passion, love, courage, excitement, warmth and attention
Orange	Feelings of warmth, joy, excitement, creativity, soothing, luminous and vitality
Yellow	Cheerful, radiant, happy, and can stimulate humans or warn humans
Green	Nature, prosperity, peace, healing, soothing and relaxing
Blue	Trust, safety,cool, confidence and dignified.
Purple	Creativity, relaxing, spirituality, exciting, mystery and power
White	Purity, simplicity, cleanliness and healthiness
Black	Powerful, mysterious
Grey	Industrious, rocky, stern or practical

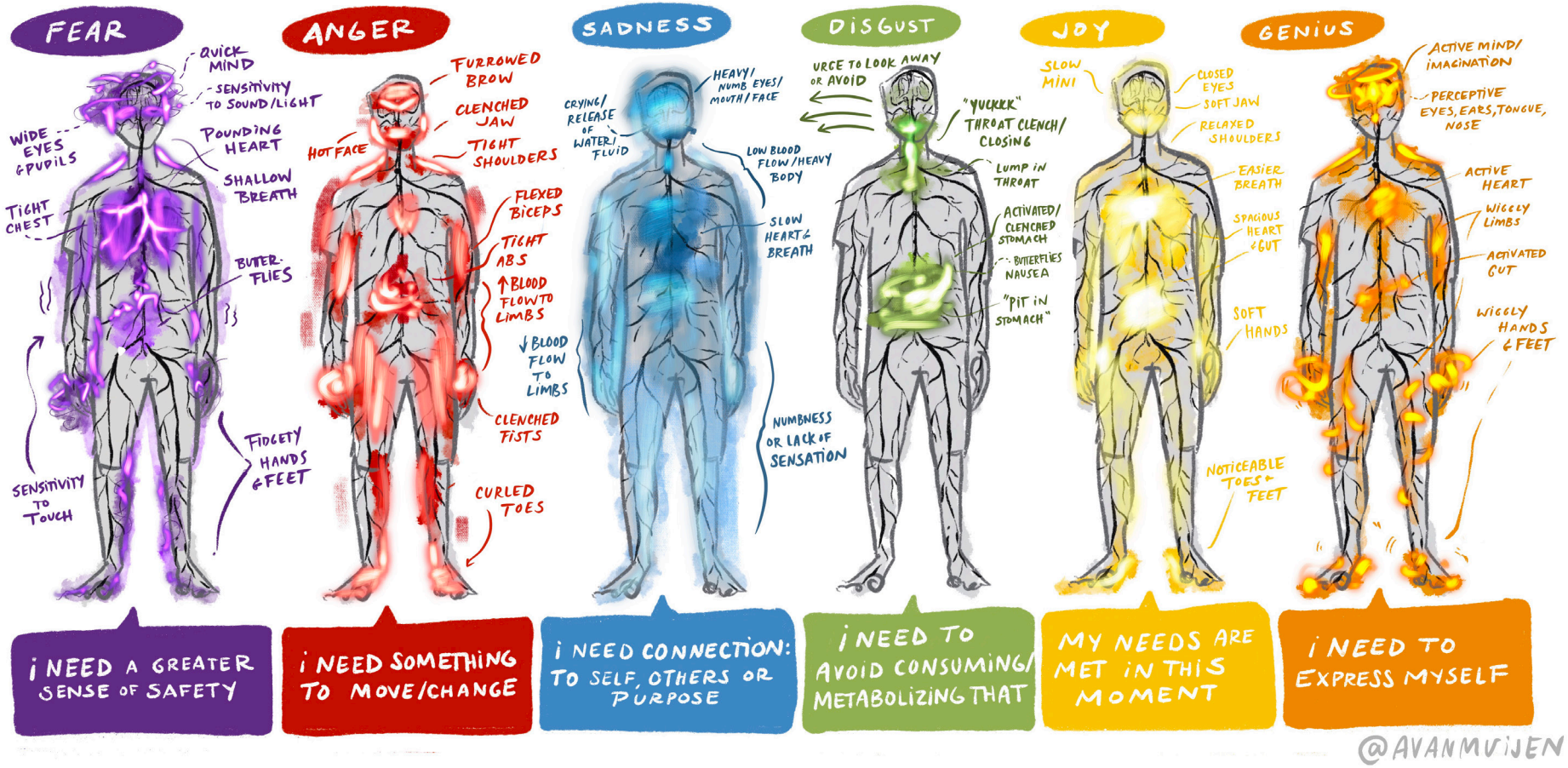
(Cao, 2023)

Colour psychology

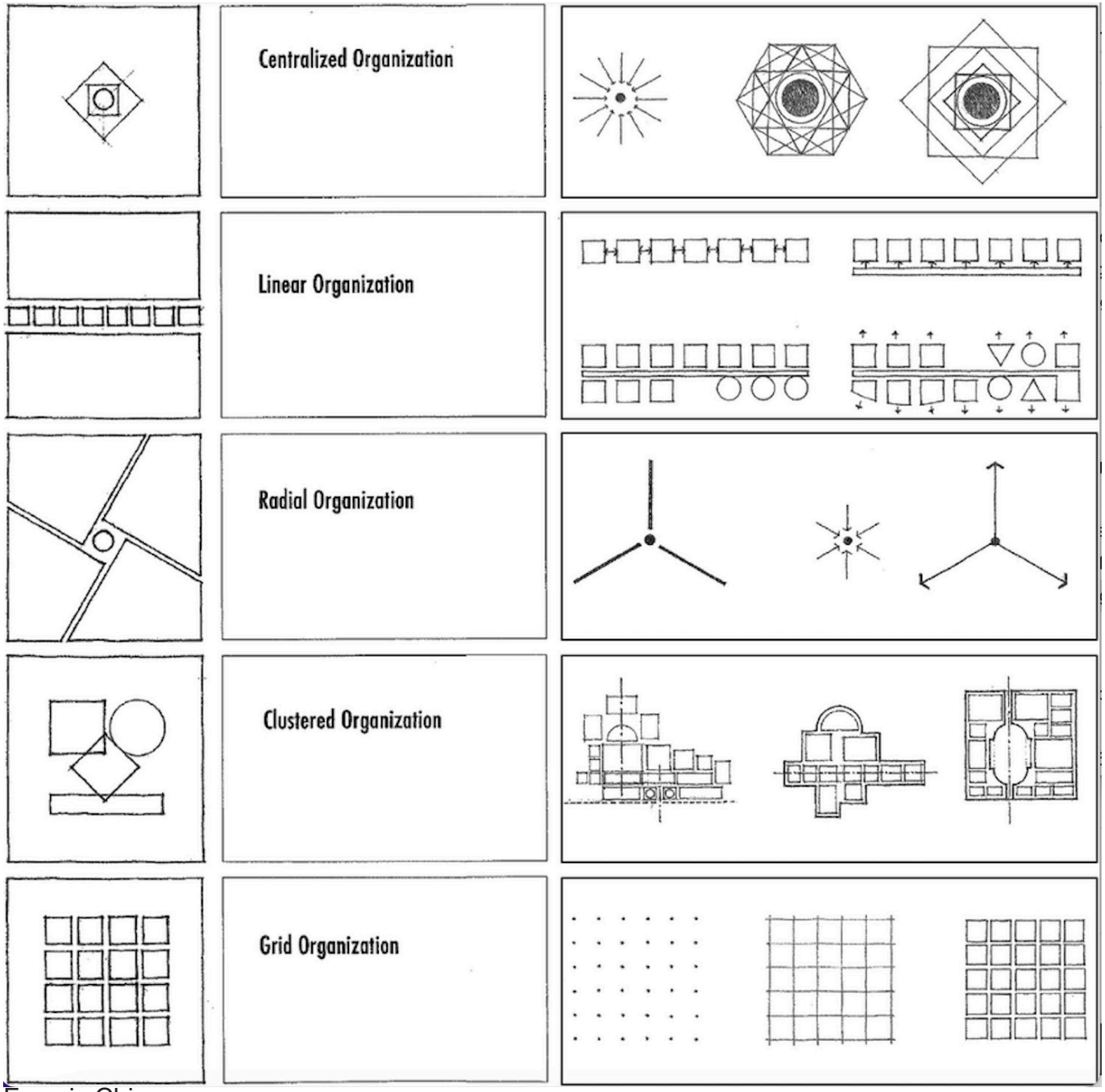
Colour plays a decisive role in affecting our emotions. Each colour has a set of emotions associated with it (see figure). Humans adapt their behaviour to the perception of the environment, and the per-ception of the colours. It contributes to how people experience the world (De Vriendt, 2021).



(Hsu, 2022)



Drawing by Abby van Muijen



Francis Ching

Spatial Complexity

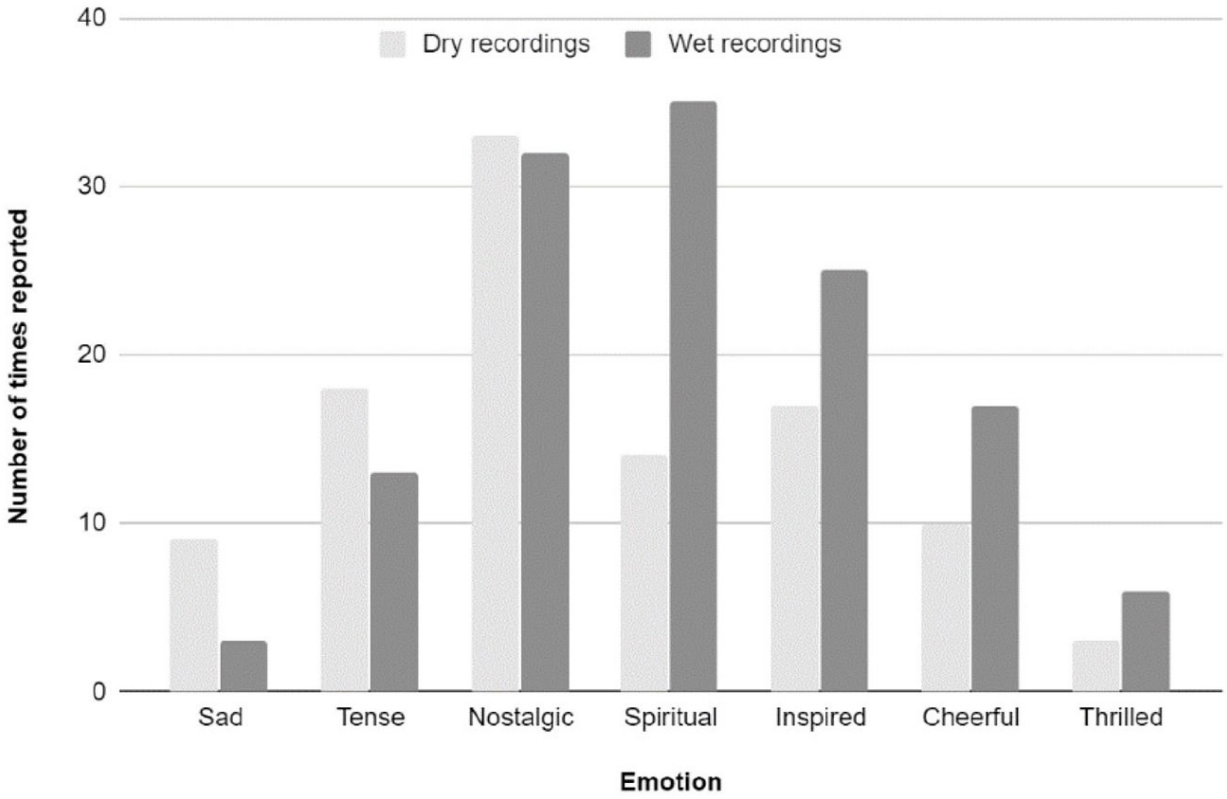
Spatial layout and functionality
Spaces as a tool for social interaction
Spaces can influence a feeling/ emotion within a building. For instance, an intuitive, organized and easy navigation of a space can evoke a sense of freedom, comfort and efficiency. Confusing layouts of space may evoke feelings of frustration or anxiety (Kristinas, 2023). Flow and functionality of spaces can together create an emotional experience in the building (Omer, 2023). The flow of a space can be used to enhance impact, sense of journey or arrival (Malhotra, 2022).

Forms and Shapes

Forms and shapes can evoke a variation of emotions, for instance, curved forms can evoke feelings of grace and fluidity. While geometric and angular forms stimulate feelings of strength and stability (dormakaba Editorial Team, 2023).

Amir, Biederman, and Hayworth (2011) investigated the adult human preferences of singular (a straight contour) and non-singular (curves contours). The results of the study showed that adults prefer shapes with high non-singular values to singular values.
Based on a mixed-method study with architects and non-architects, adding non-singular to a design can create spaces that evoke feelings of pleasant, relaxing, and calm, and make them more joyful and serene. Two statements about form and shape:

- Formal elements of a designed visual environment can be rapidly extracted to trigger a response in the limbic system.
- Curvature in the form can change the quality of the above response and affect subsequent emotional experiences (Nanda et al., 2013).



(Algargoosh et al., 2022)

Environmental factors

Light and acoustics users' comfort

The contrast of light and shadow can create dramatic effects which could influence the perception of space (dormakaba Editorial Team, 2023).

For instance, Natural (adequate) daylight exposure can evoke an improved mood and increase productivity (Omer, 2023).

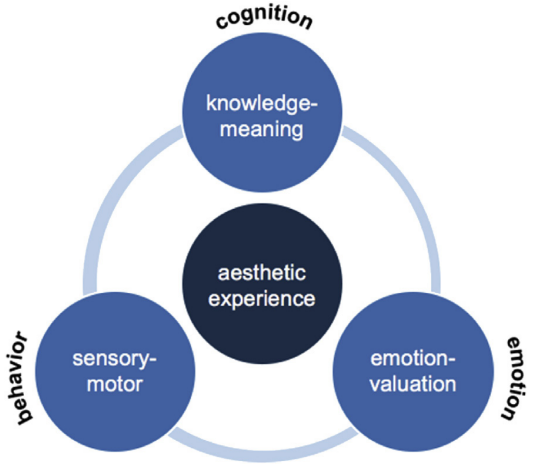
Light and acoustics are part of the term User comfort. Yanovshtchinsky et al. (2012) wrote a book about user comfort focused on climate elements. Thermal comfort is related to heating, cooling, ventilation, the degree of draft and humidity (Yanovshtchinsky et al., 2012).

The architectural features of spaces can affect the physical acoustic aspects- think of sound amplification, filtering, enveloping, note blending, and source location manipulation. These influences stimulate the emotional experience and can increase the intensity of the emotional impact. For example, the physical environment can influence sound characteristics by creating an echo. In the echo, which contains multiple sound reflections from the surfaces, the sound source may appear to be invisible, which influences listeners' emotions (Algargoosh et al., 2022). For instance, sound, when poorly designed can evoke stress, while controlled soundscapes can evoke relaxation and focus. (Omer, 2023).

Aesthetics and “Beauty”

This is the visual appeal of an architectural design that can evoke emotions. To create a sense of harmony and “beauty”, in a building, the use of proportion, symmetry, colour and materials can evoke positive emotions, for instance, joy, calmness and appreciation (Kristinas, 2023).

Viewing architectural spaces elicits a broad range of aesthetic experiences, from feelings of comfort and excitement to judgments of a building’s age and style. According to the aesthetic triad model (Fig. 1), aesthetic experiences in the built environment are mediated by three large-scale neural systems knowledge-meaning, emotion-valuation, and sensorimotor systems (Chatterjee & Vartanian, 2014; Coburn et al., 2017). These neural systems align approximately with three important domains of psychological processing: cognition, emotion, and behaviour (Coburn et al., 2020).



Five key measures of cognitive judgement in the built environment: complexity, organization, modernity, naturalness, and beauty.
Visual complexity refers to “the volume of information present in a space” (Dosen & Ostwald, 2016, p.3) and the informational “richness” of a scene (Kaplan & Kaplan, 1989, p. 53). Positive, linear correlations between complexity and preference have been found in various contexts, including the evaluation of artwork (Day, 1967; Leder et al., 2004; Taylor, Micolich, & Jonas, 1999), natural landscapes (Kaplan, 1987; Ulrich, 1977, 1983), and built environments.

The organization is also critical to the psychology of architecture. Visual order implies both an absence of randomness (Tullett, Kay, & Inzlicht, 2015) and the presence of predictable patterns like symmetry (Alexander, 2002a; Reber, Schwarz, & Winkielman, 2004; Salingaros, 2007) and structural redundancy in scenes. Perception of order can also be modulated by a building’s age, condition, and architectural style.

Naturalness the perception of naturalness is not merely determined by natural content (e.g., recognition of trees and vegetation) but is also predicted by specific low-level visual patterns that can occur in both natural and man-made objects and environments

Beauty, which is perhaps the most global measure of aesthetic judgment, is among the most frequently measured qualities in empirical aesthetics.
Beauty has long been regarded as an important quality of architectural design in cultures around the world (Mak & Thomas Ng, 2005; Patra, 2009; Vitruvius Pollio et al., 1914). Efforts to understand environmental beauty have gained traction in both environmental psychology (Cooper, Burton, & Cooper, 2014; Kaplan, 1987; Zhang, Piff, Iyer, Koleva, & Keltner, 2014) and architectural research (Kirk, Skov, Christensen, & Nygaard, 2009; Vartanian et al., 2013, 2015), perhaps because of the growing view that “attractiveness is a key element in how the built environment affects our wellbeing” (Cooper & Burton, 2014), as well as the primary role that beauty plays in our desire to live in a place.

Eight measures of emotional experience in the built environment are outlined below: personalness, hominess, relaxation, comfort, stimulation, uplift, vitality, and valence.

Hominess is the degree to which an architectural space makes a person feel cozy or “at home” (Daniels, 2015; Graham et al., 2015; Ritterfeld & Cupchik, 1996).
Personal spaces feel warm and intimate (Graham et al., 2015; Sommer, 1969) and generate feelings of “depth, tenderness, and longing” (Alexander, 2002a, p. 302), whereas impersonal spaces often feel cold and standardized.

Considerable emphasis has been placed on the degree of stress or, conversely, relaxation that people experience in response to environmental design.
Comfort is also a salient measure of occupant experience that abounds in architectural research.

Valence describes the degree to which an architectural space makes an occupant feel good or bad. Valence is among the most frequently studied affective measures in empirical aesthetics and is closely related to other common measures such as preference, liking, and pleasantness (Coburn et al., 2020).

Use materials and texture

Using local materials and techniques connects architecture to its context, strengthening the cultural identity while encouraging designers to take advantage of the local knowledge and adaptations to site-specific conditions. These techniques are adapted to local climate, using passive strategies for thermal insulation, natural ventilation and shading. To better integrate the building into its surroundings (aesthetically and culturally) these local techniques can be used. Furthermore, using local materials creates a lower carbon footprint which is better for the environment. Visual richness to the built environment can be added through textures and materials, which engages multiple senses in the perception of space. (Florian, 2023)

For instance, rough textures can evoke a sense of disturbance, anger or confusion while smooth textures can evoke a sense of calmness (Malhotra, 2022).

Scale and Propotion

Scale and proportion. The size and relationship of architectural elements can influence humans' perception of power or intimacy. For instance, grand imposing structures can evoke a sense of awe and wonder, while intimate and cosy spaces can inspire feelings of warmth and security (dormakaba Editorial Team, 2023).

Biophilic Design

There are 11 patterns of biophilic design used for Emotion, Mood and Preference as shown above. The patterns are described here in more detail, about what they mean and how the patterns can be used in a design. All patterns are shortened from for example pattern one to p1 and so on.

BIOPHILIC DESIGN PATTERNS & BIOLOGICAL RESPONSES

The table illustrates the functions of each of the 14 Patterns in supporting stress reduction, cognitive performance, emotion and mood enhancement and the human body. Patterns that are supported by more rigourous emphirical data are marked with up to three asterisks (***), indicating that the quantity and quality of available peer-reviewed evidence is robust and the potential for impact is great, and no asterisk indicates that there is minimal research to support the biological relationship between health and design, but the anecdotal information is compelling and adequate for hypothesizing its potential impact and importance as a unique pattern.

	14 PATTERNS	*	STRESS REDUCTION	COGNITIVE PERFORMANCE	EMOTION, MOOD & PREFERENCE
NATURE IN THE SPACE	Visual Connection with Nature	* * *	**Lowered blood pressure and heart rate** (Brown, Barton & Gladwell, 2013; van den Berg, Hartig, & Staats, 2007; Tsunetsugu & Miyazaki, 2005)	**Improved mental engagement/ attentiveness** (Biederman & Vessel, 2006)	**Positively impacted attitude and overall happiness** (Barton & Pretty, 2010)
	Non-Visual Connection with Nature	* *	**Reduced systolic blood pressure and stress hormones** (Park, Tsunetsugu, Kasetani et al., 2009; Hartig, Evans, Jamner et al., 2003; Orsega-Smith, Mowen, Payne et al., 2004; Ulrich, Simons, Losito et al., 1991)	**Positively impacted on cognitive performance** (Mehta, Zhu & Cheema, 2012; Ljungberg, Neely, & Lundström, 2004)	**Perceived improvements in mental health and tranquility** (Li, Kobayashi, Inagaki et al., 2012; Jahncke, et al., 2011; Tsunetsugu, Park, & Miyazaki, 2010; Kim, Ren, & Fielding, 2007; Stigsdotter & Grahn, 2003)
	Non-Rhythmic Sensory Stimuli	* *	**Positively impacted on heart rate, systolic blood pressure and sympathetic nervous system activity** (Li, 2009; Park et al, 2008; Kahn et al., 2008; Beauchamp, et al., 2003; Ulrich et al., 1991)	**Observed and quantified behavioral measures of attention and exploration** (Windhager et al., 2011)	
	Thermal & Airflow Variability	* *	**Positively impacted comfort, well-being and productivity** (Heerwagen, 2006; Tham & Willem, 2005; Wigö, 2005)	**Positively impacted concentration** (Hartig et al., 2003; Hartig et al., 1991; R. Kaplan & Kaplan, 1989)	**Improved perception of temporal and spatial pleasure (alliesthesia)** (Parkinson, de Dear & Candido, 2012; Zhang, Arens, Huizenga & Han, 2010; Arens, Zhang & Huizenga, 2006; Zhang, 2003; de Dear & Brager, 2002; Heschong, 1979)
	Presence of Water	* *	**Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure** (Alvarsson, Wiens, & Nilsson, 2010; Pheasant, Fisher, Watts et al., 2010; Biederman & Vessel, 2006)	**Improved concentration and memory restoration** (Alvarsson et al., 2010; Biederman & Vessel, 2006) **Enhanced perception and psychological responsiveness** (Alvarsson et al., 2010; Hunter et al., 2010)	**Observed preferences and positive emotional responses** (Windhager, 2011; Barton & Pretty, 2010; White, Smith, Humphryes et al., 2010; Karmanov & Hamel, 2008; Biederman & Vessel, 2006; Heerwagen & Orians, 1993; Ruso & Atzwanger, 2003; Ulrich, 1983)
	Dynamic & Diffuse Light	* *	**Positively impacted circadian system functioning** (Figueiro, Brons, Plitnick et al., 2011; Beckett & Roden, 2009) **Increased visual comfort** (Elyezadi, 2012; Kim & Kim, 2007)		
	Connection with Natural Systems				**Enhanced positive health responses; Shifted perception of environment** (Kellert et al., 2008)
NATURAL ANALOGUES	Biomorphic Forms & Patterns	*			**Observed view preference** (Vessel, 2012; Joye, 2007)
	Material Connection with Nature			**Decreased diastolic blood pressure** (Tsunetsugu, Miyazaki & Sato, 2007) **Improved creative performance** (Lichtenfeld et al., 2012)	**Improved comfort** (Tsunetsugu, Miyazaki & Sato 2007)
	Complexity & Order	* *	**Positively impacted perceptual and physiological stress responses** (Salingaros, 2012; Joye, 2007; Taylor, 2006; S. Kaplan, 1988)		**Observed view preference** (Salingaros, 2012; Hägerhäll, Laike, Taylor et al., 2008; Hägerhäll, Purcella, & Taylor, 2004; Taylor, 2006)
NATURE OF THE SPACE	Prospect	* * *	**Reduced stress** (Grahn & Stigsdotter, 2010)	**Reduced boredom, irritation, fatigue** (Clearwater & Coss, 1991)	**Improved comfort and perceived safety** (Herzog & Bryce, 2007; Wang & Taylor, 2006; Petherick, 2000)
	Refuge	* * *		**Improved concentration, attention and perception of safety** (Grahn & Stigsdotter, 2010; Wang & Taylor, 2006; Wang & Taylor, 2006; Petherick, 2000; Ulrich et al., 1993)	
	Mystery	* *			**Induced strong pleasure response** (Biederman, 2011; Salimpoor, Benovoy, Larcher et al., 2011; Ikemi, 2005; Blood & Zatorre, 2001)
	Risk/Peril	*			**Resulted in strong dopamine or pleasure responses** (Kohno et al., 2013; Wang & Tsien, 2011; Zald et al., 2008)

P1 Visual connection with nature, a view of natural elements, living systems and natural processes.

- Prioritise real nature over simulated nature, and simulated nature over no nature
- Prioritise biodiversity over area, territory or quantity
- Prioritise or enable movement opportunities that are near green space
- Design to support a visual connection that can be experienced for at least 5-20 minutes a day
- Design spatial layouts and furniture to maintain desired sightlines and avoid obstructing vis-ual access when seated
- Visual connections to even small pieces of nature can be restorative and are particularly rel-evant for temporary interventions or spaces where real estate (floor/ground area, wall space) is limited.
- The benefits of viewing real nature can be diluted by a digital medium, which can be of greatest value for spaces that by the nature of their function (e.g. a radiation ward in a hospi-tal) cannot easily contain real nature or views of the outdoors.

P2 Non-visual connections to nature are auditory, haptic, olfactory or taste stimuli that trigger a conscious and positive reference to nature, living systems or natural processes.

- Prefer nature sounds to urban sounds
- Design non-visual connections that are easily accessible from one or more locations, and in a way that allows daily engagement of 5 to 20 minutes at a time
- Integrate non-visual connections with other aspects of the design programme
- A single intervention that can be experienced in multiple ways can increase the impact
- Design such that visual and non-visual connections are experienced simultaneously to max-imise the potential for positive health responses.

P4 Thermal and airflow variability can be characterised as subtle changes in air temperature, relative humidity, airflow across the skin and surface temperatures that mimic natural environments.

- Integrating airflow and thermal conditions in materials, daylighting, mechanical ventilation and/or fenestration will help distribute variability in space and time.
- Thermal comfort is an essential bridge between biophilic design and sustainable design, es-pecially in the face of climate change and rising energy costs. Implementing thermal and air-flow variability in a way that broadens human perceptions of thermal comfort can also help reduce energy demand for air conditioning and heating.
- Designing facilities that allow users to easily adjust and modify the perceived thermal condi-tions of their environment will widen the range of acceptable temperatures by two degrees Celsius above and below conventional thermal comfort parameters (Nicol & Humphreys, 2002).
- Coordination of design strategies between a project team (e.g. architect, lighting designer and MEP engineers) already during the schematic design process is particularly important for achieving design intent.

P5 The presence of water is a state that enhances the experience of a place by seeing, hearing or touching water.

- Prioritise a sensory water experience to achieve the most beneficial result.
- Prefer naturally fluctuating water movement to predictable movement or stagnation.
- Water features with high volume and high turbulence can cause discomfort, affect humidity or reduce acoustic quality.
- Water features can consume a lot of water and energy and should therefore be used sparing-ly, especially in climates with little access to water Shading the water, using high albedo sur-faces and minimising the exposed water surface reduces water loss through evaporation and potentially contributes to the biophilic experience.

P7 Connection to natural systems is awareness of natural processes, especially seasonal and tem-poral changes that characterise a healthy ecosystem.

- Integrating rainwater harvesting and treatment into rainfall-responsive landscape design
- In some cases, making existing natural systems visually accessible is the simplest and most cost-effective approach. In other cases, integrating design tactics that respond to them (e.g. the use of materials that change shape or expand their function when exposed to solar heat, wind, rain/moisture or shade), structures (e.g. stairwells) and land formations (e.g. bios-wales, arroyos, dunes) is needed to achieve the desired level of awareness.
- Design for interactive opportunities, especially for children, patients and the elderly (e.g. in-tegrative education programmes; horticultural programmes, community gardens; seasonal cooking/dining)

P8 Biomorphic shapes and patterns are symbolic references to contours, patterns, textures or nu-merical arrangements found in nature.

- Apply to 2 or 3 surfaces or dimensions (e.g. floor surface and wall; furniture windows and soffits) for greater diversity and frequency of exposure.
- Avoid overuse of shapes and patterns that can lead to visual toxicity.
- Comprehensive interventions are more cost-effective if introduced early in the design pro-cess.

P9 A Material Connection with Nature is material and elements from nature that, through minimal processing, reflect local ecology or geology to create a distinct sense of place.

- Quantities of a (natural) material and colour should be specified based on the intended func-tion of the space (e.g. restoring versus stimulating). In the same vein, a degree of variability of materials and applications is recommended over high ratios of a single material or colour.
- Real materials are preferred over synthetic variants because human receptors can tell the dif-ference between real and synthetic, so minimally processed materials from real nature are preferred wherever possible.
- Using the colour green can help enhance creative environments; however, scientific studies on the influence of the colour green have mostly been conducted in controlled laboratory environments, so reliance on colour to elicit creativity should be considered experimental.

P10 Complexity and Order are rich sensory information that adheres to a spatial hierarchy like that in nature.

- Prioritise artwork and material selection, architectural expressions and landscape and master planning schemes that reveal fractal geometries and hierarchies.
- Fractal structures with iterations of three will have more impact than a design limited to two iterations.
- Computer technology using the algorithms of mathematical and geometric functions can pro-duce fractal designs for architectural, design and planning applications with ease. When pro-ducing fractal designs, consider using geometries with a medium dimensional ratio (broadly D=1.3-1.75).
- Overuse of and/or prolonged exposure to high fractal dimensions can lead to discomfort or even anxiety, counteracting the intended response: nurturing and reducing stress. Avoidance or underuse of fractals in design could result in complete predictability and disinterest.
- A new building or landscape design should consider its impact on the fractal quality of the existing urban skyline.

P11 Prospect is an unobstructed view over a distance for monitoring and planning.

- Orienting buildings, windows, hallways and workstations helps optimize visual access to in-terior and exterior vistas, activity centres or destinations.
- Designing with or around an existing or planned savanna-like ecosystem, water body, and evidence of human activity or habitation will increase the information richness of the per-spective. Providing focal lengths of ≥6 meters, preferably 30 meters; when a space has suffi-cient depth, spatial properties can be exploited to enhance the experience by removing visual barriers. Limiting the height of the partition walls to 42 inches creates spatial barriers while allowing seated residents to look over the space. Understory vegetation or hedges should use a similar guide; The desired height restrictions depend on the terrain and how the space is most experienced (e.g. sitting, standing or cycling)
- Locating stairwells on the perimeter of the building with a glass facade and glass stairwell walls on the inside can create a double prospect situation.
- When high ceilings are present, perimeter or interior spaces raised 12 - 18 inches will im-prove Prospect condition.
- Often the viewing quality and the balance between Prospect and Refuge will be more im-portant than the size or frequency of the experience.
- Refer to [P1] Visual connection with nature to optimize the Prospect experience with a quali-ty image.

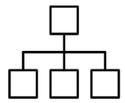
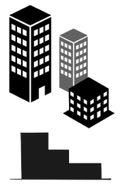
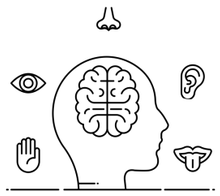
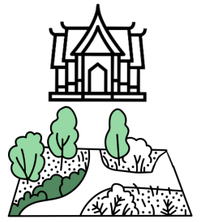
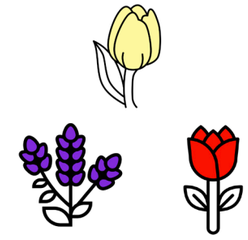
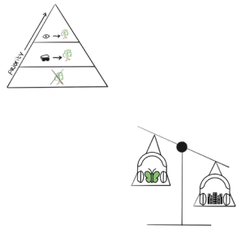
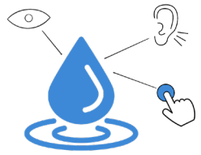
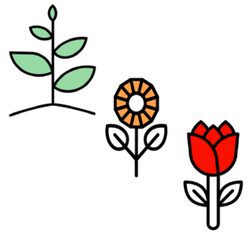
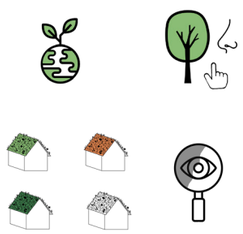
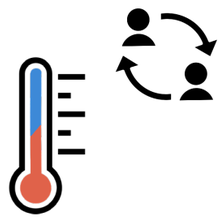
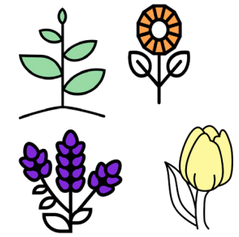
P13 The promise of obtaining more information through partially obscured images or sensory de-vices entices individuals to delve deeper into the environment, creating a sense of mystery.

- Curved edges that gradually become visible are more effective than sharp corners in gui-ding people through a room.
- Using dramatic lighting and shadows can enhance the feeling of mystery.
- However, strategies that rely heavily on dark shadows or shallow depth of field may gene-rate surprises or fear, which may not always be appreciated.
- The speed at which users move through a space will influence the size of the aperture and the size of the subject, with faster move-ment typically requiring a larger size.
- Organically evolved conditions that create a sense of mystery (such as low-maintenance gar-dens with winding paths) are expected to change over time. It is important to mo-nitor these changes, as they may enhance or degrade the mystery condition, potenti-ally transforming it into a surprise condition (such as overgrowth of plantings leading to an obscured depth of field).

P14 Risk/peril is an identifiable threat linked to reliable security.

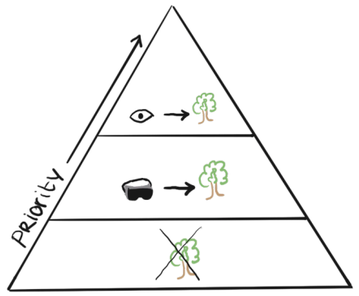
- Risk/risk design interventions are usually very deliberate and as such will not be suita-ble for all user groups or places.
- Design strategies that depend on spati-al conditions will be easier to implement if they are al-ready integrated into the concept design and schematic phases of the design process.
- The safety element must protect the user from harm and at the same time enable the experi-ence of risks (Browning et al., 2014).

Toolbox

Elements / Scale	Biophilic Design	Spatial complexity	Forms and Shapes	Body (user experience/ comfort)	Mind (multi sensory experience)	Aesthestics and "Beauty"	Materials and texture	Colour psychology
City (Landscape)								
Street (Transtion landscape to building)					 Visual			
Door (Urban Oasis)					 Senses			
Strong connection with emotions	xx	xx	xx	xx	xx	x	x	xx
Strong connection well-being/ mental health	xx	x	x	xx	x	x	x	x

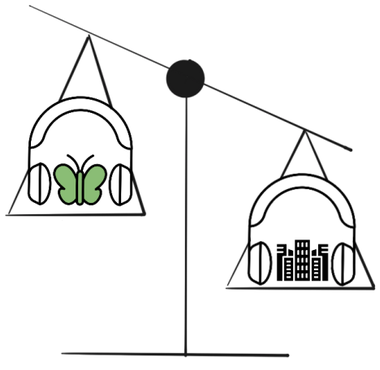
Legend

Visual connection with nature

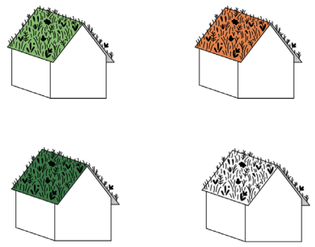


Prioritize real nature over virtual nature over no nature

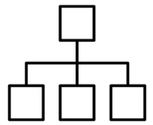
Biodiversity



Prefer nature sounds over urban sounds

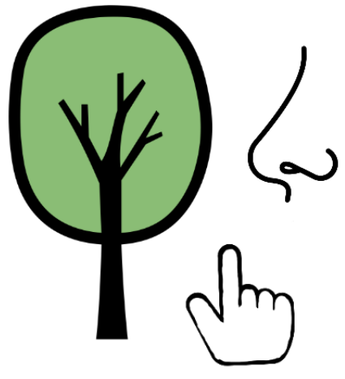


Connection to natural systems, for example green roof

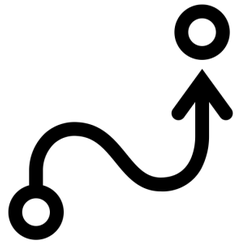


Order/ clean organisation

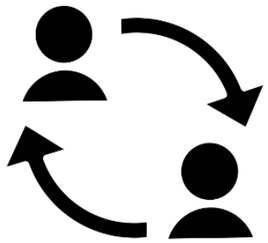
Eclipses create a sense of mystery and seduction



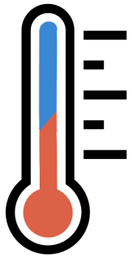
No visual connection with nature, but senses nature.



Journey/ flow of space

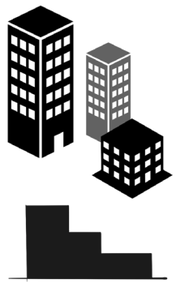


Social interaction

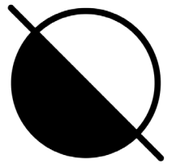


Thermal comfort

Curves pattern/ shape

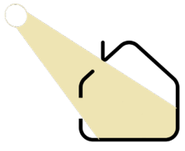


Levels, scale and proportion



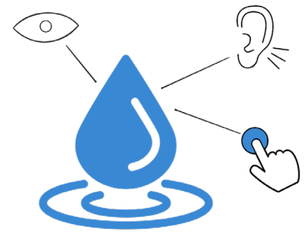
Contrast
Light & shadow

Sound/ acoustics

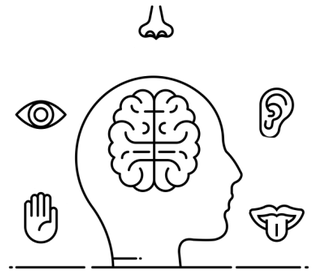


Natural daylight

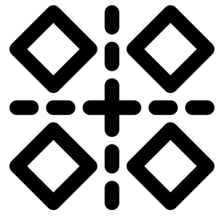
Local materials



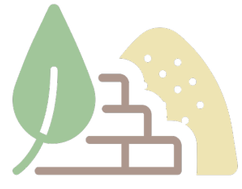
Presence of water (senses)



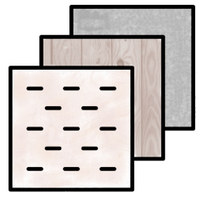
Multi sensory



Symmetry



Materials



Textures

Colour psychology

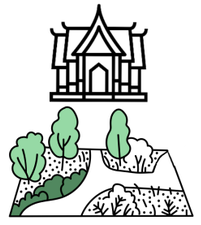
Red

Orange

Green

Yellow

Purple



Local techniques
Blending with landscape

The body

The human body can be viewed as a natural element and a key component of form. In the past, it was regarded as the most fundamental measure of self. Researchers have examined how a lived body can effectively create a more emotionally charged space and foster an emotional connection within architecture. The physical body and its emo-tional connection can stimulate the sensory experience of architecture. The body can be a form that interacts with space, allowing humans to experience the interior envi-ronment that generates spatial perception. Bodily movement can be divided into two aspects: physical movement and visual movement. These provide dynamic experienc-es through changes that occur due to spatial sequences. This reveals that bodily sens-es and movements provide a constant dialogue with space, allowing for a rich spatial experience (Lee, 2022).

The mind