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ARCHITECTURE FOR HUMAN NATURE

The Quest for Embodied Resonance in the Modern Habitat

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Architecture of Resonance

The Attunement of the Built Environment To the Nature of Human Beings, The Embracement of the Ever-evolving World Through All our Senses; And that we can Transcend To a connecting Image of Awareness, By Embodying our environment In all its Diversity and Richness, So that We can take part In Creating a Future, In which All forms of Life can Thrive.

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Preface

Prelude

When I traveled through Greece during the summer of 2019, I visited many of the UNHCR constructed 'temporary' settlements, which are supposed to secure the human rights of refugees in the form of food and shelter. They are consistent in their model: As a clean slate, the square site is covered with white-grey gravel, burning in the Mediterranean sun. So-called Iso-boxes, uniform grey plastic containers, are neatly placed in long repetitions, forming a predictable grid. The whole is concealed by metal fences, barbed wire, and lamp posts, solidifying the lack of perspective. Besides the most basic sanitary and food facilities, there are no places to gather, nor is there any shade to relax outside. There is no room for plants or trees or any other form of life; secluded places to have private thoughts or conversations are banned; any impulse for ideas, adventure, or interest are retorted by the facades of the ubiquitous grey boxes. Even prayer is not met by any sort of gesture. 'But they have food and shelter, right?'

Introduction

The East-African Savanna, a rich mosaic of biomes. Varying from dry shrublands, subtropical forests, wet grasslands our species used to live in an incredibly diverse set of natural spaces.¹ We hunted across open fields with far horizons for hours, then reside between bushes and trees with wide canopies that filtered the sunlight from its intensity. Another day, we might have been exploring a subtropical jungle, the thick trees stretching far into the sky, creating room for a spectacular ambiance of bird sounds, on a background of innumerable shades of green. Finally, we could have been refreshed by the presence of a river, carving the stones under its surface into an ever-evolving pattern.

As we commonly quote in architecture how we are shaped by our environment, this is the habitat that has shaped us for millions of years and deeply resonates with our bodies.² Evolution left us no other option than finely attuning our aesthetic^{1,-3} perception to these pristine natural

¹ As there is some confusion and many associations around the word 'aesthetic', let me refer to the Greek origins of the word: aisthētiko, which literally means "relating to the perception of [all] the senses". It refers to the physical qualities of our surroundings that emotionally 'move' us through the experience by the corporeal

surroundings, framing them by our intrinsic conditions to thrive as a species.

While our bodies and brains have not dramatically changed,⁴ our habitat has. More than half of the human world population now lives in the urban realm, distinctive biotopes, that surpass the complexity of any other social structure in the animal world. And, while our ancestors have tried to replicate the order of nature in both structure and ornamentation throughout the built environment, we have also left that tradition behind to follow a more industrial logic of our own. Especially the utilitarian approach to architecture - that has blossomed over the last hundred years, during the age of the machine - appears to be comfortable with the eradication of decorative forms of ornamentation or the poetic junction between light, material, and space.⁵ We have been bold in our separation from our origins. However, what might be the consequence in terms of our embodied and emotional well-being?

In 1984, a young scientist called Roger Ulrich set out a moderate study on the recovery of surgical patients in hospitals, and what possible role their aesthetic

senses. This is different from many taxonomies in architectural theory, emphasizing a more intellectualized or abstract idea.

See also: Juhani Pallasmaa. The Embodied Image : Imagination and Imagery in Architecture. Chichester: John Wiley, 2011.

environment could play in it.⁶ His method was simple. He compared the data between the patients with a view on nature and those who looked out on a brick wall instead. And, his findings were very clear. Not only had the patients with a view on nature recovered faster, but they also had requested less pain medication than those with the view on a brick wall.⁷ Ulrich probably did not realize at that time what trend his study would set into motion.

That same year, ecologist Stephen R. Kellert, and already notable biologist Edward O. Wilson had posited the Biophilia hypothesis. Biophilia, meaning 'love for life' describes our intrinsic tendency to seek connections with other forms of life and the natural environment, as a very vital part of our human nature.⁸ Ulrich's study implied a fresh clue of evidence for this hypothesis, and many studies have been conducted on the positive health effects of 'biophilic design' ever since.⁹ Nowadays, biophilic design, under the heading of evidence-based design, is being applied in hospitals all around the world without hesitation. The inclusion of aspects like improved access to daylight, natural ventilation, and stress-reducing plants have booked significant successes in improved rates of recovery.¹⁰ Besides physiological benefits, the application of these design tools is also linked to feelings of calmness, a reduction in depression, and improved concentration. Hence, schools and offices are also starting to pay more attention to the design trend. Even more alarming, green neighborhoods correlate with lower cases on the pathological spectrum, like autism and ADHD. Urban planners can hardly think any longer about a public space without plants and trees.

The fact that plants and daylight have a positive influence on our well-being may not be so surprising anymore. In this respect, we can calmly assume that people (cross-culturally) have surrounded their buildings with gardens and parks for centuries with good reason.¹¹ Yet, if we think again about Ulrich's study, we might wonder: what about the other patients, looking out on the brick wall? Why did they perceive it to be so lacking compared to the view on nature? Suddenly, a very common element of Modern architecture stands in a notorious light. One could argue that the brick wall is just neutral compared to the healing view on nature, but we could simultaneously pose it the other way around: the natural view is the natural basis to depart from, and the brick wall might have some detrimental physiological or psychological effect. Either way, it might be interesting what the biologists and neuroscientists can tell us about the aesthetics of architectural elements, and why certain forms of them dissonate compared to natural elements.

Despite the strong health benefits of natural surroundings, a habitat dominated by modern materials like concrete slabs, glass facades, and white-plastered walls has not scared us off. Driven by economic opportunity and cultural attraction, masses of people world-wide abandon the rural countryside for a chance to make it in the big city.¹² It seems that our persistent attempt to separate ourselves from nature is driven by an image of economic security, comfort, and luxury. However, the trend of urbanization does not come without ecological consequences. The common production methods for these modern environments take their toll in resource exploitation and waste pollution, and other forms of ecological degradation.¹³ If the industrial culture of spatial production leads to such ecologically destructive outcomes, its aim with creating balanced environments for humans might as well be less evident. Biologists and architects might probably find consilience in this statement. But unfortunately, major project developers - constrained by strong beliefs in the solving forces of laissez-faire models might need more than ecosophical arguments alone.¹⁴

Regarding Western cities and suburbs at least, there is a good reason for concern though. Looking at the alarming rates in obesity, social alienation, stress levels, and insomnia, and pathologies,¹⁵ there might be a link to Modern urban aesthetics, as compared to the uncultivated aesthetics of our ancestral environment. Multiple studies have shown for example that people living in the countryside, surrounded by natural landscapes, are significantly more satisfied in life than urban citizens while having fewer economic opportunities.¹⁶ As it could be argued that it is the responsibility of the social sciences to detect destructive habits, I argue that it is the responsibility of the discipline of architecture to detect destructive habitats. It is self-evident that habitats are shaped by their habits. But what do we actually know about how the aesthetic qualities of form, space, and materiality influence our habits, our emotional life, and our perception of the world? Departing from the hypothesis that habits and habitats are indeed interrelated, the aesthetics of the urban environment, and the Modern building traditions that underlie them, come into reconsideration. If urban aesthetics are out of synchronicity with our very human nature, how can we, as architects, recognize that? And more importantly, what can we do about it?

Although few would probably give up the city, to reside back into the wild, a more qualitative understanding of how our ancestors from the Pleistocene related to their surroundings via their senses, might reveal new insights. What can the evolution related sciences, such as biology and neuroscience, teach us about how to detect aesthetic dissonances and opportunities in our contemporary environment? Altogether, this leads to the research question:

What can we learn from the **biological sciences** about **architectural aesthetics** in order to enhance **physiological** and **emotional well-being** in the Modern Urban Habitat?

Premeditation

In this essay, I aim at a natural scientific understanding of how our bodies physiologically and psychologically synchronize with their environment, and what role architecture plays in this. Sometimes I will refer to this phenomenon as the search for *Resonance*, hence the subtitle of the essay. Another important guiding theme is the re-exploration of the concept of *human nature* – based on the newest insights from the disciplines of biology, neurology, and evolutionary psychology – and the formulation of their implications for architectural practices. We will look at the origins of our species and the intrinsic affiliations we universally inherited that make us idiosyncratic in respect to the other species.

Simultaneously, by leaving anthropocentric notions about ourselves behind, we create room for a more critical and even existential understanding of our human being in a larger whole. We will look at how our human nature has grown in an ecological relationship with the environment, whereby our senses and emotions were constantly engaged. We will see how this relationship has radically changed ever since our ancestors left East-Africa, but especially since the industrial age. In line with the increasing ecological misery over the last century, our biological connection with the world has been distorted beyond recognition, transforming the habitat and the fundamental nature of being human itself.

Approach

The essay consists of three parts. In the first part, *Nature* and *Nurture*, I will explain the basics on how we embody the (built) environment through our senses, nervous system, and brain. I will demonstrate how this biological relationship is crucial to our physiological and psychological well-being, approaching the research question mainly in an *objective* and *generic* manner first. Then, I continue by elaborating on the possible implications this might have for architectural practices. In this order, the first part aims at the development of a science-based paradigm for architectural phenomenology. I consider it as a necessary preparation for the following part, which would otherwise be more vulnerable to misinterpretation and ungrounded speculation.

The second part, *Origins*, builds forth on the formulation of our intrinsic needs in relation to the environment, but my method works in a complimentary way to the first part. It approaches the research question within a *thematic exploration* on the basis of our evolutionary history in addition to the insights of the first part. Guided

by the example of evolutionary psychology and biophilic design, I hope with the narrative to contribute to an *intersubjective* understanding, which designers can connect to more intuitively for their design process. Moreover, the thematic categorization is also used to pin-point a collection evidence-based design tools, show their links to the evolved traits, and thereby place them in a context. Thus, while the chapters are thematic, they hold the natural scientific affiliation nonetheless.

In the third part, *Synthesis*, I will reflect on the extent that the two parts managed to answer the research question and opens up the discussion for future research.

Part One: In the first chapter, I start off by discussing the bio-neurological approach in its exceptional position to the architectural discourse, which has traditionally been only approached by the humanities and social sciences. The classical opposition between the natural sciences (nature-oriented) and humanities/social sciences (nurture-oriented) has a certain history that still seems to stand in architecture academies today. Yet, the developments in biology and neuroscience, of especially the last two decades, presents us with inexorable insights around our human behavior and well-being. As these factors appear to be inseparably interlinked with our habitat (or

environment), the fresh premise promises implications for architectural theory.

The second chapter, *Our Neural Heritage*, I have written as an introduction for designers to the basics of neuroscience, and how our sense of well-being is linked to various layers of our brain. I will present here a specific selection which I will argue to be of special relevance in relation to the understanding of our perception of architectural aesthetics. I will draw here from the expertise of the most proponent researchers of this time, like Antonio Damasio, Jaak Panksepp, Francisco Varela among others.

Chapter three, Neuroscience & Architecture, closes the first part by focusing on the semiotic bridge between neurology and architectural phenomenology. Harry Mallgrave has been the first and foremost *architectural* theorist to specifically advocate this disciplinary merger over the last decade, followed hitherto by only few others (most notably, Sarah Goldhagen, Juhani Pallasmaa among others). Therefore I think it is crucial to build further on the divergent notions he has made so far. From the side of neurology in contrast, there has been a big hand-out we, since see a great rise in so called neuroaesthetics. Another key figure on the thesis is neuropsychologist Colin Ellard, who has made decisive contributions to the field. Neuro-aesthetics will continue to be an important scientific source for the second part of the essay, as that is more dedicated to the formulation of applicable design tools.

The first part must have provided, by then, the most essential neurological basis for designers about the dynamics of the body and mind in relation to the built environment.

Part two: The second half of the essay consists of five chapters that are analogous in their set-up. Each one is dedicated to one of the intrinsic affiliations (or instincts), which are linked to our well-being in relation to the environment. They are individually distilled from the research done in chapter two, *Our Neural Heritage, but* this time they are placed in their evolutionary historical context. This allows us to develop a more qualitative image.

The chapters are dedicated as follows:

- Chapter four, *Biophilia*, is about our homeostatic affiliation that resonates with other forms of life.
- Chapter five, **Refuge and Intimacy**, is dedicated to activity related to the parasympathetic nervous system, securing restful and inward-focused behavior;
- Chapter six, *Exploration and Play*, focuses on the activity related to the sympathetic nervous system, encouraging curious and outward-focused behavior;

- Chapter seven, Arts and Crafts, explains the urge to search for and perceive emotional meaning in the environment;
- Chapter eight, *Awe and Transcendence*, is focused on the affection for rituals and ceremonies to amplify contemplative and transcendental experiences.

After exploring these affiliations in their evolutionary context, we will have a look at how they relate to the contemporary urban environment. In this regard, I will try to address some alarming trends and broad opportunities. At last, every chapter provides practical design tools on the basis of neuro-aesthetics and environmental psychology, how the different affiliations can be encouraged. Here, I will use the phenomenological framework that is discussed in chapter three.

In the third part, *Synthesis*, I will complete the essay by summarizing my conclusions and remarks in relation to the original research question. Further, I hope to reflect more broadly on the meaning of my research for the field of architecture and society in general.

Nature & Nurture

The embodiment of our environment

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Nature & Nurture

My research question poses an explicit scope in approaching architectural aesthetics. The evolutionary sciences, drawing knowledge from fields like biology, ethology, neurology, and psychology are characterized by their objective interest in the nature of humans.¹⁷ Therefore, they leave room for the humanities and social sciences to fill the remaining gap with intersubjective knowledge. Taking a natural scientific stance on topics like the perception of architecture is still rare, or extraordinary at least. At the roots of this oddity might lie the omnipresent idea that the perception of our environment is completely unique per individual, or culturally constructed otherwise. This could result in objections such as: Are we not all exceptional and have a different opinion on matters like art and architecture? What merit does it have to discuss the culture of architecture from the perspective of nature? However, the rise in the last two decades of neuro-scientific research is revealing insights on our common human nature that the humanities (including architecture) can no longer leave out of the picture.¹⁸

First, we need to break with some of the long standing distinctions in this regard. Timothy Morton, a

professor working at the intersection of philosophy and ecology, explains how a divide between culture and nature appears to be deceptive.¹⁹ Although most of us would have a fast association with the one and the other, there is actually no such thing as *nature*, because we are also *nature* in our very essence, and so are all the things we produce as 'artifacts'. Regarding ourselves as separate from nature is by definition anthropocentric. This does not mean though, that we should underestimate our powers to change our environment in drastic ways, which have already resulted in ecological disbalances for other organisms, but also for ourselves. Hereby comes immediately into question the *nature* of the architectural objects we produce.

Just like the nature-culture division, the study of humans – with all their thoughts, feelings, sensations, and behaviors – is often outlined by the classic oppositions of nature versus nurture (genetically invoked vs. learned behavior). At least until the late 1960s, the debate was dominated by the social sciences, in which human behavior was almost completely explained by cultural adaptation and could be shaped into basically anything from birth on.²⁰ Nevertheless, strong opposition came in from two evolutionary biologists, namely Richard Dawkins and Edward O. Wilson. They argued that, although people are susceptible to certain cultural norms, our genes define our susceptibilities in the first place. The attempt to curb ourselves by projected cultural ideals cannot go out of line with our human nature without conflicting consequences.²¹ Especially Wilson had the ambition to formulate a new branch of science, called sociobiology, defined as "the systemic study of the biological basis of all human behavior".²² He got fierce criticism for his attempt, which he confuted in his book On Human Nature (1978); and was able to back-up more extensively with evidence in his later work The Social Conquest of Earth (2012).²³ He argues that we cannot explain human traits by either attributing it purely to nature or nurture, but only by seeing it on a gradient scale of the two. Nonetheless, he explains that there are many traits and biases already predefined by our DNA, which our ancestors needed for survival, as will be explained later.

Further, Wilson resumes that nature and culture are actually in constant interaction with each other. While our brains need to be nurtured by the natural and social environment to develop, culture is greatly 'stirred' by our universal natural biases.²⁴ He explains that these biases are expressed in the way our 'senses perceive the world, the symbolic coding by which we represent the world, the options we automatically open to ourselves, and the responses we find easiest and most rewarding to make.'²⁵ This leads to consistent patterns in our behavior, which are idiosyncratic compared to other animals. Throughout prehistory, this alternation of nature and culture has led to so-called 'gene-culture co-evolution',²⁶ responsible for the development of our strong sense of social intelligence and group behavior. This implies that also cultural evolution is

not so random at all. In fact, certain typical human traits are universally inherited and thus cross-cultural, like language, hygiene, cooking, dancing, etc. These are all typical social traits of the human species. Despite the disapproval of sociobiology by many academics back in the early seventies, Wilson regained his status as one of the world's most renowned biologists. Sociobiology has gone under the name of evolutionary psychology since the eighties, which is by now considered a fundamental academic approach.²⁷

Today, the divide between nature and nurture has become increasingly irrelevant. In line with Wilson's notion of nature and culture constantly interacting with each other, many scientists are regarding the whole formation of our human being as a result of a complex ecological system, containing the brain, body, and its environment.²⁸ In this line, Evan Thompson and Francisco Varela distinguish three layers in our embodied consciousness as cycles between the body and its environment:²⁹ 1. Our consciousness arises from within the body by our nervous system, as a result of self-regulating processes like homeostasis that keep our body and mind in balance. 2. The body processes its physical surroundings via the senses, allowing our consciousness to expand towards its environment, and evaluate it emotionally. 3. Socially, the body processes input from other humans or emotional beings. We do this via mirror neurons that amplify intersubjective exchange, hence we have cultural phenomena (see fig. 1). These three cycles are always in motion and leave our human nature far



Figure 1. Thompson & Varek's three cycles of embodied consciousness. (illustration by author)

from static or singular in any sense. Biochemically, our consciousness is actively being expanded by our environment, and in return, the environment is constantly altering our body and mind.³⁰ In this sense, the embodiment of our environment is more now than philosophical abstraction. It has become a biological reality, framing our perception of the world.

Just like other ecological systems in nature, the miraculous exchange between our habits and our habitats might be driven by a preprogrammed desire for equilibrium, in human terms, I imagine terms like 'health, peace and prosperity'. However, in the case of the Modern City, the enlarged social apparatus tends to lose touch with these values, favoring its systemic functionality over collective well-being. Thus, what are the preconditions, or the 'epigenetic rules' Wilson was mentioning, that we inherited from our ancient ancestors in order to experience and be motivated to chase resonance with our environment? And how can the architectural environment nurture these needs? While we have studied for a long time now what aspects mammals desire from their habitat under the heading of ethology, we have barely touched the surface of our own environmental affiliations, as prof. Harry Mallgrave points out: "In response to issues of health, we have enacted legislation to improve the gualities of the air that we breathe, and in most building projects we are quite conscious of protecting the habitats of our fellow creatures in the animal world. But we have, for whatever reason, directed precious little attention to considering the emotional or livable qualities of our human habitats."³¹

First off, the formulation of our embodied needs requires a critical understanding of our neurological structures, and how they have been shaped by natural demands for survival through the course of evolution, which I will discuss in the next chapter. It will become clear how insights from the last two decades in biology and neuroscience contradict some of the formalistic taxonomies in architecture. Especially the strong distinction between our cognitive behavior and the processes in our body; and the diminution of the role of emotional perception in architectural design, show to be problematic.

CHAPTER TWO Our Neural Heritage

From an evolutionary perspective, the human brain has evolved over millions of years in mainly uncultivated surroundings.³² This way the brain is environmentally adapted to indicate and evaluate what is perceived by the senses to help us thrive. Our aesthetic preferences were thereby key to survival.³³ This instinctive lens of evaluation didn't come without consequences though. While certain aesthetic characteristics better our sense of well-being, others might as well worsen it to motivate us to move somewhere else.³⁴ Only, in contrast to the savanna, in the Modern urban habitat we often don't have the possibility to 'go somewhere else' whenever our body urges us to. Many of us are confined by an industrial, commercial or bureaucratic work-place. In addition, tied to stay within a practical geographic distance from the working place, we are often left with little practical choice on where to dwell. As depriving or disturbing as the appearance of your workplace or neighborhood can be, many people just got to live with it. Therefore, the aesthetics of a simple brick wall, as we discussed with Ulrich's study, might not be so innocent per definition, especially, if you have to stare at all day long.

Our brain is not just the receiver of physical stimuli, a place for literal input to 'wrap our head around' with our thoughts and feelings to make deliberate decisions. Foremost, it is an automatized organ, regulating physiological processes via neural circuits and hormone secretion. The input our brain gets from the nervous system, including aesthetic stimuli via the senses, plays a role in our sensations, mood changes, and cognitive performance. Thereby stimuli motivate us to behave in certain ways, also in relation to architectural spaces. But maybe even more important, each layer of the brain requires specific forms of resonance with the external environment to develop and maintain its vital functions properly, and thereby secures a distinct form of physiological and psychological well-being.³⁵ The implication is that (architectural) aesthetics can be guite literally regarded as sensory nutrition, or in some cases malnutrition. However, are there no other aspects in our environment more important, like social factors? We will see in this chapter that the obvious distinction between input from our social, natural, and architectural environment can also no longer be seen as so sharp.

The order in which the human brain has evolved and is structured by evolutionary preconditions show how our bodies function in relation to our environment, and what kind of resonance or nutrition it desires. As there is a great rise in neuro-aesthetic research, I suppose we cannot stay behind as architectural designers by being ignorant to their semiotics. Without a common basis, it is mostly impossible to understand and interpret their knowledge to its full extent. It might be comparable to the discourse of psychologists and psychiatrists, who need to know the basic theory of neuropsychology in order to understand their clients. I namely don't think we are all simply talented enough to fully sympathize with the user's experience naturally. For this reason, I have dedicated this chapter as a primary introduction to the workings of our brain, but feel free to go directly to the conclusion of this chapter, where the most important remarks are summarized.

<u>The Human Brain</u>

Traditionally, biology makes a distinction between three parts of the brain: 1. the brainstem & hypothalamus ('reptilian' heritage); 2. the limbic system ('mammalian' heritage); and 3. cerebral cortex ('human' heritage).³⁶ Certainly, the specific functions of these parts of the brain have changed through interactive adaptations over the course of evolution (so the 'reptilian brain' for example should not be interpreted as fully representative for reptile species). Nonetheless, this categorization will still help in summarizing some key functions in the processing of sensory information, and the effect on our health and emotional well-being.



1. Brainstem & Hypothalamus

The brainstem and the hypothalamus are the oldest parts of the brain in evolutionary sense.³⁷ They lie at the very center of the first station where the signals of the nervous system enter. First off, the brainstem is foremost responsible for the conveyance of sensory and motor pathways (the latter relating to the movements of our muscles) between the rest of our brain and our body. This means that they are a gateway between our brain and environmental stimuli.³⁸ If this gateway is damaged, two crucial functions are taken away. When the signals of the brain can no longer be transferred to the nervous system, the body is in paralysis,

and the mind is 'imprisoned' in the body. But even more astonishing is the other way around. When the nervous system can no longer give signals to the brain, no state of consciousness is possible (even when the rest of the brain is just fine), and the body enters a state of coma.³⁹ This means that consciousness - the perception of an individual self arises from the body, not from isolated prefrontal lobes as was assumed for a long time (so, good luck with uploading your mind to a computer then).⁴⁰ As we share this anatomy with many other animals, it probably implicates that other animals are conscious beings as well.

The wakefulness and attention span, but also our circadian rhythms (e.g. awake – REM sleep – non REM sleep) that are so crucial for *all* processes in our brain and nervous system, are dependent on, and also regulated by the brainstem.⁴¹ Hence the importance of sleep. During our sleep, our bodies are not so inactive as it seems. They are very active in restoration processes to keep the body healthy and free of toxins.⁴² Relevant for architecture, these insights reveal that our environment, as it surrounds and stimulates our body, has a direct influence on our state of consciousness.⁴³ Hence we should wonder what kind of neurological input the brainstem needs to function well.

Secondly, we have the hypothalamus, which strongly collaborates with the brainstem. Although it is very small, compared to the other parts of the brain, it is responsible for
the most important vital processes of our body, like the regulation of our temperature, heartbeat, blood pressure, breathing, digestion, and also arousal.⁴⁴ These processes are heavily intertwined with the emotional mechanisms by the other parts of the brain, as we will see in a moment.

All these functions, of both the brainstem and the hypothalamus, lie at the basis of homeostasis. It is the process that ensures physiological balance, which we need as a key part of being an organism.⁴⁵ Homeostasis is far from *static* though, as this sort of balance is ever adapting and evolving, hence biologist Steven Rose proposed the word 'homeodynamics' as a replacement for the term.⁴⁶ No matter what our bodies have to endure by external input, it will keep its instinct to search for a balance by internal adjustment. If we drift too far off this balance, we simply get sick or die. The homeostatic process is not only physiological in its purpose, it also ensures the basic conditions for our mental well-being, for example in the case of sleep and wakefulness.⁴⁷

The *psychological* understanding of the role of the brainstem and hypothalamus is still very limited because its functions lie deeply into our subconsciousness (we cannot deliberately control our heartbeat or digestion for instance). Yet, it must be said that compared to the other parts of the brain, they have been most subjected to evolution over time and can be biologically regarded as structurally more 'advanced' than the other parts of the brain. While conscious

thoughts and feelings are for sure remarkable, the hypothalamus might be a lot more influential in our (environmental) biases than we might think.⁴⁸ It is important to leave the distinction between our mind and body behind (Cartesian dualism) as it is a false understanding of how our behavioral responses are disconnected from the physical processes of our body.⁴⁹ This insight only emphasizes why nurturing the subconscious parts of the brain matters, also to our sense of vitality. We will later see how prevalent the presence of life and lifelike patterns have an impact on the brainstem and hypothalamus, actively enhancing our overall vitality and sense of well-being (see chapter three, *Biophilia*).



2. Limbic system

Looking at the human brain as some sort of mushroom unfolding itself, the next couple of layers are called the limbic system. Highly relevant to experiencing aesthetics, this part of the brain is responsible for our spatial recognition, memory, and learning mechanisms (hippocampus); our emotional and behavioral responses (amygdala); but also influencing physiological processes with the use of hormones such as dopamine (besides hypothalamus, ventral tegmental area, basal ganglia).⁵⁰ It should be said though that all the different parts of the brain work together to make specific functions possible.

First off, emotions in a biological sense should not be

misunderstood with the experience of feelings, as many emotional responses remain in the subconsciousness. Rather emotions are complex mechanisms that lead to instinctive or survival-related behavior like hunger and thirst, but also affection, pleasure, anger, and anxiety.⁵¹ They are literal motions in the body, while feelings are purely the resulting sensations. Emotions affect our behavior, posture, and body processes before we become aware of our (cognitive) mind.⁵² An example of this is the fight-flight-freeze response. If you get almost hit by a bus, you don't just 'wait and think about it'. Before you realize your shock, you have already jumped aside. Just like with the bus, we have already evaluated our environment emotionally and adapted to it physiologically,⁵³ before we have understood it terms of semiotic or taxonomic. value as we emphasize in architecture. How often do we stand still by our physiological/emotional responses in buildings, before we rationalize it in our intellectual frame of reference?

Additionally, the amygdala and hippocampus work together to evaluate experiences of places from the past by linking emotions to memories.⁵⁴ In this respect, it seems that our brains do not only carry memories from our own experiences, but also those from our stone-age ancestors, resulting in intuitive preferences for certain spatial qualities that helped us to survive.⁵⁵ A broadly applied principle is 'prospect-refuge', the tendency to search for spaces to hide

and keep an overview of the surrounding area at the same time (more about this in chapter four, *Refuge and Intimacy*).⁵⁶ Further, the hypothalamus rewards us with dopamine – the hormone that we need to be motivated – when an environment triggers our curiosity. Aesthetic features again play an important role in offering the right amount of complexity, in terms of spatial and pattern sequences (more about this in chapter five, *Exploration and Play*).

Why must we regard emotions as so fundamental to our biases and behavior? Antonio Damasio has famously portrayed how decision-making disorders come out of the misfunctioning of emotions, not so much reasoning abilities.⁵⁷ Emotions are mechanisms with which we can evaluate stimuli from outside, and prioritize certain factors (social, physical) over others. Without them, we lack motivation to optimize our behavior for our own or group's sake, and it is impossible to give meaning to the different options at stake. Our values are empty without emotional engagement. In this sense, conflictive decision making can be primarily considered to be part of limited emotional intelligence. It means that we are not logical or rational beings, whose reasoning processes are out of line with our emotions, like was long imposed by philosophers as Descartes. Our feelings assist the efficiency of our reasoning processes.⁵⁸ A computer program might for example be very efficient, but if the underlying values are badly defined, it is

likely to generate poor outcomes. The same case could be made in the case of a building program.

Our emotions have evolved to detect dissonances within our nascent social systems and natural environment,⁵⁹ certainly not excluding the architectural environment. But how many times in architecture do we avoid questions like: 'What would you feel if you need to spend 20 years of your life in a building like this?' I imagine buildings such as distribution centers with bare views outside, or large retail stores where the acoustics make you dizzy and every minute you have to process thousands of visual stimuli. Therefore, I think we should ask ourselves what psychological effect the aesthetics of these places have on us.



3. Cerebral Cortex

The last part and the youngest in evolutionary terms is the cerebral cortex, forming the outer layer of the brain with the left and right hemispheres.⁶⁰ Viewing it in the order of the front layers to the layers at the back of our head, it is responsible among others for: thinking, planning, abstraction (frontal lobe); voluntary movements (motor cortex); the processing of sensory information from the body (somatosensory cortex), and from the senses (parietal lobe, occipital lobe); long-term memory (temporal lobe) and further processing of emotions (insular cortex).⁶¹

First off, the frontal lobe is the part of the brain with whom we can objectively describe an architectural space, and make an abstract understanding of it as is common in morphological analysis. Although the frontal lobe is for example very good at indicating utilitarian merit, it is less the part from which we empathize with the user's experience. If the architect excludes the emotional/instinctive experience of the space, or filters/alters it strongly through cognitive biases, this might lead to a sort of cognitive dissonance.⁶² This means that, although the architect is certainly capable of predicting for example the experience *awful* acoustics, he or she pursues their vision nevertheless based on their initial abstract concept. While this is still in the power of the designer to change. Go for example a scale bigger: how much room is left for the emotional perception of a public space, when a puzzle of countless logistic demands needs to be solved first? The same case might go up for structural or functional demands of a large building. It becomes guite a challenge to keep the emotional perception in mind.

Although the workings of the frontal lobe seem particularly familiar and idiosyncratic for human beings (we are by far the most equipped of all animals to perform analytical cognitive tasks),⁶³ the other parts of the cerebral cortex are just as extraordinary. In terms of emotional intelligence and valence, the insula particularly plays an important role. The insula is divided by a right and left lobe, responsible for complementary forms of activity.⁶⁴ In this case, the *left insula* is associated with introverted moods and behavior.⁶⁵ It describes a state of safety, relaxation, and

being nourished by affection, or intimate social bonding (group-orientation).⁶⁶ We call this parasympathetic brain activity. The *right insula* is more active with extrovert moods and behavior, like assertiveness, autonomy (self-orientation), the will to go out in the world and engage in new (social) situations. We call this sympathetic brain activity. We will focus in part two of the thesis on what role architectural aesthetics can play in stimulating these moods (see chapter five: refuge and intimacy; and chapter six: exploration and play).

Thirdly, when it comes to experiencing architectural aesthetics, mirror neurons appear to be crucial. They are located in the motor cortex, somatosensory cortex, and parietal cortex. Mirror neurons are special nerve cells that are activated when you share an action or sensation with someone else (they are part of neural circuits with the limbic system).⁶⁷ This makes them crucial in terms of our social intelligence, but there is more to that.

Over approximately the last million years our species and predecessors (Homo Sapiens, Homo Erectus, Homo Habilis) have evolved strongly in groups, whereby social intelligence was important for survival.⁶⁸ This implies that we have all kinds of social instincts (like empathy), to secure a place in the group. Later, this refined social sense allowed us to cooperate in large groups. The first extraordinary consequence to mention is that emotional harm or joy brought by the group activates the same parts of the brain as purely physical input.⁶⁹ For example, if the words of your peer hurt you, your body reacts similarly to physical pain and is therefore just as *real* as physical pain.⁷⁰ The experience of safety and the possibility for refuge from group-activity is one of the things which architectural aesthetics can essentially provide (see chapter five *Refuge & Intimacy*).

Mirror neurons play a major part in our social intelligence, as they help us navigate and adjust to our social environment. They make us empathize with others and read their intentions. Additionally, they are crucial in our learning behavior in terms of imitating others. Our longing for artistic expression is a result of this evolutionary trait, as will be discussed in chapter six (Arts and Crafts). Moreover, and here it gets interesting for architectural aesthetics, mirror neurons are not solely activated by humans and other animals, but also by other organisms or even objects. From the perspective of phenomenology, mirror neurons make us relate empathetically to the world and enable us to give emotional meaning to it.⁷¹ This means that factually, nothing is interpreted as neutral in our embodied perception. However, we might as well become emotionally disengaged with our environment due to the lack of qualitative architectural aesthetics.

When we use metaphors to describe something, it is often not so much an abstract analogy. When we describe

for example a room as 'warm', because the space reflects red and yellow tones, we physically experience it as warmer compared to a space with 'cooler' tones.⁷² It even goes further. The *character* of the space, its ambiance, shapes, and materials are not so evaluated differently by our nervous system as the presence of an actual person or animal.⁷³ For example, objects that are made out of very heavy materials and disproportionately bigger than the human scale, are likely to invoke a sense of dominance, much like a person standing next to you who is bigger and heavier.⁷⁴ I will elaborate on this further in chapter seven (Awe & *Transcendence*).

Reflection

The biological understanding of our brain implies that the experience of architectural aesthetics is not just something visual or abstract. In the first place, it is a fully embodied experience, whereby the stimuli of the senses nurture our emotions and bodily processes continuously.⁷⁵ We can only thrive in our environment by maintaining our physiological and psychological balance and therefore, we have no other option than to experience our world emotionally. Architectural aesthetics play a role not only in our well-being in the short term in processes like homeostasis but also in the long term in the development of our brain. They can affect our posture, mood changes, cognitive performance, and wakefulness throughout the day, and throughout our lives. Our mirror neurons are not well-equipped to evaluate architectural aesthetics differently in terms of sensory stimulation than the natural or social environment. In fact, our bodies seek the same forms of homeostatic resonance with architectural objects, making them partially accountable for meeting our needs of sensory nutrition.

Prof. Harry Mallgrave emphasizes how the new scientific paradigm underscores some of the profound theories that were already present in architectural phenomenology, but were only based on intuitive observation.⁷⁶ This means that phenomenology is now starting to be elevated from its esoteric circles, and with the support of neuroscience and neuro-aesthetics, it carries implications that even the most 'down-to-earth' engineers and planners can no longer discard. It reminds me of the words of Juhani Pallasmaa: "Every place, space, and situation is tuned in a specific way and it projects atmospheres promoting distinct moods and feelings."⁷⁷

Moreover, as Mallgrave points out, the biological view is at odds with how many architects themselves conceptualize buildings today. Often they rely with great emphasis on functionality or intellectualized ideas that result in some variant of abstract formalism, but little regard for the physiological and emotional impact.⁷⁸ Even in the academic environment, students are likely to get a 'bias training', that rejects their personal sentiments, while it simultaneously decreases empathy with the user's experience.⁷⁹

Especially with the ongoing dominance of computation, there is a great risk for abstract and conceptual diminution as leading incentives in architectural design. These trends move us further away from the direct experience of the user in all its sensational richness and intricacy. Nevertheless, Colin Ellard, a professor working on the intersection of architecture and neuroscience, demonstrates that this trend could be outbalanced to some extent by new technologies on virtual reality, bringing the experience of the digital building concept closer to the user.

Still, when it comes down to the early concept phase, the utilitarian rationale might have to make room for a crucial biological consideration of how the perception of architecture influences our well-being physiologically and psychologically. This, in turn, may have repercussions for the people who formulate the initial strategy and the resulting brief (Generic requirements document; PVE in Dutch).

These first two chapters have presented a qualitative overview of the biological relationship between our environment, body, and mind. Although it is not fully clear yet to what extent architectural aesthetics have an effect compared to direct physical stimuli or social triggers, certain clues can be traced by further studying biological and neurological theory, but this time we will be more focused on the specific role of architectural elements. In the next chapter, I will discuss how the taxonomic framework of neuroscience and architecture can be synchronized. This will prepare us for the second part of the essay, in which I will try to formulate some of our intrinsic needs concerning aesthetics based on evolutionary psychology and accompany them, as much as possible, with studies retrieved from evidence-based design.

CHAPTER THREE Neuroscience & Architecture

a) I Imagine I launch Revit from my desktop. From an empty plot, I extract four plastered walls in a square. I place a ceiling with integrated LEDs on top and I finish the room by placing a door. So far, not a shocking space in terms of architectural taxonomy. Yet, if you would take into account the fully embodied aesthetic experience of this space over a longer amount of time, the picture could change immensely. For example, in the prisons of Iran, the exact same room functions as one of the worst forms of psychological torture called white torture.⁸⁰ The prisoner here is isolated in a white room, with only white clothing, white tasteless food, and no views to the outside world. The first symptoms already occur in a couple of hours. And within months, prisoners lose all sense of identity, become delusional and psychotic, and undergo astonishing forms of pain. Human-rights activist Atena Daemi, a survivor of this torture, describes her experience as: "a tin which you feel is being pounded outside by a hammer, to crush it"⁸¹

b) I imagine after an intense day, I shut off my laptop as I am starting to get tired. I look up from my screen and get my

orientation back of the small messy room that I have been in for the last six hours. From a reflex, I pick up my phone, which triggers me with new demanding messages, e-mails, and the latest updates around Covid-19 in the news. My headache grows and I feel stressed, as I cannot ignore the industrial noises of the roadworks next to my window. I decide to go for a walk outside in an attempt to ease my mind. And why would I not combine this walk with getting the necessary groceries? Still a bit disoriented, I almost crash into a bicyclist, not being able to process the dozen traffic flows that are surrounding me at high speed. Next, I enter a dense shopping street, where my attention drifts further off by huge discount banners, LEDscreens, and bright colored logos. When I get into the supermarket, I'm standing mesmerized by the countless options, and I have no clue what to cook for the evening. And somehow. I come home with all kinds of stuff I did not intend to buy.

Neuropsychologists speak of sensory deprivation when there are so few external stimuli, the body's arousal system gets disoriented and eventually starts inventing stimuli itself in the form of hallucinations or other (painful) simulations (example a).⁸² At first, sensory deprivation can have a deeply calming effect, whereby a so called sensory reset refreshes your senses and sharpens them, like is the case with minimalism. However, when one is exposed to it for too long - already starting from a couple of hours – the homeostatic balance in the body starts to get lost, which finally results in a horrific, painful experience.

At the other end of the spectrum, there is sensory overload. When so many stimuli are being experienced by the body, it is incapable of processing them fast enough (example b).⁸³ While sensory overload is often used in entertainment to stimulate sensations of arousal, an overdose again causes detrimental psychological effects. People first start to experience symptoms ranging from numbness, fatigue or stress. But if any escape from sensory overstimulation is impossible, symptoms arise such as a pounding headache, panic attacks, or other forms of physiological stress; possibly resulting in seizures or heart attacks. It is clear that our bodies seek resonance within certain boundaries of stimuli. In this case, wild natural environments are often considered as most balanced in terms of stimuli, hence their nurturing effects. So, how can we chase an equally balanced stimulus diet when it comes to architectural aesthetics?

First off, let us have a specific notion of how architectural stimuli actually enter our body and reach our nervous system via our senses. Harry Mallgrave describes in his book *Architecture and Embodiment* very specifically on how the different senses are conceiving architectural aesthetics multimodally.⁸⁴ I abstracted his findings in the

scheme on the left (fig. 2). He makes a distinction between four categories of architectural elements: light, space, form, and materiality; and he links them to the various forms of sensory-related perception: visual, kinesthetic, auditory, tactile, and olfactory.⁸⁵ I will discuss some of his key remarks below and make additions based on my own research.



Figure 2: The embodiment of architectural qualities via the senses, based on the notions of prof. Mallgrave. The connecting lines tell how our bodily senses are influenced by light, space, form, materiality. The opacity of the lines express to what degree the aspects are related. (illustration by author)

<u>Light</u>

The mediums of light and ambience seem by far most ungraspable to discuss or measure, compared to the geometry related aspects in architecture. Still, they have been most central themes throughout architectural history. Light is the primary element that allows all other qualities of space, form and materiality for us to come alive. Most notably, modernists, ranging from Le Corbusier to Alvar Aalto have put much effort in studying the its significance. However, Mallgrave argues that except for some religious or iconic works, architects have had little freedom to uncover its full potential, despite the technical advantages we have acquainted over the last hundred years. This becomes unmistakably clear when we look at artists like James Turrell, Robert Irwin, Helen Pashgian and Olafur Eliasson, unlocking the full multisensory experience by radically devoting materials to the dynamics of light.⁸⁶ Their experiments and artworks have inspired a movement of neuroscientists to further discover its perceptual and psychological effect.

The workings of light can be explored by the way it is emerging in a specific range of colors, framed by edges of walls and ceilings, reflected by mirroring or matte surfaces, or filtered by translucent materials. This way, the spectator can be engaged visually but also kinesthetically, as how it guides us through space; and even tactically, as light determines how the material qualities come alive. Eliasson's The Weather Project seems significant in terms of evolutionary psychology. Basically, a whole set of orange lights are reflected by a large metal disk, which scatter the light as if it is a some sort of enlarged sun. People intuitively lay down, as if they are watching an impressive sunset. It might be the case this specific ancient experience, that was inherited form our predecessors, was exploited by the intensified parameters. Although these kind of experiences still need a lot of neurological research, developing further hypotheses around the perception of light, opens up an expanded field of potential experiments.



Figure 3: Olafur Eliasson's The Weather Project.⁸⁷ People intuitively lay down, embracing the full aesthetic sensations.

<u>Space</u>

The perception of space is biologically most relevant in terms of orientation and how we move through space. According to Mallgrave, this is much aligned with classic phenomenological theories like those of Martin Heidegger and Gaston Bachelard, hence their thoughts might still feel so relevant to us.⁸⁸ In contrast, many early modernists often held a more abstract view around the perception of 'spacetime', later countered again by people like Kevin Lynch with his work The Image of the City (1961).89 A more defined notion had yet to wait, as the postmodern movement with a semantic obsession, failed to give the qualities of space any substantial meaning. In countermovement, we find people like Christian Norberg-Schulz, Kenneth Frampton, Charles Moore, and Peter Zumthor. Today, we are finally able to ground the discussion better with the rise of bio-neurological studies on the perception of space.

First of all, our sense of orientation seems important in our cognitive abilities and memory. Some neurologists refer here to so-called 'place-cells', 'grid-cells', and 'bordercells'.⁹⁰ Variety, the spatial sequence, and landmarks naturally play a major role.⁹¹ Secondly, the experience of the space is above all motoric, whereby our vision and hearing can inform us beforehand how we can move through space.⁹² The way space allows our movements alters our sense of kinesthesia, meaning the awareness of how our limbs move through space and stimulate the proprioceptors in our muscles and joints. Concretely, this means that length, height, and the curvature of the space influences our posture, movements, our physiological processes, and even our perceived physical abilities.

Form

The qualities of form have long been studied by their geometric measures, like curvature, complexity, rhythm, and other factors of composition. In this respect, evolutionary scientists have tried to discover optimal parameters like Semir Zeki and Denis Dutton, focusing on universal artistic preferences.⁹³ Or Nancy Aiken and Nikos Salingaros, who have studied the multifaceted benefits of natural patterns, curvature and complexity.⁹⁴ Although we should certainly not discard their findings, Mallgrave urges that we should be careful in our interpretation of them. He emphasizes that the perception of form is far from static or quantitative in any sense, like we are able to do with two-dimensional graphics as photographs and paintings.⁹⁵

First of all, Mallgrave reminds us that we have evolved in a highly organically structured world, without any straight lines or self-evident order.⁹⁶ What is being perceived by our senses needs to be filtered and interpreted by different parts of our brain working together. In this way, we can distinguish physical objects from each other and emphasize one over the other. Moreover, with the aid of mirror neurons, as we have seen earlier, we recognize certain figures and give meaning to it, making our relations to objects far more interdimensional. Therefore we should focus on the holistic perception of form in their wider context, rather than the individual formalistic gualities. Mallgrave closes his argument that the concept of good forms may stay elusive, but that neuroscience can certainly inform us on what aspects matter in our perception.⁹⁷ Although I agree with Mallgrave's concerns (made in 2013), I do think now that institutions like the Association of Neuroaesthetics and the Max Planck Institute for Empirical Aesthetics have made significant progress in developing more specific tools we can adopt in practice. I will further demonstrate these in the second part of the thesis.

Materiality

Matter, originating from the words *materia* and *mater* (which means *mother*),⁹⁸ might be the most intimate form of architectural aesthetics. Unlike how we can simulate material objects in the computer with picture-mapping, the real experience of materials is felt by their wide variety, each with a different physiological and psychological effect. Think about color (dark-light, vibrant-pale), reflection (shiny-

absorbent), texture (rough-smooth), patterns (rigidorganic), weight (heavy-light), plasticity (hard-soft), thermic properties, acoustics and odor (natural-chemical). To fully perceive its physical qualities we need to close our distance, as we have to touch it and smell it, and - often in the case of young children - even taste it. Think for example about the experience of furniture, how it sits, how the materials touch your skin and how your whole experience is defined by the right balance of support and softness. Furthermore, even when we are only seeing materials, or hearing their acoustics, not only the occipital lobe (vision) or auditory cortex (hearing) are active, but also the somatosensory cortex (touch). Our brains perceive the world so multimodally, that we simulate the direct feeling of the materials through our whole body. In this way, materiality matters a lot in our sense of relaxation or stimulation.⁹⁹

According to Mallgrave the sensory experience of materials is often neglected today through industrial production, leaving us with standardized and unarticulated materials, like plastics, but also concrete, glass or asphalt.¹⁰⁰ He stresses that the human imprint on these materials might make a crucial difference in our ability to sympathize with them. For example, the concrete walls of Tadao Ando are very different than the concrete slabs of an industrial parking lot.

"We shape our self to fit this world and by the world are shaped again. The visible and the invisible working together in common cause, to produce the miraculous. I am thinking of the way the intangible air passed at speed round a shaped wing easily holds our weight. So may we, in this life trust to those elements we have yet to see or imagine, and look for the true shape of our own self, by forming it well to the great intangibles about us."¹⁰¹

- David Whyte -

PART TWO

Origins

The existential affiliations of our Human Nature





"The innate tendency to focus on life and lifelike processes".¹⁰²

– Edward O. Wilson –

Life, a miraculous phenomenon, so mesmerizing that its origins have been debated in continuous fashion across the past millennia, sprouting numerous mythologies, rituals, philosophies, and sciences. It is something deeply embedded in the essence of our being, because after all, we are life. We share this wonder with all other organisms, and without it, we biochemically fall apart. Yet, we know surprisingly little about life. The natural processes that define it seem so complex, that it is still impossible to fully replicate in a lab from scratch. And although the study of single organisms is increasingly covered by biology, the study of living systems is only at its very start under the heading of ecology.¹⁰³ The cooperation of different forms of life is far greater and more complex than we can perceive with the bare eye. Somehow, when we surround ourselves with complete natural ensembles, that transform the soil, the air, and filter the light, we thrive in our sense of being alive as well. Neuro-aesthetic studies have largely proven that this healing connection with nature stretches far beyond physio-chemical reasons, like improved air quality. But *how* this exactly works biologically, still remains a mystery.

Despite the existential need for the presence of organic phenomena, a biophilic approach have been far from ordinary in the industrial era. Most particularly, Modernists in the early twentieth century initiated the idea of buildings as machines,¹⁰⁴ as they were fascinated with the rationale of efficiency. As the market adopted their rationalistic ideas of functionalism and translated it into economic reductionism. the majority of Modern buildings today carry little message for life or living systems. The integration of flora and fauna is still often deemed as expensive, in need of maintenance, or only decorative in its purpose.¹⁰⁵ And in the modern city, where we spend on average ninety percent of the time inside buildings,¹⁰⁶ green strokes and public parks are minimally in our direct presence. In countries like the USA, the average office worker does not even have views outside.¹⁰⁷ Also within architecture, we are not always rewarded when we integrate the nature that we actually do have as an option. I remember how the use of plants and trees are sometimes called out as 'architectentroost' (meaning consolation for architects), referring to them as a compromise to the design or even draws suspicion by hiding design flaws.

Evolutionary-wise, this organismic deprivation is something unprecedented in our lineage. Until the rise of

industrialization, our species and its predecessors have known little else than surroundings that were high in biodiversity. They demanded constant attunement in their search for an ecological equilibrium through the laws of nature.¹⁰⁸ We embody this search ourselves with a process called homeostasis, orchestrated by our nervous system as mentioned in chapter two (see hypothalamus and brain stem). Basically, all natural systems tend to fall into disorder, and homeostasis is the biochemical process that opposes it. Thus, it chases an essential order, a biological architecture, that keeps us alive and we inherited an instinct to surround ourselves with entities that do the same. Maybe via our senses, our bodies replicate the living patterns that are surrounding us. When we replace these biological stimuli with more nihilistic or homogeneous aesthetics, we might as well surround ourselves with stimuli of lifelessness. Beyond physiological homeostasis, exposing the senses to nature is widely proved to help concentration and cognitive performance, and decrease fatigue, anxiety, depression, and pathological disorders.¹⁰⁹ So how do we integrate a balance of natural stimuli into the built environment?

Stephen R. Kellert has devoted much of his life to developing principles in how biophilia can be satisfied throughout the built environment. In his book *Nature by design*, he has outlined these principles extensively.¹¹⁰ Although biophilic design is often associated with green

walls and installing plants, its practice is not so arbitrary. Kellert stresses the ecological and psychological principles behind the individual measures, which arise from underlying emotional values of a connection with nature. He argues for aspects such as cohesive ecosystems, biodiversity and personal and communal connections with nature (e.g. gardening). Biophilia is therefore more like a philosophy, or a guiding theme rather than a recipe, nonetheless based on empirical evidence. Much compelled by his line of thought, I continued his example by developing a thematic framework of my own, that adds to biophilia four other categories, set out over the next chapters. Like biophilia, these affiliations find their roots in our shared evolutionary history, making them cross-culturally relevant. Within each theme I provided a toolset, based on environmental psychology and neuroaesthetics, to make the insights directly applicable to the design process.

Light/ambiance. In terms of light, our relationship with the natural environment goes far further than the quantitative doses of daylight that we crave via our skin to produce vitamin D. The ambiance of the sky is constantly changing throughout the day, with its energizing light in the morning and calming light around sunset. The clouds filter the sunlight sporadically and spread a white calming presence. The changes inform us about the time of the day and the time of the year. They give a most natural orientation in our lives, hence many rituals are determined around seasonal changes. A qualitative and abundant connection with the sky has been proven to be crucial in healthy circadian rhythms, increased visual comfort, improved heart rate, and concentration.¹¹¹ Large vertical windows and skylights can be therefore argued to be crucial in any building. Additionally, we should be aware of how much light windows transmit, as normal windows already block substantial amounts, decreasing the healing effects of daylight.¹¹²

We can strengthen the connection with the natural ambiance further by allowing small breezes of air into the building that touch our skin, ideally still carrying the odor of flowers and plants. Airflow variability appears to be an important aspect in buildings in terms of comfort, hence the importance of operable windows, as opposed to closed ventilation systems.¹¹³ Likewise, natural a-rhythmic sounds like streaming water, rustling grasses, and chirping birds have a positive effect on our concentration and overall well-being, in contrast to machinal or traffic sounds.¹¹⁴ As it is still hard to replicate these natural stimuli artificially, the potential of architecture is to facilitate and frame them optimally.

Space. Varying from open grasslands to dense forests, the natural environment exhibits a wide variety of spaces. Rather

than straight walls, nature marks these spaces by alternations in the landscape with hills, rocks, trees, and bushes, all adding to a diverse set of spatial parameters. While a highly organic alternation could be said to be chaotic and inefficient, it appears to be a perfect match for our senses in terms of novelty, horizon, and other sensory engagement. In this line, city plans with intrinsic fractal properties for example tend to be more preferable.¹¹⁵

Natural spaces are in sharp contrast with the spaces of many offices and schools, where attention is often required at singular focal points throughout the day, making us tired, stressed, and less capable to process our environment substantially. Walks in nature, or the Japanese practice of *shinrin-yoku* ('forest bathing'), are argued to offer a perfect sense of stimuli triggering our attention to various points in our surroundings at the right pace. ¹¹⁶ This might explain its drastic healing physiological and psychological effects².¹¹⁷

Especially in urban settings and inside buildings a connection with nature is far from abundant. Architects can

² These include according to the researchers: "Remarkably improving cardiovascular function, hemodynamic indexes, neuroendocrine indexes, metabolic indexes, immunity and inflammatory indexes, antioxidant indexes, and electrophysiological indexes; significantly enhancing people's emotional state, attitude, and feelings towards things, physical and psychological recovery, and adaptive behaviors; and obvious alleviation of anxiety and depression."

integrate natural spaces into their buildings by focusing on transitional spaces between the interior and a surrounding natural landscape or garden, or even include green spaces in the interior of the building.¹¹⁸ Stephen Kellert advices a mixture of natural elements such as shrubs and trees, colorful foliage and flowers, native plants and natural pathways (see fig. 4).¹¹⁹ Additionally, we should try to strive for diversity in spaces, with alternating sight-lines, room dimensions, and shapes, transparency and enclosure, chasing a pristine balance that feels comfortable and timeless.¹²⁰



Figure 4: Piet Oudolf in collaboration with Peter Zumthor at the Serpentine Gallery, United Kingdom.¹²¹ The project is a good example of the maximum integration of biodiversity into the building, whereby the architectural spaces is embraced by the architectural envelope.

Form. Whether it were the measures in ancient Greek temples, the tree-like columns in Gothic churches, or the plant-like ornaments in Art Nouveau, the aesthetic principles of nature have been foremost copied in proportions, patterns, shapes, and textures of building elements. It is an aesthetic tradition that dates back to the first forms of culture and has appeared cross-culturally over time. So far, it seems that particularly since *technical* functionalism (not to be confused with the functionalism of Louis Sullivan) we have aesthetically broken with nature as a direct source of inspiration for patterns and ornaments. I frequently hear how we decry them now as kitsch, since old-fashioned associations like floral wallpaper or neo-classic decorations appear inevitable. But why exactly have natural shapes and patterns appealed to us for so long?

Although research on aesthetic preferences is still in development, the first indications are that natural rhythms and patterns simulate a right balance of complexity that enhances our positive interest towards our surroundings, thereby engaging and nurturing our brain and body.¹²² Throughout evolution, they probably have played a vital role in our capacities for rational thinking, problem solving, curiosity and creativity.¹²³ Design principles that fall into this order are the Fibonacci sequence, the Golden mean, symmetry, fractals, phyllotaxis (the arrangement of leaves on
an axis or stem), and other forms of progressive repetitions. In contrast, non-fractal artwork and overly complex patterns are likely to induce stress and are associated with headaches and nausea (for example Moiré patterns).¹²⁴ This emphasizes the importance of surrounding ourselves with consciously proportioned ornamentation throughout our daily environments. Since the eradication of ornamentation by economic or reductionistic paradigms, this critical note can definitely be seen as a call for drastic rediscovery. Or maybe it can be a progression on a cross-cultural tradition, that was so natural to us for most of human history.

Materiality: In line with natural forms and patterns, natural materials – ranging from different types of stone, clay, wood, thatch, skin – have been fundamental ingredients in our built environment. They were local out of necessity, and vernacular traditions processed them in authentic ways. The richness that was contained by the material itself, was further exposed in its tactile qualities by the craftsmen, commemorating the local identity. Eventually, the weathering effects on these materials contributed to a natural look, and added a historic dimension of time.¹²⁵ However, by terms of strength, efficiency, and accountability, we have massively abandoned natural materials to grant room for an endless array of fabricated materials, like steel, concrete, plastic, and glass.

Nevertheless, this obsession with manufactured or synthetic materials has come into reconsideration under the critique of models for circularity. Generally, the fewer materials are processed, the more easily they can return to the natural landscape without ecological harm.

Now, the first studies suggest that our connection with materials is far more than cultural alone. In line with the cognitively appealing patterns that are omnipresent in natural materials, our bodies are likely to have a positive physiological response. One study showed for example that when a room is covered by wood for more than 45 percent, diastolic blood pressure drops to healthy levels, and people experience an increase in comfort.¹²⁶ Another study showed that natural colors, in particular greens, can increase cognitive performance.¹²⁷ While more research have to be awaited, the return to natural materials promises significant benefits to our well-being, not to forget improved ecological circularity.

Biophilia is the most central theme among the five intrinsic needs that I have formulated throughout the thesis. Since the natural environment is the environment we have evolved in, it would naturally offer all the aspects we are genetically inclined to seek for. Therefore it can be considered the mother of all the other themes. Nevertheless, our different needs can be aesthetically pleased in different, more specifically targeting ways, as I will demonstrate in the next four chapters.



CHAPTER FIVE

Refuge & Intimacy

The intuitive need to seek safe and embracing places that shield from threatening or disturbing influences

No different than most mammals, we have evolved as a vulnerable species, that has been challenged by various survival pressures of the environment. These ranged from indirect threats such as harsh weather circumstances to direct threats like enemies or predators. In order to defend ourselves and our offspring from these triggers, we have an inherent instinct that drives us to places of refuge and subconsciously, we still watch out for them at any time.¹²⁸ These are places in which one can withdraw (with a few others) from its surroundings by seeking mostly protection from behind and overhead.

Places of refuge became more particular to our species through the course of evolution. In the wild East-African environment, refuge must have often resembled the edge of a forest, so that our primate ancestors could hide in the bushes or trees while keeping an overview (prospect) on the nearby plain.¹²⁹ We still seem to show this preference today, and referring back to biophilia, not all types of forests

are preferable. For example, high dense woods (such as industrial forestry), are likely to evoke more fear than relaxation.¹³⁰

Around 2.5 million years ago, after the mastering of fire, the hearth became a crucial place in the existence of our Homo Habilis ancestors.¹³¹ Edward O. Wilson wrote in his book The social conquest of Earth, on the special role of the fireplace in our social and mental development.¹³² With a fireplace, we not only attained protection from wild animals but also practiced unique social rituals like cooking, sharing food, exchange stories and holding ceremonies or feasts.¹³³ It became a central place for small groups to gather and return to after hunting and foraging activities. With the help of cooking, our diet became more dependent on meat, which is argued to have helped the growth of our brains throughout the Pleistocene.¹³⁴ Together with the socio-cultural rituals, this could explain the particular development of our social intelligence and group behavior.¹³⁵ The fireplace, although often banished in Modern housing, still has a powerful impact in defining space for good reasons

Further, in terms of architecture, the division of labor that appeared during this social development, resulted in the first 'primitive huts', constructed forms of refuge. They date back to at least 1.5 million years ago, improving circumstances of rest and safety during sleep.¹³⁶ These huts were to us no different than nests are to birds. Our models for nests eventually evolved into dwellings, places that meet our affiliation for refuge and intimacy in the most existential way. After all, there are seldom words so emotionally charged as the word 'home'.

The intrinsic need for refuge might be guite obvious. Do we not all need a place to live, to hide from the weather, feel safe and be in peace with our loved ones? Shelter is considered as a human right for good reasons,¹³⁷ but architecturally, we often deal with this need from a purely functional or technical perspective, and less from a psychological and aesthetic (read: sensory) point of view.¹³⁸ Colin Ellard describes the importance of the perception of refuge or safety related to architecture as follows: "In built settings, difficulties are when effective responses to perceived threats [which can be social], for one reason or the other, are not available to us. In such cases, we are forced to dwell in uncomfortable locations of high, perceived threat, giving rise to a cascade of neural and endocrinological responses that may produce mental pathologies or decrements of our physical health."139 I associate this personally with Greek refugee camps, with their lack of hiding spaces and privacy.

Also in many Western urban environments these pathological patterns (anxiety disorders, clinical depression, schizophrenia) are apparent 'for reasons not yet well understood', according to Ellard.¹⁴⁰ They may vary from socioeconomic to exposure to toxic pathogens, but he also argues the built environment unmistakably plays some role. In his experiments he observed with brain-scanning technologies the live responses of people walking through different types of streets. Lively streets with many possible interactions between inside and outside (high permeability) evoked totally different kind of neurological responses than long, closed, and monotone streets for example.¹⁴¹ In the first case people had a calm and attentive physiological responses, while the latter case caused stress or fear within a couple of minutes.

It appears there are distinct architectural features that can help with feelings of comfort and security.¹⁴² When these conditions are being met aesthetically, it can induce an experience of restoration, calmness, and improved concentration (lowered blood pressure and heart-rate), and reduce a sense of irritation, exhaustion, vulnerability. It seems that places of refuge therefore is aligned with parasympathetic activity in the brain as mentioned in chapter two, which is associated with a restful, inward oriented and intimate behavior.

Light/ambiance. In urban settings, it is well known that we can reduce fear of crime by installing street lights (even when the crime rate actually stays the same).¹⁴³ Also the interior lights of buildings might help to encourage visual

connections with secure settings, giving a sense of safety. In more intimate settings a relaxed state of mind can be encouraged by installing lower placed warm lights, which are preferably adjustable. Most obviously we associate these tools with dwellings, restaurants, spa's, but maybe we could also apply them occasionally in meeting centers and offices, promoting more relaxed and soothing behavior.

Relevant to the building's orientation, watching the sunset helps our bodies to adapt and set into a more relaxed state of visual perception. Most importantly, we need to avoid blue light in the evening that blocks the production of melatonin.¹⁴⁴ This is crucial for maintaining circadian rhythms and be able to fall asleep at night. When there is a lack of melatonin we suffer insomnia, causing stress, fatigue and depression. All these advices may be intuitively evident to some designers, yet, how often do we refuse or forget these relevant aspects, regarding temporary urban spaces and buildings?

Space. First of all, to establish a secure and comfortable public space, we need to control the concentration of people, especially in the city where you are constantly surrounded by strangers. A density of people that is either too high or too low, can cause extra triggers for stress and even pathological syndromes.¹⁴⁵ Studies have shown that people can get mentally used to social threats in case of crowded spaces,

but their bodies keep reacting physiologically the same nonetheless.¹⁴⁶ Another example shows how low density buildings result in higher social cohesion.¹⁴⁷ At the same time, single households contribute to collective loneliness.¹⁴⁸ Particularly at a workplace, personal customization of spaces can induce a sense of ownership, strengthening social cohesion.

Within buildings, the feeling of embracement, privacy and relaxation can be facilitated by limiting visual and auditory access.¹⁴⁹ To promote refuge and security visually, think about the way that *semi-enclosed* spaces give cover from overhead, the back, and the sides, but preserve visual possibilities for orientation on the surroundings (prospect).¹⁵⁰ Within bigger spaces, lowered ceilings, canopies, temporary walls all add to a narrowed spatial perception. It is important to maintain a range of spatial possibilities to the user, so that a claustrophobic effect is never imposed. Further recommendations range from the use of shades, curtains, big couches, and such.¹⁵¹

Form. On the level of the street or a large public/communal space, façade permeability in the form of hiding places and visible escape routes might be most important to encourage feelings of comfort and security.¹⁵² Forms that guide the interaction between interior and exterior might help, as mentioned earlier. Furthermore, according to Oshin

Vartanian, sharp pointed edges in buildings can cause stress and even fear, as the orbitofrontal cortex and singular cortex registers them as possible threats.¹⁵³ In the same line, we largely prefer rounded shapes instead, especially on the level of the interior. Stephen Kellert promotes a fireplace or hearth like areas to encourage relaxation and intimacy.¹⁵⁴ In this case, he argues that the absence of real fire could be compensated by the use of ornamentation or artwork that resemble its aesthetic qualities.

Materials. Auditorily, excessive street noise or crowded spaces, can cause huge stress. It is therefore recommended to have proper acoustic insulation, limiting echoes and reflections. Decorative examples are curtains, carpets, and wall/ceiling panels. However, especially when there is a connection to natural or social sounds in the background (raindrops, chatting people), it is preferrable to filter them only to a moderate extent, to enhance cognitive performance.¹⁵⁵ When sounds are totally eradicated, you create circumstances for auditory deprivation, making it actually harder to concentrate.

In terms of sight, the use of mild and natural colors is preferable, whereby, cool colors (like blue and green) are likely to have a more calming effect.¹⁵⁶ Further suggestions include the use rough textures on the exterior of the building and soothing materials on the interior.

CHAPTER SIX Exploration & Play

The urge to seek novelty, mystery and horizon, and playful interaction with the environment

Aligned to the biophilic affiliation, there is another vital force to be distinguished in our human nature, called curiosity or the 'seeking instinct'.¹⁵⁷ Since the refuge instinct is characterized by parasympathetic activity, the seeking instinct is complementarily related to sympathetic activity in the brain. It means that curiosity is our drive that gives us the courage to step into the world and embrace new places that give us a reward.¹⁵⁸ It widens the perception of our reality and let us imagine what is beyond. Hence, it must have been the instinct that gave our Sapiens ancestors the courage to migrate from East-Africa around 70.000 years ago onto the rest of the globe, always looking for new horizons.¹⁵⁹ They had to face new climates, challenging landscapes, dangerous animals, and sometimes split with their native communities. And this all seemed to be dedicated to the search for a promised land, full of new plants, fruits and prey. 70.000 years ago we reached central Asia, followed by Australia (50.000 y.a.) and Europe (40.000 y.a.).¹⁶⁰ Around this time, we met (or clashed with) other Homo species, like Homo Neanderthalensis and Homo Heidelbergensis, now all extinct. The American content was reached (12.000 y. a.) and our youngest territory is New Zealand, (1500 y. a.).¹⁶¹

This instinct gave us many physiological and psychological advantages. Neuroscientists Celeste Kidd and Benjamin Y. Hayden summarize the existential role of curiosity as follows: "In the domain of evolution, it seems that curiosity can tentatively be said to improve performance, yielding fitness benefits to organisms with it, and is likely to be an evolved trait. In the domain of mechanisms, it seems that the drive for information augments internal representations of value, therefore biasing decision-makers toward informative options and actions. It also seems that curiosity activates learning systems in the brain. In the domain of development, we can infer that curiosity is critical for learning and that it reflects both external features and internal representations of own knowledge."162 So far, this demonstrates the importance of curiosity for our overallwellbeing.

Still, curiosity might not have always been so beneficial to our species for thriving on the long-term. Much like the myth of Adam and Eve warns us, the *forbidden fruit* could be a symbol for the irreversible decisions that have been made in our lineage. Philosophers and theologists refer here to the *sins* of lust or excess: the desire to always want more, even if it harms us or our environment in the long run.¹⁶³ In this sense, curiosity – as linked to a desire for novelty and excess – might have driven us away from the Savanna, that we were so finely attuned to. Across cultures, we depict paradises as great fertile landscapes, like gardens or green fields, possible signs of nostalgia to the habitat in which we once thrived. The word paradise non-coincidentally originates from the old Iranian word *paridaiza*, meaning both paradise and garden.¹⁶⁴

Nevertheless with our thrill for new knowledge we also developed the tools that enabled us to survive, even in the hardest of circumstances, like the Sahara desert, Siberian icescapes, or far up the Himalayas. Apart from our planning abilities, humans have a very long stamina, outcompeting many other mammals with our persistence and patience.¹⁶⁵ Further, in combination with our advanced social intelligence, we were extraordinarily efficient in hunting and gathering activities allowing our diet to become more focused on meat.¹⁶⁶ Although we managed to survive, many other mammals got extinct soon after we settled in. In fact, our destructive ecological footprint already started to appear a long time ago, ever since we mastered fire for hunting purposes. The disappearance of many species correlate with the arrival of Homo Sapiens, which leaves us few other explanations than our severe ecological role.¹⁶⁷ Our desire for excess and expansion can bring us advantages and riches, but also environmental devastation. With the industrial tools of the last couple of centuries, we even managed to single-handedly cause climate change. This all seems mostly the result of the fact that we did not want to settle for lower standards of comfort, pleasure and expansion. Overconsumption and mass-obesity point in the direction that we find it overall very hard to restrain ourselves with sustainable values; and even the people around us that are trying very hard, cannot escape a minimal footprint on to our most precious habitat.

Curiosity or exploration appears not immediately as the biggest theme in the architectural discourse. Nonetheless, especially in the Modern urban environment of today, they might be the number one factor commercial designers strive for. Colin Ellard describes how in the rise of mass-consumption, when shopping became leisure, chain stores and shopping malls have developed and tested all kinds of tools to engage our attention as long as they can.¹⁶⁸ Even before them, theme parks, and exceptionally casinos have done numerous experiments on the use of aesthetics (patterns, curvature, lights, materials) to guide people's behavior and feed patterns of addiction.¹⁶⁹ The corporate tricks were developed within a private domains of companies, far away from the architectural scholars, which might explain why we still know so little about the dynamics

between aesthetics and behavior academically.

In line with Ellard's observations, I think it is very problematic when the primary environments that draw our curiosity in the big city, are commercial in essence. I don't think we should normalize the phenomenon of shopping malls and streets as our most essential public spaces, commodifying social engagement and interaction. It is devastating to both ourselves and the rest of the biosphere, to exploit our instinctive need for novelty, entertainment and social engagement, by creating shopping addictions and all its devastating ecological consequences. Simultaneously, I wonder how much our surroundings can still keep up in engaging us with a doses of captivating stimuli, as many of us appear to struggle to stay off their phone anyway. Thus, I hope with the design tools I will describe below, to be able to contribute to an (artistic) countermovement in urban public spaces and buildings. By creating appealing works, we might be able to attract people and bring them together in the streets, while shifting away from unsustainable habits. We can trigger them for instance to take part in playful behavior, or other forms of physical exercise.

Light. Most importantly, daylight, emitted by blue skies evokes sympathetic activity in the nervous system, actively awakening the body and improving creativity and cognitive performance. Apart from this insight, *artificial light* opens up many possibilities to draw our attention, hence it is used in so many billboards, logo's and traffic boards. However, there seems to be fine balance in its use that is not causing fatigue or stress in case of long exposure. Therefore in buildings, it is recommendable to use daylight as much as possible. Interesting patterns can be created by patterned frames, colored glass, textured glass and the like. Strong rhythms, high contrasts, and surprising reflections can all add to encourage curiosity of course.

Space. Interesting spaces occur in all variety, activating our dopamine reward systems. Yet, many urban spaces are surprisingly *boring*, because of their predictable and monotone sequences, resulting in sensory depriving routes.¹⁷⁰ Large and longitudinal dimensions that facilitate large traffic flows is certainly one factor to a lack of spatial diversity. Also Modern square grids, compared to those which are organic (e.g. medieval) effectively reduce our curiosity.¹⁷¹

The key to a compelling space is *mystery*. According to Ellard, mystery as a spatial quality can be defined as "the likelihood that further investigation of a scene will yield new information."¹⁷² Mazes and labyrinths are probably the most primary archetypes, but interesting spaces can also arise without burdening complexity or triggers for fear responses. The most apparent advice seems to be the use of

rounded/curving walls, sinuous walkways and oblique corners and edges (over sharp ones), continuously changing the perspective of the perceiver.¹⁷³ Further, there is a correlation between the speed of walking and ceiling height, whereby the greater the ceiling height, the more physically and mentally engaged people are likely to become.¹⁷⁴ The dynamics between prospect and refuge spaces are most important. Effective surprising single elements can be visual or auditory interventions, such as obscuring frames, hiding places, tunnels, jumping ceiling heights etc.¹⁷⁵ Here, we need to remember to trigger all the different senses, like tactile and olfactory variation.

Besides mystery, risk appears to be another important factor. In both cases we need to prevent triggers for stress or actual fears, such as dark shadows, short visual depths, and physical safety risks.¹⁷⁶ Positive perceived risks can be great heights, with the aid of balconies, atria, glass flooring, small bridges, stepping stones over water etc.¹⁷⁷

Form. First, I refer to the biophilic forms and patterns described in chapter four. In essence it is important to design ornamented and detailed features (think about old building facades), instead of predictable, homogeneous repetition (like modern, standardized facades). Our interest can be further caught by drawing multiple affordances, actively provoking the body to behave in surprising or

challenging ways. The presence of playful affordances and artistic stimuli is crucial for children to prevent the development of pathological disorders like ADHD.¹⁷⁸ This explains the importance of well-designed playgrounds. Yet, how many daring shapes and attributes do we successfully apply in the adult-oriented environment? Environmental deprivation correlates with maladaptive risk taking behavior and vandalism.¹⁷⁹ In terms of physical activity, the seated position is such a second nature, that we often don't stand still about the fact that we are applying this throughout most of the day, while our bodies have evolved for frequent kinesthetic alternation. Participation of the whole body does not only trigger curiosity, but also encourages spontaneous social exchanges and therefore social bonding.¹⁸⁰

Materials. Besides bright, highly contrasting colors, shiny and reflective surfaces have proven to catch our attention as we are caught by our own reflection. In particular, warm colors (red, orange-yellow) are likely to stimulate sensations like excitement or arousal, which might be helpful to evoke playful attitudes.¹⁸¹ Further, the use of tensile structures and fabrics invite the user to play along, actively searching for its boundaries and modalities. The use of natural elements like mud, sand, air and water are interesting for people who are not afraid to get even more tactically engaged, like young children.



The intrinsic affiliation for human expression and an empathetic association with the environment.

While we share the first three affiliations with many other animals, the affiliation for our own creations in the form of arts and crafts is exceptional.¹⁸² Yes, beavers make dams, birds make nests, and ants create whole networks of spaces underground. This might be very comparable to the tools, huts, and paths we have been making ourselves, as they are all directly beneficial for individual or group survival. Art on the contrary, distinguishes itself by going beyond direct practical benefits, or even leaves these behind. Why is our species inclined to use energy and resources for things that *seem* not completely necessary?

Our primate ancestors, apart from some stone tools, most probably did not have art yet. Their aesthetic (read: sensory) preferences were directed at their natural or social environment. The formation of a tree or the expression of a fellow primate's face had self-evidently value, as they communicated information that we needed to survive. Their subjective perception, and frame of emotional evaluation was naturally tied to biological advantages. We still carry the affiliation for these pleasurable aesthetics with us, as explained earlier. However, what is idiosyncratic to our species, is that we managed to invent forms of *artificial* sensory input, by manipulating materials in deliberate shapes and orders.¹⁸³ These artifacts could therefore help us to *simulate* distinct emotional experiences like pleasure, curiosity or fear.¹⁸⁴ Therefore they excite passion for actions, but also alter the structure of our brain (mostly in the cerebral cortex), hence that art is key to our well-being.¹⁸⁵

One of the earliest found artifacts that some consider as an example of this are Acheulean hand axes, that date back till 1.5 million years ago.¹⁸⁶ As they were sometimes shaped in explicit oval shapes, they are argued to aesthetically exceed their practical value. More compelling archaeological evidence is a bit younger, such as ochre body paintings (230.000 y. a.), mortuary sites, ornamental shell heads and bones (130.000 y. a.) more sophisticated tools and ornaments (100.000 y. a.) ochre crayons, abstract patterns (75.000 y. a.) and *nuanced speech* (40.000 y. a.). The findings show out that Neandertals shared similar forms of art with Sapiens, strengthening the argument that our artistic inclination must date all the way back to their common ancestors (Homo Erectus).¹⁸⁷

That we managed to discover this short-cut for pleasurable aesthetic sensations and made purposeful

attempts to create these simulations, is only possible thanks to our advanced reason and planning abilities (prefrontal cortex) and refined motoric skills and kinesthetic sense.¹⁸⁸ In contrast to most other animals, we can imagine things that don't exist yet, and have the precision of our hands to create the tools to bring them to existence. Historians refer to this change as the cognitive revolution, that happened during the Upper-paleolithic period (c. 70–12 ka).¹⁸⁹ This is the same time that language, abstract thought, and syntactical language must have emerged.

However, what advantage did art have for us in terms of evolution? Why was is so necessary that it became deeply entrenched in our human nature? Artistic aesthetic dedications might as well be argued to be wasteful and distracting, compared to activities that were directly beneficial for our individual survival and offspring, like gathering food, and making spears. It draws us to a wellknown problem in Darwinian theory. Darwin himself was obsessed by the tail of a peacock, because as beautiful as it is, it makes the bird more vulnerable to predators.¹⁹⁰ Hence he came up with his theory of sexual selection, arguing that the peacock uses his tales to impress peahen. His extravagance would be a sign of excess to the female, demonstrating that he is above the standards of mere survival and is therefore an extra capable mate. These courtship traits have later been projected on the

development of arts and crafts among people, whereby mates would impress each other by the use of jewelry, dance, music etc.

In terms of group survival, art has been very vital to our social structures from the very start. Archeologists speak of the creative explosion around 60.000 years ago, which coincides with the migration towards the Eurasian continent.¹⁹¹ As our cooperation became more important for collective survival, art is likely to have started as the tool to communicate emotional messages and values, encouraging order and balance in the social and natural habitat.¹⁹² The artistic instinct is can be interpreted as a homeostatic impulse to construct specific aesthetic experiences, which compensate for emotions like grief, anger, sadness, and amplifies joy, hope and courage.¹⁹³ Additionally, symbolic representations, or metaphors, can be experienced emotionally thanks to our mirror neurons, which enable us to interpret the intentions of the artist empathically. On the collective level, art was used for creating emotional or transcendental group events, such ceremonies and rituals, which emphasized communal values, justice and hierarchy.¹⁹⁴ Therefore art seems to have evolved as a very different medium than the intellectual exercise of conceptual abstraction as we commonly see in contemporary art and architecture.¹⁹⁵

The embodied experience of art stresses the role of

artistic expression through the built environment. The proportions, materials, patterns, ornaments, and even (mythological) symbols all contribute to a rich emotional and meaningful experience of space through our senses and mirror neurons. And as we experience our environment mostly subconsciously, it is not necessarily dependent on intellectual knowledge or sophisticated taxonomy. For example, Mallgrave implies that metaphorical speech on how we experience space and relate to it emotionally is a lot more informative than initially conceived. In contrast, conceptual or morphological abstractions, often amplified by computation, might actually be reductive to the real embodied experience. This means that when we experience a building as 'cold, anonymous, suppressing', we should take that more seriously than an innocent analogy.

Art is the medium with whom we give meaning to the built environment, and the neuropsychological sciences suggest we collectively need that expression as a precondition to thrive as a society. Cookie-cutter towers, endless parking lots and logistic junk spaces not only deprive our senses, but can also make our individual existence feel meaningless, in a larger whole of ubiquitous duplication. It might be up for politics, whether it is the responsibility of local residents, the government or the private sector to enrich our built environment artistically. But what I am trying to argue, is that art can no longer be seen as an excessive luxury. Personally, I see street art and graffiti exactly as an expression of the artistic instinct to compensate for sensory depriving, oppressing, or depressing spaces. Instead of seeing it as public demolition we can also see it as a symptom that people are seriously thirsty for a reflection of their personal identity, or a manifestation of something emotional.

While the previous chapters were dedicated to particular affiliations, like biophilic restoration, security, or curiosity, I think that art is the one category that cannot be framed by any standards or specific tools. Art has always had a role in the creation of novelty, hence it is exactly known for breaking with rules and fascinate us with new perspectives and experiences. Moreover, it seems very much dependent on a cultural and historical context. Yet, it is interesting how for example Bach is appreciated in Japan, aboriginal paintings are adored in the West, and jazz music led to its own Nigerian subculture. This means that the appreciation of art can neither be culturally dictated, nor restrained. Also, some art-forms seem to be more universally appreciated than others. Therefore, some neuroscientists have differentiated on this matter by trying to formulate objective characteristics for good art. Most prominent figures are Semir Zeki, Dennis Dutton, Nancy Aiken and William Hirstein. While their efforts can be very compelling, Edward Vessel has guite recently demonstrated how objective standards for aesthetic appreciation only appear to be

consistent with natural environments and human faces, not so much with more abstract art-work as it is too much influenced by personal tastes and associations.

In terms of architectural recommendations, we can draw our attention to numerous factors to trigger our 'artistic instinct'. I think it is therefore very hard to formulate any generic recommendations. But to not leave the reader with empty hands, I have tried to formulate a couple of ideas to consider throughout the design process.

- Symbolic representations and ornaments opposed to merely technical details.
- Deliberate light accentuations opposed to abundant interior lighting.
- Scenographic spatial sequences opposed to predictable or economic repetition of spaces.
- Captivating acoustics when it comes to the experience of sounds and music.
- In terms of building materials, I recommend personal detail and craftmanship as opposed to mass-fabricated element, since we empathetically can easier relate to the intentions of the artist.



Awe & Transcendence

The search for enthralling experiences and the experiential understanding of oneself in position to a greater whole.

The experience of awe transcends the other aesthetic experiences in its rareness and emotional complexity. Colin Ellard describes it for example as the 'unique combination of a sensation of beauty and fear', and can be considered a distinct emotion. It is an experience of vastness, in which our body has a hard time in processing the sensory input, most typically characterized by having goosebumps.¹⁹⁶

Neurologist Edward Vessel has found how the state of awe or transcendence only arises when an aesthetic experience is so emotionally moving, our body resonates in self-conflicting ways, which need active reconfiguration of the mind.¹⁹⁷ On one hand, the attention networks of the brain (insular cortex, prefrontal cortex etc.) are fully engaged, simulating a so-called 'flow-state'. In this case we are fully in the present and everything around us disappears in the background. It might resemble the emotional state described at *Exploration and Play*. On the other hand, the experience of awe is simultaneously linked to high activity in the *default* mode network. The default mode is normally the opposite of the flow state, when the wakeful attention is not directed at a specific goal or target, like remembering the past or thinking about the future. It is when somebody zooms out and intuitively reflects on their position to a larger context, whether that is autobiographical, social, or otherwise.¹⁹⁸ Therefore it is crucial for a sense of self-awareness and the experience of personal identity. However, when activity in the default mode network is too high, it correlates with paranoia and schizophrenia.

The combination of these two states can lead to a so called transcendental or spiritual experience, in which one is totally present in the moment, undergoes strong emotional sensations and feels connected to a larger whole. Religious buildings like temples, mosques and churches have purposefully attempted to emphasize such experience through the means of architecture. This religious craft dates back to even before the start of civilized settlements (12.000 y. a.).¹⁹⁹ The oldest burial sites that have been found are 95.000 years old for instance. Further, archeological findings suggests that shamans often resided in caves, which were dedicated to ritualistic experiences and 'magical content'.²⁰⁰ The places offered strong aesthetic experiences, using techniques like sensory deprivation and sensory overload, sometimes in combination with hallucinatory herbs. While the cave is from itself deprived from light and natural orientation, the use of echoes, murals, decorations, rare materials scents might have overwhelmed the spectator with extraordinary experiences.

These aesthetic experiences must have been deliberately constructed for ritualistic or ceremonial purposes, marking important live events for tribe members and solidify group structures.²⁰¹ According to Edward Wilson, rituals did not only emphasize the greater order of things, but also created them between group members.²⁰² As we used to live in small groups, whereby its functioning as a whole was crucial to our very existence, these changes were probably of enormous impact. Strong artistic means were necessary to promote altruism by symbolically granting honor, dignity, group belonging and the psychological benefits that come with them.²⁰³ In the same line. Aesthetically, Harry Mallgrave argues that rituals "emerged during human evolution as multimedia elaboration of rhythmic modal capacities that by means of these elaborations gave emotional meaning and purpose to biologically vital activities."204 Rituals and ceremonies should therefore not be regarded as mere sociological abstractions, fully programmed by a cultural context. They are essential expressions of our human nature, and we need them to give meaning to our individual lives and group identity. Göbleki Tepe in Turkey is one of the oldest religious sites and forms of architecture that have been found so far

(10.000 y. o.). Interesting about this structure, is that it is most likely erected by the cooperation of nomad tribes. This is just one of the examples that point in the direction that religious sites are older than the first cities.

Although the theme is closely aligned with Art and Crafts, in the case of awe and transcendence we *can* speak of a distinct emotional sensations, that could be triggered by specific aesthetic choices.

Light. When I imagine a feeling of awe in relation to light I think about particular natural phenomena, like the sun breaking through the clouds, shattering translucent beams on the surface of the earth; a rainbow in the humid morning sky; thunder firing in static bifurcation; or how the sun turns deep red when it sets. We all know this feeling deeply intuitively, the presence of something so overwhelming, it goes far beyond comprehension. It might therefore be no surprise that religious buildings have been so oriented to the way that light is guided through space, accelerating the search for transcendence. How one building has a more dramatic effect than others might remain a mystery. Still, there are some consistencies. First of all, natural light, explicitly transmitted by high and elevated windows, flood the space with a luminance that can hardly be achieved by spaces with low ceilings. It guides our gaze upwards, evoking

strong physiological impact (see *Space*). The first filter for natural light can be colored glass, like stained glass, diverging the spectrum though the building, spectacularly expressed for instance in the side aisles of the Sagrada Familía cathedral in Barcelona. Then, the shape of the masses can help in creating vivid contrasts. At last, the reflectiveness and texture of the materials are all of great prominence to the way our eyes finally receive the light.



Figure 5. The interior of the Sagrada Familía cathedral in Barcelona, by Antoní ${\rm Gaud}{\rm (}^{\rm 205}$

Space. To arouse awe in spaces, the designer can primarily concentrate on how our view and hearing is directed. In most situations, people are occupied with their attention to their peripersonal space. This is the direct physical environment

your body interacts with, strengthening proprioception (awareness of your own body). in these cases, your gaze is mostly directed below the horizon and your hearing is focused on nearby sounds.²⁰⁶ However, when the gaze is directed upwards and the echo is delayed, it draws the attention automatically to the extrapersonal space, which is far away or to the infinite. It distorts our normal relationship with the world, partially dissolving the perceived boundaries of the body. This happens both in wide natural panorama's, like at the mountains or at sea; or in cathedrals, with their vast spaces and rigorous vertical order. Colin Ellard describes how the vertical gaze creates a sort of mystic state, in which our dopaminergic systems drive us away from daily worries and connects us with the universe.²⁰⁷ It is a state that can arise by looking at the stars or praying upwards in a church, giving a sense of hope or relief. Ellard says it activates the "operation of brainsystems that encourage us to feel contact with the sublime and celebrate the miracle of self-awareness. [which] are supremely and uniquely human".²⁰⁸ He continues that this trait might have evolved by the protection we enjoyed as young children, looking up to the protection of their all-powerful parents. It is the relation that gives us identity, a place in the larger social context. This way, large vertical spaces might evoke transcendence but also impose (patriarchal or maternal) hierarchy, a form of intimidation that is not always welcomed by every spectator.

Form. The perception of a space in its vastness is dependent on rhythmic modalities. Especially with great distances above hundred meters, our mind needs anchor points in the form of distinct shapes or ornaments to interpret the vastness of the space. But the greater the distance, the easier a perspective can be manipulated by repeating elements in continuously decreasing scales. Think again about Gothic churches, in their multilayered arcades and galleries. The primary shape of construction can inform us about the tactile qualities of the construction, exposing the material forces in play, apparent in the shape of vaults. At the mercy of the geometry we can walk underneath monolithic stones, conjuring obedience and awe at the same time.

Materials. The use of heavy materials and big masses, sometimes emphasized by a rough textures or relievos, informs our mind about the great gravitational forces around us. As these forces are outside of our control, there is no other choice than to surrender to their presence, giving ourselves to something 'higher above'. We sensorily simulate them through our bodies, changing our posture and intensifying our attention. Further, the history in the use of glass reveals that it has been a lot more precious to us in current urban environments. They were used to highest aesthetic advantages, hence I think that medieval churches,

mosques, temples, pyramids etc. can still be great examples for their application.

If there is one physical matter that embodies the qualities of transcendence chemically, it might be water. As the source of all life, it is the encompassing element that connects us with all other organisms. Aesthetically, it is fully transparent, reflective, and softly it filters the light. It can solidify, evaporate, transform in any shape, streams or fall still like a mirror. It can be soft and gentle to touch or ice-cold, 'hitting you with a thousand knives'. A well, a pond, a lake, a river, a waterfall, a glacier, the bigger the entity of water, the more powerful seems to be its presence. And most enthralling of all, might be the endless ocean, an infinite field that stretches beyond the horizon and beyond our imagination.

The symbolic value of water is present amongst every culture, and it has been used in architecture frequent times to render specific aesthetic effects. My first association goes to the Alhambra in Grenada with its fountain stream in the middle. Palaces around the world are surrounded with bodies of water or whole canals. Our affiliation for water is also deeply rooted biologically, hence it goes with many health benefits. Research has shown that exposure to the sight and sounds of water includes numerous benefits, like a decrease in heart rate, blood pressure, and stress levels; and increase in focus and memory restoration and positive moods.²⁰⁹

PART THREE

Synthesis

Towards an architecture of Resonance


The Journey so far

My research started with the question: What can we learn from the biological sciences about architectural aesthetics to enhance physiological and psychological well-being in the Modern urban habitat?

The question has demanded an open attitude towards a field of knowledge that has been quite unfamiliar to the architectural discourse so far. It soon shocked me how little we in architectural design actually know about the bodies and psyches we design for. In the first chapter I have tried, with the aid of biological philosophy, to overcome the dichotomy between nurture and nature, which seems to explain this disciplinary aloofness from the side of our field. And after this bridge was made, I only started to realize that the research question had opened the gate for multiple approaches. The outcome has been seven more chapters, each forming a small essay on its own.

In the second chapter on our neural structures, it appeared that physiological and psychological well-being are so interlinked that the research question had departed from a false distinction between our body and spirit. Our body is not the house that our mind dwells in. Rather, we are the house; maybe more than we would like to admit. Our thoughts and emotions are linked to the processes in our body, which in turn are impacted by what we sense in our environment. The third chapter has taught how we can be nurtured in this respect by architectural aesthetics via a neuro-phenomenological approach. So far, the first three chapters had only given a generic theoretical basis, and the gap towards actual design principles still had to be overarched.

For the development of intersubjective guiding themes, without stepping out of the boundaries of the biological sciences, I turned towards our evolutionary history. This has resulted in a narrative set forth over five chapters, each exploring a form of instinctive resonance with the aesthetic environment. The biggest lesson is that we need to be surrounded by a variety of specific sensory experiences, in order to be nurtured in all layers of our embodied health. The aesthetic environment is essentially not much different than a dietary pallet. We might differ per person what we specifically need to function optimally, there are common ingredients nonetheless. Although I am sure there can be many more instincts explored, I hope with the five themes to inspire anyone to continue to do so.

Postlude

May, 2019, on the Greek Island of Lesvos. The days started to feel very long, and – unlike Dutch spring – this time of year felt already like deep summer. Every day I naturally woke up with the sun burning me out of my bed, eat a bowl of yoghurt, get a cool shower and hop on a bus without a good sense of orientation in time. The remaining 500 meters, I needed to climb a hill, while having a wide panoramic view towards both the camp and the sea, the eastern sun revealing the landscape in a fresh glow. Most times, I would still be alone when entering the community center, so I could calmly start my daily routine of preparing the tools, before the rest of the volunteers and hundreds of visitors entered the site. By then, we had been working for over two months on the new playground, which was almost finished. The initial design idea was still visible: the division of the plot into different patches, the peephole of the playing house at the sand pit oriented at the tower bridge, which in turn overlooked the coast; and the treehouse, resting in the shade of the fragrant Eucalyptus tree. Nevertheless, the original blueprint illustrated at most a template of what had been built by then. The construction process went very spontaneous and adaptive,

dealing with the materials at hand, while trying to ignore the hot weather and the fuss around us. We reused most of the scrap wood, cutting it to where it could fit, then sanding it to avoid splinters in the small hands of the children. Sometimes you could still recognize the previous location of the wood, by the light blue paint strokes on the surfaces. Faraz, the Afghan carpenter, was very thoughtful to discuss the height of the treehouse stairs, winding between the massive branches. And so, every detail became finely attuned to the human scale of a six years old child. At other times, we needed to improvise with the limited range of materials we could locally buy, since the island is guite small. The slide for example, was made by gluing and shaping wooden boards, and bending a sheet of stainless steel. The soft ropes of the bridge were originally meant for sailing boats, and the thematic buoys are painted tires we found along the road. We finished the wood with a natural look, leaving some room for the artists to paint small murals.

And then, finally, it was the day of the opening. Although every day I imagined how the structures would be used, it did not prepare me for the scene that was about to unfold. First, the kids hesitated to come in, standing mesmerized by the fence, some of them had never seen a playground in their lives. But after it

became clear it was specifically built for them, little encouragement was needed for them to burst out all over the place. The smallest seemed delighted to play house in the sand, intuitively understanding the use of the small kitchen: some others were more artistically oriented, drawing with the chalk on the blackboard fences. The wildest kids had their adventure by climbing into the tree house, taking the slide, and then fly at the bigger wooden structure. I sometimes felt stressed, as the kids found all kinds of ways of hanging and climbing I had not foreseen. Some more reserved kids found their place in the shade along the marble track (marbles, the small glass balls), which could be customized with every use. The total scene felt like one cheerful chaos, a liveliness beyond comprehension. From total control over the design for months, to nothing to say at all when it became used; a shocking, beautiful and grateful experience. It was this experience that taught me the unique power architectural design, a memory that I deeply cherish in myself, and nothing that can take that away.

Epiloque

Towards a Habitat of Resonances

The second part has been set up as a thematic framework that illustrates five of our human intrinsic needs towards our habitat. Each theme was consciously provided with a neuroaesthetic toolkit that can be directly applied into the Modern habitat for both analysis and design. This way I hoped to optimally guide the reader in the translation from bioscientific theory into the design practice. Still, the chapters tell little on how to integrate this knowledge in a sensitive and ethical manner. Further, especially the field of neuro-aesthetics revealed such a new way of looking at architecture, that it represents a new design paradigm, thereby re-assessing the role and the responsibilities of the architect.

First of all, it would be a sensible misinterpretation to see the five themes with the provided toolsets as a direct recipe for creating optimal habitats for human beings. Instead, it is about *principally* understanding the different biological and emotional needs we have in relation to space. The design tools are just a set of available design ingredients in a widely varied spectrum. It is hereby important to not confuse the means with the goal: creating emotionally rich spaces that resonate with the user's sensory responses and adequately reply to the existing historical and ecological context. Thus, although some tools can be understood as universal for human beings, we should not fall into the trap of 'one size fits all' again.

Early Modernists in this respect came up with all kinds of inventive and abstract design principles, that have greatly helped the industry of standardization, but later resulted too many times in endless repetition and monotony. I don't believe it was the Modernist's main intention to prioritize economic incentives (the means) over those of livable spaces (the goal). Many of us are for example familiar with Le Corbusier's Five Points of Architecture. However, it did actually not prohibit the architect himself to design something like the Notre Dame du Haut in Ronchamp, with its thick loadbearing walls, organic shapes and materials, and a fantastic dramatic interior. He rather integrated his design tools into his repertoire to reinvent the emphases in buildings and encounter the shortcomings of the past traditions.²¹⁰ In this way he aimed to liberate architecture from its dogmatic stylistic past, not to create a new set of dogmas instead. The five themes in my research were intended in that same line.

Nowadays, I aim with the five guiding themes to help in counterbalancing the emotionless concrete canvasses that are still being created by the utilitarian, reductionistic principles we inherited. Essentially, our evolutionary history demonstrates an intense connection with our aesthetic surroundings, whereby our imagination has been key in enriching our habitats. Since then, we were inclined to build in a playful cocreation with nature. Yet, our models of Modern formalism blocks this reciprocal relationship. Instead of departing the design process from a perfect white cube – as we often seem to do in architecture – our human biology suggests that we should rather take the natural habitat as a primary reference. Modernists like Louis Sullivan, Frank Lloyd Wright, Alvar Aalto, and many other influential figures already advocated for the nature-oriented perspective with great devotion,²¹¹ but it got unfortunately less understood compared to their functionalistic ideas.



Figure 6. The interior of the Notre-Dame du Haut in Ronchamp, France, by Le Corbusier. $^{\rm 212}$

Simultaneously, the research point out that we should also not celebrate all open-ended extravagances of the postmodernist reaction and deny our aesthetic responsibilities by sanctifying our artistic freedom. As Pallasmaa says: "Every place, space, and situation is tuned in a specific way and it projects atmospheres promoting distinct moods and feelings."²¹³ I am convinced we owe it to the user to be aware of the physiological and psychological impact of our design decisions. Especially in the last twenty years, the amount of neuroscientific studies is piling up to such an amount, that I believe it is starting to become simply careless to ignore what they have got to tell (think about evidence-based design to improve healing purposes in hospitals, but also offices, schools, etc.). Yet, for many designers it is still easier to remain captivated with more intellectualized or conceptual practices.

The embodied experience of the user is very real and crucial for their whole well-being, and might be the most important thing to consider next to the conventional functionality aspects. Instead of regarding the architect's profession as the bilateral combination of the rational planner and the iconic artist, the biological and psychological insights give us a greater potential.

First, we can understand the intrinsic desires of the user from a holistic notion, see the person we have in front of

us and try to empathize with their position. The focus is not so much on quantitatively listing what they want, but searching for the subconscious drives that underlie their wishes. On the basis of our deepening human understanding, we can ask critical questions when we detect disbalances in the current environment of the user. We can invite them to go beyond solidified patterns. At other times, it might just be a matter of recognizing to what they deeply value already, and understanding to what extent these values flourish in the existing context. By cleaning out all the distraction around them, there is space for values to further manifest themselves. Either way, let us also not forget that there are always basic aspects that improve our health, such as abundant daylight in living spaces, presence of biodiversity and possibilities for natural ventilation and climate adaptation (see chapter four: Biophilia).

On a bigger scale this sensitive and personal attunement is easily being blown away by a greater, mostly economic, set of demands. In the collision of traffic flows, real estate development and industrial spaces, the personal human experience of the city gets commonly undermined; and so does our collective well-being. As a consequence, the Modern city is making us physically and mentally sick, as compared to more natural habitats. The discovery of the public park typology as an intervention in a dense urban fabric might be the strongest example of a reaction to the industrialized habitat, greatly restoring our healing connection with nature. In the same line, hofjes (semienclosed courtyards), playgrounds, public sports fields, spiritual sites are all directly aimed at our well-being. Today however, these typologies might not be enough on their own, as in the dense city centers, they tend to get individually muffled by trends of urban commodification, gentrification, densification, car invasion etc. As a result, they can get isolated, neglected, or even unnoticeable by their hectic or dissonant surroundings. There might be a risk to increasingly meet our needs with privatized solutions, like roof terraces, gyms, indoor playgrounds, private swimming pools, galleries etc. But I don't believe this a sustainable strategy.

I believe we need a statement to create a countermovement within the dense urban fabric, radically demanding space for human's most intrinsic affiliations. This countermovement would aim at connecting the individual resonant spaces into a larger ecological network, that could finally transcend the polluting grid of vehicles that are now cutting up the city in isolated blocks. The resonant places could potentially be upgraded with the aid of architecture, in the form of public spaces or pavilions, which unique and direct purpose is to facilitate healing sensory experiences. In between these urban pinpoints the network should encourage movement of pedestrians and cyclists, and they would act as hearts, pumping life into the interdynamic web. Along this routes, sensory pollution (like traffic noise, billboards etc.) could be strategically filtered out, while a wild collection of plants and animals could be brought in to stimulate a diverse interaction with nature. The routes might be further enriched with playful installations, art works and more contemplative spaces. The final goal would be to liberate the experience of being human itself, both reconnecting with our natural origins, while enjoying the wide manifestations of our imaginations in our Modern ensembles.

I believe strongly that it is possible to reach a synthesis between the natural environment and the Modern metropolis, so that we can create a habitat that responds better to our human nature than current ones. But in order to achieve this, we also need to have the courage to intervene on a systemic level. This in turn demands for debates, in which the old paradigms and new paradigms must be faced with each other. They will sometimes collide, but if we persist, we can overcome the reciprocal misunderstandings and grow into a new consensus of values.

I hope with my thesis to have given a contribution to this quest from a biological perspective, defining resonances based on some of the oldest affiliations in our bodies. But, who knows what valuable perspectives others might come up with, so that we can collectively define the future Architecture of Resonance. Nothing lasts Except for Light – Love – Truth

Notes

Introduction

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