

Neuroarchitecture: Beyond a spatial sensation**Neuroarquitectura: Más allá de una sensación espacial**

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Abstract

Architecture and urban space go beyond satisfying functional, formal, technical or social needs, it is the space in which we are immersed in our daily lives, where spatial limits maintain a dialectical relationship with the human being. It is from this spatial experimentation that the effects generated go beyond any sensation, it is then that we go from an embodied experience to a somatosensory experience, from which we get emotional responses, but also physiological and behavioral ones, result. That is why being able to control these effects play an important role in improving the habitability of the space, since the design of the stimulus, that is, the design of the architectural or urban object will depend on the effect to be generated. It is here where Neuroarchitecture acquires relevance, since it is from its neuroscientific basis so strategies can be provided that contribute to the design process.

Resumen

La arquitectura y el espacio urbano van más allá de satisfacer necesidades funcionales, formales, técnicas o sociales, son los lugares en los que nos vemos sumergidos en nuestro día a día, en donde los límites espaciales mantienen una relación dialéctica con el ser humano. Es a partir de esa experimentación espacial, que se generan efectos que van más allá de una sensación, es entonces que vamos de una experiencia corporeizada a una experiencia somatosensorial, de lo cual, resultan respuestas emocionales, pero también fisiológicas y conductuales. Es por ello, que el poder conocer y controlar dichos efectos, juega un papel importante en la mejora de la habitabilidad del espacio, pues del diseño del estímulo, es decir, del diseño del objeto arquitectónico o urbano, dependerá el efecto a generar. Es aquí donde la Neuroarquitectura adquiere relevancia, pues es a partir de su base neurocientífica que se pueden aportar estrategias que coadyuven en el proceso de diseño.

Neuroarchitecture, Senses, Space, City**Neuroarquitectura, Sentidos, Espacio, Ciudad**

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Introduction

THE GENERAL WELFARE OF INDIVIDUALS CAN BE SEEN SIGNIFICANTLY INCREASED BY THEIR CONTACT WITH ENVIRONMENTS CONSIDERED OF HIGH AESTHETIC VALUE.

CORRALIZA & GALINDO (2012)

The main object of this paper is the analysis of the relationships between urban space and the human beings that inhabit it. Some advances of an ongoing research project are presented here, with the purpose of showing the sketch of a methodology that allows describing and interpreting the interaction between urban space and the human beings that inhabit it. Human perception, in its interaction with the environment -particularly the urban-architectural environment- is the key element to be understood.

This work is essentially divided into two parts plus a conclusion. The first part describes some concepts and the essential notion to understand the phenomenon of perception, its ways of acting with the environment, and the effects of this interrelation. From this, in the second part, a methodological sketch is given to show the importance of neuroarchitecture as an essential discipline for the field of urban and architectural studies.

Finally, some reflections on the implementation of the proposed methodology are presented, based on some preliminary results of the field work. At the same time, a series of questions are posed to broaden the debate on the importance of human perception, both in the development of urban studies and in the formulation of strategies and policies for the spatial configuration of human environments.

Perception: sensations and emotions

We live in a world composed of environments and objects, where the only way to know and live them is through a perceptual experience, where the relationship between environment, sense and brain are the main vertebrae of this experiential process.

As human beings, we are endowed with a complex system that allows us to develop physiologically and mentally in a physical environment and in a society. In this system, there is a set of organs with infinite functions and interrelationships. In the following, we will refer to those linked to the phenomenon of perception, alluding to the relationship between the human being and the environment.

To speak of perception is to speak of the senses, since it is identified that this alludes to a sensory impression that is activated from an experiential experience, that is, from the experience of some activity, object, thought or physical space, where each of the senses are immersed, acting before diverse stimuli, such as sounds, temperature, colors, shapes and flavors.

According to Goldstein (2010), perception is in charge of explaining the functioning of the senses, such as experiences and behaviors, that are the result of their stimulation. Goldstein (2010) classifies them into six categories, the first refers to the cutaneous senses (touch, pain, itching, tingling), the second is the chemical senses (taste, smell, flavor), the third the vision, the fourth the hearing, the fifth the proprioception and kinesthesia (awareness of body positions as well as the position and movement of limbs) and the sixth the vestibular or balance sense.

However, it is important to emphasize that none of them act independently, but are affected by each other (Goldstein, 2010). For her part, Galvez (2019) starts from this general theoretical basis, but she makes different groups, referring to the somatosensory, auditory, taste-olfactory, visual and interoceptive systems. In this context, two terms that have a lot to do with the topic stand out, they are the somato-sensory and proprioceptive.

The former alludes to tactile, thermal, itch, pain perception, as well as proprioception, while the interoceptive refers to the internal, physiological and affective atmosphere of the human being (Goldstein, 2010). That is, we are beings that are constituted of elements that condition the translation of our perception of any agent with which we are in contact.

Talking about the concepts that interfere in the subject, such as sensation and emotion, represents something complex, since they are phenomena that are interfered by multiple factors and contexts. At least, in the case of emotion, Cano-Vindel (1999) points out that it influences people's behavior, and also enables adaptation to the environment and vice versa.

On the one hand, sensations represent those impressions derived from each of the sensitive organs caused by the stimulus to which it is subjected. In this sense, Arriagada (2004) considers that it is precisely the sensations that makes an emotion feel in a certain or specific way.

While emotions refer to those reactions that occur at a later time to the sensations caused by a stimulus, Fernández (1995) structures this concept as a process that is originated by the evaluative assessment of a situation, which produces an alteration in the physiological activation of the organism. It is precisely from this appraisal that personal well-being is interfered with, since positive and negative aspects emanate from this appraisal. The former are produced by a particular kind of benefit, while the negative emotion derives from the evaluation of a kind of harm. It is relevant to recognize that this evaluation is influenced by a set of beliefs, objectives surrounding the person and environmental circumstances.

On the other hand, as mentioned, emotional activation is a complex process, since it involves several systems, at least Cano-Vindel (1995) refers to 3, the cognitive-subjective or experiential-subjective (feeling or moods of the subject), the motor or behavioral expressive (reaction identified by an observer or the subject himself before a stimulus) and the neurophysiological-biochemical (changes in the organism at the physiological level).

For her part, Corraliza & Galindo (2012) consolidate this approach, referring to that aesthetic activities are an essential element for the health of human, recognizing the capacity of all the stimuli that intervene in the environment, since under their characteristics, they modify the basal activity of people, having a direct impact or reflection on human behavior.

In this way they emphasize the importance of the aesthetic qualities in the human health.

It is necessary to point out the results provided by the study by Corraliza & Galindo (2012), as this forms part of the background of this research. Corraliza & Galindo (2012) identify the reasons that essentially determine the two poles of aesthetic valuation, high and low.

In relation to the first is attributed in the first place, to the naturalism of the place (existence of vegetation, absence of noise, natural place), secondly to positive affects (amplitude, light, harmony of elements, central location) and thirdly to the organization spatial (historical and known). While the low valuation, is attributed in the first instance to the absence of naturalism and in the second, to social aspects (Corraliza & Galindo, 2012).

Sensory experiences in space

Recognizing the role of perception allows us to see the probability of the infinite perceptions that can be of a physical environment; in this sense it is important to emphasize that no decision in relation to the design of the environment is absolute, however, if we can interfere in the improvement of environments that by their appearance are causing negative sensations in a majority, or potentiate those environments that are causing positive sensations.

From this, it can be alluded to perceptual experiences, because through these there is a relationship between design and spatial experience, where the experience of light, smell, sound, touch, temperature, etc., are the elements responsible for producing or sending electrical signals to the human brain and thus perceive the world we inhabit (Goldstein, 2010).

In this sense, it is worth emphasizing this psychophysical approach that seeks to determine or identify the stimuli that are associated with each sense and how the qualities of each of these stimuli influence perception (Goldstein, 2010).

With the above, it is pertinent to mention that the stimulus acquires the role of independent variable, since it is based on the qualities of the stimulus that the type of reaction will be defined. Yale (1996) considers that "[...] a stimulus is an elemental energy that affects a sensory receptor and that it is also a physical process in which the physical causes are physical, a physical process in which physical causes mechanically produce a physical effect" (p.99).

It is this that leads to the questioning of which are those stimuli that generate reactions or positive or negative effects and how these effects impact on the physical or psychological state of people.

Effects of space and neuroarchitecture

It is important to mention that what it wants to be discussed here is not recent, there are several case studies that show a similar concern, but it is not the only one. There are several case studies that show a similar concern, but these are approached from different perspectives. As an example, it is worth mentioning a huge number of works associated with the soundscape of cities, or those that study visual pollution. In the case of this research, it is chosen to give a neuroarchitectural approach, since it is considered that, being a multidisciplinary discipline, it allows to approach the subject in a more comprehensive way.

The origins of neuroarchitecture are associated with the discovery of the polio vaccine by Jonas Salk (Mombiedro, 2017, p.1).

"This discovery came at a very specific moment in his life; after many months of research and work, the American scientist decided to take a spiritual retreat to an Italian basilica. It was there, in the basilica of Assisi, that he found inspiration, and managed to come up with the solution to the vaccine issue. When he returned to the United States, he contacted the American Institute of Architects (AIA), explicitly asking for research into how the layout of architecture influences the brain and, consequently, human behavior." (Mombiedro, 2017, p.1).

This begins to take shape, when the 1971 finding of John O'Keefe, May-Britt Moser and Edvard Moser is taken up. The clues reveal the discovery of hippocampal neurons that encode the position of the subject in space called, "place neurons". Their studies revealed that the frequency of firing increased when the subject was in a specific location in a habitat (Roblero, 2015).

To have a broader picture of what neuroarchitecture is, this will be referred to the formal establishment, which is framed with the rise of these was the Academy of Neuroscience for Architecture (ANFA), which is an institution created in the city of San Diego, United States, as part of the origin of a multidisciplinary scientific current, called Neuroarchitecture, whose main objective is to demonstrate the impact on health and behavior, generated by the spatial configuration of the environment in which we live, light, color, sound, surface texture and the arrangement of physical space, with the understanding that "[...] that neurons are activated and form spatial networks, depending on the external physical environment." (Manzano, Muñoz & Sanz, 2015, p. 1).

From this, investigations have been developed that reveal the effects of spatial design in humans, however, not all have seen the light in its application.

Some of the themes in which he has been honored have been those that have evidenced the importance of each "piece" of design that intervenes in a process of embodied experimentation of a space.

One of the most outstanding investigations are those of Chatterjee, Coburn, & Vertanin (2017) who have examined visual permeability, identifying that closed rooms caused users to decide to leave the space, because certain regions of the space were activated. the amygdala. On the other hand, they explored the issue of height of ceilings, where the highest were classified as beautiful because they activated specific structures of the brain. This author also identifies that it is more effective to be coupled to understandable designs as opposed to those that present too many complexities.

Sketch of a methodology

Until now, the importance of the production of positive stimuli or environments has been pointed out, however, little has been said about how to create this type of space. Undoubtedly there are studies that are responsible for assessing environments, these are preference studies, which are instruments that review categories such as the descriptive scale, the affective scale and the evaluative scale (Corraliza & Galindo, 2012).

These scales pursue two major objectives, one that seeks to solve a “landscape problem” and another that focuses on the development of conceptual and theoretical frameworks so that an explanation regarding aesthetic judgments is given (Corraliza & Galindo, 2012), but In both cases it is an evaluation that is generated from the aesthetic tastes of the subject that evaluates a representation, in which the imagination and the feeling of pleasure or disgust generated are prioritized.

Despite the constant use of these instruments, what is identified is that they are only governed primarily by an aesthetic judgment, not referring to neurophysiological effects. Although there are many neuroscientific researches related to physical environments, many of them are not implemented in the design processes, essentially due to the high complexity of the use of language, lack of dissemination or because these studies are considered to have application only in the study site.

This is why the need arises to develop a methodology that allows the professionals involved to implement strategies that are scientifically recommended for their effectiveness in the development of positive effects in the desired site.

For this purpose, a methodology of qualitative and quantitative approach is proposed, which in essence values and identifies design strategies derived from previously generated scientific studies, based on the use of instruments structured under Kansei engineering, the latter recognized for extracting the value of emotional design.

The approach methodology combines aspects of Kansei engineering for its recognized efficiency in design, in addition to including elements that allow obtaining a perceptual characterization of the territory.¹

The methodology consists of 5 phases:

Phase 1: selection of scientific studies,

Phase 2: extraction of perceptions of the study site,

Phase 3: extraction of desired perceptions,

Phase 4: strategy selection, and

Phase 5: immersive evaluation of strategies applied to the virtual stimuli generated.

As a first aspect, it is sought to identify the impact on the perception generated by spaces that include neuroarchitectural properties. To do so, it began with phase 1, in which was reviewed with scientific studies that refer to the impacts generated by formal characteristics that allude to each of the senses. Subsequently, a table of the most related properties that could be applied to public space was extracted. Subsequently, a formal and perceptual survey of the study site was made, so that, together with the elements and properties previously extracted, the three stimuli to be evaluated in phase 2 and 3 could be elaborated.

In total, 4 stimuli will be evaluated, each one consists in a photorealistic image and a virtual environment of an urban proposal of the study site.

In both, '1' and '2' were applied all the formal strategies were applied and which were identified as positive, the difference is that in the first, straight counters were applied, while in the second the curved counters were applied. The stimulus '3' is a proposal that contains a formal solution 'typical' of the interventions that are applied in the region. And the stimulus '4' refers to the current state of the study site.

¹ It is important to point out that, given the current situation generated by the Covid 19 epidemic, the fieldwork had to be restructured, so that its application was mainly digital.

It is therefore that it arises an assignment of values to each identified strategy, where '0' means the absence of this and '1' the presence (see figure 1).

Main senses to stimulate	Element through which it will be stimulated	Strategy	Stimulus 1	Stimulus 2	Stimulus 3	Stimulus 4
Sound	Water (Water fountain types)	Water fountain type "gush" (Ideal)	1	1	0	0
		Water fountain "typical" (Not recommended)	0	0	1	0
Tactile	Origin of materials	Preval natural materials (Ideal)	1	1	0	0
		Preval Synthetic materials (Not recommended)	0	0	1	1
	Types of surfaces	Texture synthetic surface (Ideal)	1	1	0	1
		Flat surface (Not recommended)	0	0	1	0
	"Antigravity effect" application in formals compositions	With antigravity (Ideal)	1	1	0	0
		Without antigravity (Not recommended)	0	0	1	1
Spatial opening	Permeable space (Ideal)	1	1	0	0	
	Closed space (Not recommended)	0	0	1	0	
"Tension effect" application in formals compositions	Include elements with visual tension (Ideal)	1	1	0	0	
	Not include elements with visual tension (Not recommended)	0	0	1	1	
Contour types applied to formals elements	Curved contour (Ideal)	0	1	0	0	
	Straight contour (Not recommended)	1	0	1	1	
Color combinations	Harmony combination (Ideal)	1	1	0	0	
	Without harmony combination (Not recommended)	0	0	1	1	
Smell - Sound	Types of vegetation	Wooded areas with endemic species (Ideal)	1	1	0	1
		Low vegetation areas (Not recommended)	0	0	0	1

Figure 1 Table of assignment of values of each property in each stimulus, according to its presence or absence
Source: Own elaboration based on data processed in IBM SPSS (Statistical package for the social sciences) and collected through digital questionnaires

Secondly, in order to identify those elements and properties that are key to the stimulation of positive emotions according to the study site, it is proceeded to phases 2, 3 and 4. Phases 2 and 3 allowed to extract the perceptions generated by the study site under the conditions it currently has, as well as the desired ones. These desired perceptions will be obtained using the Kansei methodology (Nagamachi, 2020) (quantitative and qualitative approach) and from the evaluation of 3 stimuli derived from the study site.

Finally, from the results obtained in phase "4", it was determined which are those elements or spatial characteristics that, supported by a scientific study, have a similar perceptual impact on the community, since from this it will be possible to associate a possible beneficial impact.

As the last part, there is phase 5, in which a portion of volunteers from the original sample is subjected to an immersive experience of the 3 stimuli, with this is intended to make a specific evaluation for each of the selected strategies, in order to determine the impact generated by each of them.

Based on the analyses carried out in each of these phases, a brief synthesis of some preliminary results of the research project is presented below.

Preliminary results

Under the application of this methodology and the corresponding analyses (descriptive, discriminant, semantic universe, correlation between the semantic universe-properties and multilayer perceptron) of the extracted data, which were carried out by means of a software called IBM SPSS (Statistical package for the social sciences) in its version 21, the following results were found.

The properties with scientific support that were identified are:

The sound of falling water jets as elements that promote relaxation. On the other hand, it can act as a barrier to reduce the perception of environmental noise, as well as acting as a visual attraction.

As part of the tactile stimulation, it is advisable to include materials with textured surfaces or with changing surfaces. On the other hand, due to the stimulation of tranquility and stress reduction it causes, the use of natural materials, such as wood, is recommended.

In visual aspect, the permeability of the space is a feature to be promoted, as it helps to reduce stress or fear levels, unlike what is caused in enclosed spaces. Even though no scientific evidence was found, the visual and antigravity tension of elements will be tested at a formal level, since in literature it is considered as an element that determines the permanence in space.

In the visual and olfactory theme, tree barriers will be promoted, since a direct association with base and survival characteristics was identified. In addition, it was found that the aromas given off by the vegetation contribute to relaxation and neutralization of bad odors. On the other hand, it was formally found that curvilinear contours cause greater attraction and relaxation than straight contours.

According to the analysis of the results of the questionnaires applied, it was identified that there is indeed a correlation between the properties studied and positive emotions. On the other hand, the 5 factors that group the perceptions of the stimuli, attractive, daring, open, calm and invasive, were identified, the first being the most desired by people. From the latter those properties were extracted which contributed to obtain these perceptions, in this sense the main properties were (the order given indicates their relevance: 1) wooded areas with endemic species, 2) harmonious combination of colors, 3) with antigravity, 4) predominance of synthetic materials, 5) contains elements with visual tension, 6) "jet" type fountain, 7) textured surfaces, 8) curved contour and 9) closed space (see figure 2).

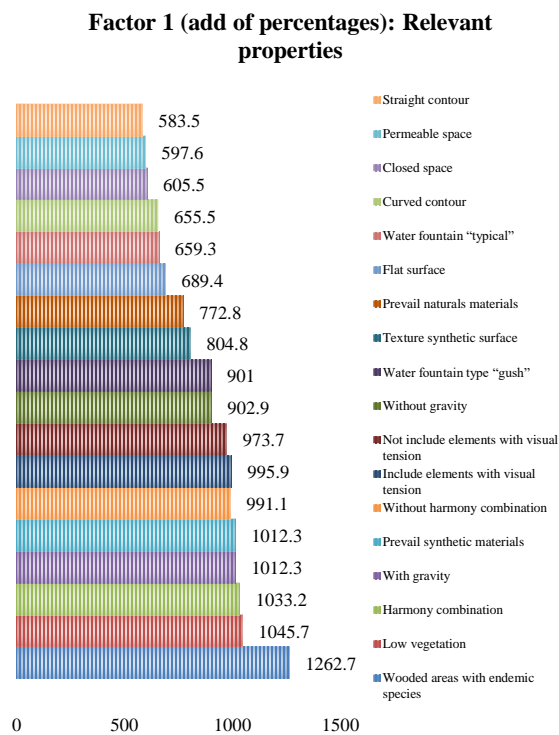


Figure 2 Graph of the percentages of the properties identified in factor 1
 Source: Own elaboration based on data processed in IBM SPSS (Statistical package for the social sciences) and collected through digital questionnaires

Conclusions

It is hoped that, from these results, interest will be generated to continue applying this methodology, so that more positive properties can be extracted for other types of environments. This allows the extraction of strategies, so that professionals involved can implement in their designs, since from the exploration of these, they will be able to identify their variants and use them in a way that suits their design needs. In this way, it could contribute to the development of urban and architectural design spaces that are committed to their habitability, rather than just an aesthetic need, which does not always satisfy the needs and sensory effects described here.

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