



## CASA MILÀ AS A SENSORY LABORATORY A Neuroarchitectural Approach to Gaudí's Modernism

MARÍA BELTRÁN-RODRÍGUEZ (MARIA.BELTRAN@UDIT.ES)<sup>1</sup>, CHLOE SHARPE (CHLOE.SHARPE@UDIT.ES)<sup>1</sup>,  
ALEJANDRO MARTÍNEZ GONZÁLEZ (ALEJANDRO.MARTINEZ@UDIT.ES)<sup>1</sup>, IVETTE CALDELAS  
(IVETTE.CALDELAS@UDIT.ES)<sup>1</sup>

<sup>1</sup> University of Design, Innovation and Technology (UDIT), Spain.

---

### KEYWORDS

*Neuroarchitecture*  
*Gaudí*  
*Casa Milà*  
*Spatial complexity*  
*Multisensory perception*  
*Urban creativity*  
*Cognitive-emotional*  
*response*

---

### ABSTRACT

*This paper examines Antoni Gaudí's Casa Milà (La Pedrera) through the lens of neuroarchitecture, exploring how form, light, and texture shape perception and emotional response. Integrating architectural analysis with neuroscience, it proposes an experimental framework combining EEG, eye-tracking, and behavioral data to assess spatial experience within immersive environments. By linking formal complexity to cognitive and physiological responses, the study reveals how Gaudí's architecture transcends aesthetics to engage the brain's sensory and emotional systems. The approach positions his work as a bridge between art, science, and urban creativity, expanding our understanding of architecture as a multisensory cognitive phenomenon.*

---

Received: 01 / 11 / 2025

Accepted: 15 / 02 / 2026

## 1. Introduction

Antoni Gaudí is an icon of Catalan Modernism and a unique figure in 20th-century Art Nouveau and organic architecture. Transcending the architectural scale, his work—collectively designated a UNESCO World Heritage Site—is closely linked to creativity, spirituality, and urban art. In commemoration of his centennial and coinciding with Barcelona's designation as the "World Capital of Architecture 2026", it is more relevant than ever to reexamine his work from new perspectives, such as the one proposed in this study, which integrates cognitive science, perception, and neuroarchitecture.

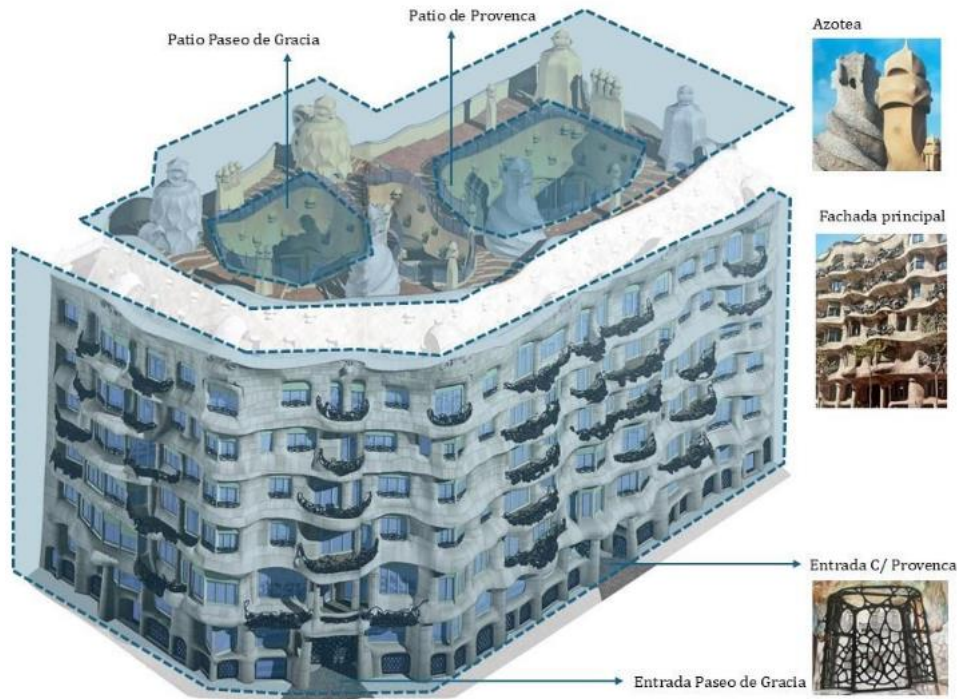
In recent years, some of his buildings have been examined from different perspectives, including biophilic and multisensory design (Blázquez, 2023; Casa Vicens, 2023). As part of this trend—which also includes the re-evaluation of designs by architects such as Alvar Aalto and Frank L. Wright (Sharpe et al., 2025)—the "IMMERSIA" research project has emerged, which transfers iconic architectural spaces to a controlled applied neuroscience laboratory. Casa Milà (also known as La Pedrera) and the subject of this article, is a particularly significant case to be studied using neuroscientific methodologies and technologies, as it combines spatial complexity with sensory richness, directly impacting the user's perception, emotion, and behavior.

Casa Milà (1906–1912) represents Antoni Gaudí's most ambitious urban project and his only foray into collective residential housing. Commissioned by the Milà-Segimon couple, it was conceived to "meet the needs of modern life" (Fundació Catalunya La Pedrera, n.d.), integrating structural innovation and a profound reflection on contemporary urban living. Located in the heart of Barcelona's Eixample district, at the intersection of Passeig de Gràcia and Carrer de Provença, the building is embedded in the heart of the early 20th-century bourgeois city fabric but deliberately breaks with the rational orthogonality of the Cerdà plan. Gaudí transforms the urban block into a sculptural organism that merges with the city, establishing a plastic and symbolic dialogue with its surroundings (Meirelles et al., 2019).

The building is approached at three distinct scales to enable its adaptation as a laboratory and to facilitate the subsequent analysis of the impact of architectural elements and qualities—both formal and material—on visitors' perception, emotion, and behavior (Figure 1). The first, the urban or neighborhood scale, examines the building's interaction with its immediate surroundings. It includes the façade—as an interface of urban perception—and the rooftop—as a topographical extension and a visual and symbolic connection to the Barcelona landscape. The next, the community or collective scale, focuses on spaces of transition or social interaction. It includes courtyards, staircases, and entrances, which mediate between the public and the private. The third scale deals with individual or domestic spaces. It relates to the intimate experience of living in the dwellings and in each space within them.

This article addresses the first two scales, the urban and the community. For the reconstruction of these spaces and their reproduction in the applied neuroscience laboratory, original plans and graphic representations are used, as well as later works such as those by the publisher Dosde Publishing (2023), which virtually reconstruct many of Gaudí's buildings. It should be noted that the original documents for Casa Milà are very limited, as the original plans were lost in a fire that occurred in 1936 in the crypt of the Sagrada Família.

**Figure 1.** Three-dimensional exterior reconstruction of Casa Milà, highlighting the spaces and elements under study.



Source: Created by the authors based on field documentation, the authors' photographic material, and a 3D image modified from Dosde Publishing (2023)

The building's undulating façade—described by many authors as a veritable sea of stone—meets functional criteria, but also serves an expressive purpose. These undulations or curves provide shade and protect the south-facing apartments from direct sunlight, while creating a shifting visual rhythm through light and movement. The wrought-iron details of the railing, featuring highly diverse and symbolic designs, are crafted from recycled materials. They can be interpreted as abstract sculptures that reinforce the organic dynamism and connect Gaudí's work with the duality of the artisanal and avant-garde in Modernist Barcelona. The relief of uniquely shaped chimneys and towers on the rooftop of Casa Milà is perceived as symbolic figures against the city skyline. The staircases and spaces connecting them, scattered like a topography, transform this place into a space where the functional and the sculptural or expressive once again intermingle. The roof transforms into an elevated urban stage, from which to look out over the city as a sensory extension of the building itself.

Casa Milà, through both the topography and formal expressiveness of its façade (vertical) and roof (horizontal), establishes a sensory and reciprocal dialogue with Barcelona's urban landscape (Fundació Catalunya La Pedrera, n.d.). Both its exterior envelope and its interior—courtyards, doorways, staircases—transcend the architectural work and are conceived as urban artifacts, where architecture, sculpture, and public space converge. One could say that this case study foreshadows the contemporary notion of urban creativity and art in public space, positioning architecture not only as a landmark in the city but also as an active agent that acts upon and interacts with it—as an image, symbol, and collective experience (Bolli, 2016).

To all these perspectives, which have been more extensively studied, we add that of a multisensory environment, capable of stimulating the visitor's sensory systems. Notable aspects include the changing light on the stone, the curved textures, the acoustics of the courtyards, and the circulation of air on the rooftop. All these architectural qualities are orchestrated to generate an immersive experience for the user, activating proprioception (perception of the body's internal state) and proprioception (unconscious perception of the body's position and movements), and

allowing one to “feel” the architecture beyond the sense of sight. This multisensory perspective, grounded in neuroscientific evidence, positions Casa Milà as an exceptional setting for investigating how architecture and its perception through stimuli—visual, tactile, acoustic, and olfactory—can modulate aspects such as emotions, attention, or perception. This is the key to the methodological proposal and experimental approach presented in this article: to objectively (quantitatively) and subjectively (qualitatively) measure physiological, emotional, and cognitive responses to varying degrees of spatial complexity through immersive models. This work presents a theoretical and methodological-experimental framework for translating Gaudí’s architectural complexity into a controlled experimental environment within an immersive laboratory using sensors and applied neuroscience techniques.

## **2. Theoretical Framework**

### ***2.1. Neuroarchitecture, Complexity, and Emotion***

Neuroarchitecture is a relatively new discipline that focuses on studying how physical environments modulate brain activity, emotions, and behavior. It analyzes variables of the built environment such as spatial or formal complexity, lighting, color, and texture. These architectural characteristics affect the brain’s systems of attention, motivation, and memory, and directly influence well-being (Azzazy et al., 2020; Eberhard, 2009). Recent studies show that physiological arousal correlates with spatial complexity and visual fascination, especially when formal diversity and perceptual coherence converge (Gregorians et al., 2022; Makanadar 2024). Experiments by Colin Ellard’s research group (Negami & Ellard, 2023; Srikantharajah & Ellard, 2025) in urban environments, facades, and interiors confirm that designs with low complexity generate apathy and disinterest, while those rich in variation, rhythm, and texture evoke pleasure, curiosity, and sustained attention.

This neuroarchitectural approach to formal complexity and emotions is grounded in Daniel Berlyne’s inverted U-curve theory (1971). According to this theory, aesthetic pleasure peaks at an optimal level of stimulation—not so low as to cause boredom, nor so high as to generate anxiety. This optimal or balanced complexity is of particular interest when studying Gaudí’s work. Casa Milà exemplifies this relationship between stimulation and harmony perfectly. For example, its undulating stone façade with symbolic wrought-iron details on the railings, which creates transitions of light and shadow, acts as a multisensory stimulus. The same is true of the other spaces examined in this research, making this building a paradigmatic case for exploring how formal complexity can modulate emotional arousal and cognitive attention from the perspective of the neuroscience of space.

**Figure 2.** Selection of architectural elements and details, example of multisensory stimulation



Source: Prepared by the authors based on field documentation and photographic material.

The selection of images in Figure 2—examples of architectural elements that foster multisensory perception—illustrates the concept of optimal complexity. These examples simultaneously display formal and material variation alongside structural and formal coherence. It is this blend that generates the balanced sensory stimulation that captures attention without overwhelming the senses. Casa Milà and its details—wrought-iron balconies, ceramic trencadís, sculptural chimneys, and the curves of the façade—demonstrate the capacity of Gaudí’s architecture to maintain a constant visual and thematic rhythm, where each element introduces a perceptual microvariation, yet within a connected whole. These elements—their texture, gradients of light, or spatial sinuosity—elicit multisensory stimuli that foster positive activation, exploratory curiosity, and sustained attention (Gregorians et al., 2022; Negami & Ellard, 2023).

## ***2.2. Capacity for action, orientation, and spatial decision-making***

When experiencing architecture, the user’s capacity for action—through their body—in response to the spatial characteristics of their surroundings is also relevant. Urban studies investigating this capacity for action (Condia et al., 2020) confirm that peaks in physiological arousal occur during moments of anticipation, orientation, and spatial decision-making, rather than during simple visual contemplation. This finding sheds light on architecture’s capacity to induce active participation—users as agents, not static spectators—through the interpretation of space via movement and decision-making.

James J. Gibson (1979), through his ecological theory of perception, introduces the concept of affordances—or possibilities for action that an environment offers based on its morphology, scale, or capabilities. In architectural terms, affordances can be applied to transitional spaces—thresholds, ramps, stairs, passages, or openings—which guide visitors’ spatial decisions and encourage their exploration. This theory is closely linked to the methodology proposed in this study and underscores the importance of legible and coherent architectural designs that foster a sense of agency—a perception of control and mastery—for the well-being of users (Condia et al., 2020; Farrow, 2024; Pallasmaa, 2005).

**Figure 3.** (a) Floor plan of the apartments, (b) exterior elevation, and (c) cross-section of Casa Milà, showing the undulating continuity of pathways and heights, where the perceptual sequence of anticipation and resolution is manifested.



Source: Own elaboration work based on original plans reproduced in Freixa Serra (2020).

At Casa Milà, the sinuous routes, changes in height, and dynamic lighting structure a perceptual sequence based on the alternation between anticipation and resolution. The visitor moves through curves that conceal and reveal, generating continuous micro-decisions that activate both visual attention and the motor and vestibular systems. Added to this experience are the reliefs on the ceilings, the plaster moldings, and the textures of the door and window frames, which amplify haptic perception and reinforce bodily proprioception: the body feels the form before fully seeing it. This study proposes to experimentally investigate these characteristics through neurophysiological measures—electroencephalography (EEG), galvanic skin response (GSR), or eye-tracking (ET)—which allow for the identification of correlations between peaks of cortical and autonomic activation and moments of spatial decision-making. In this way, Casa Milà is proposed as a cognitive setting, where form guides behavior and movement gives meaning to space.

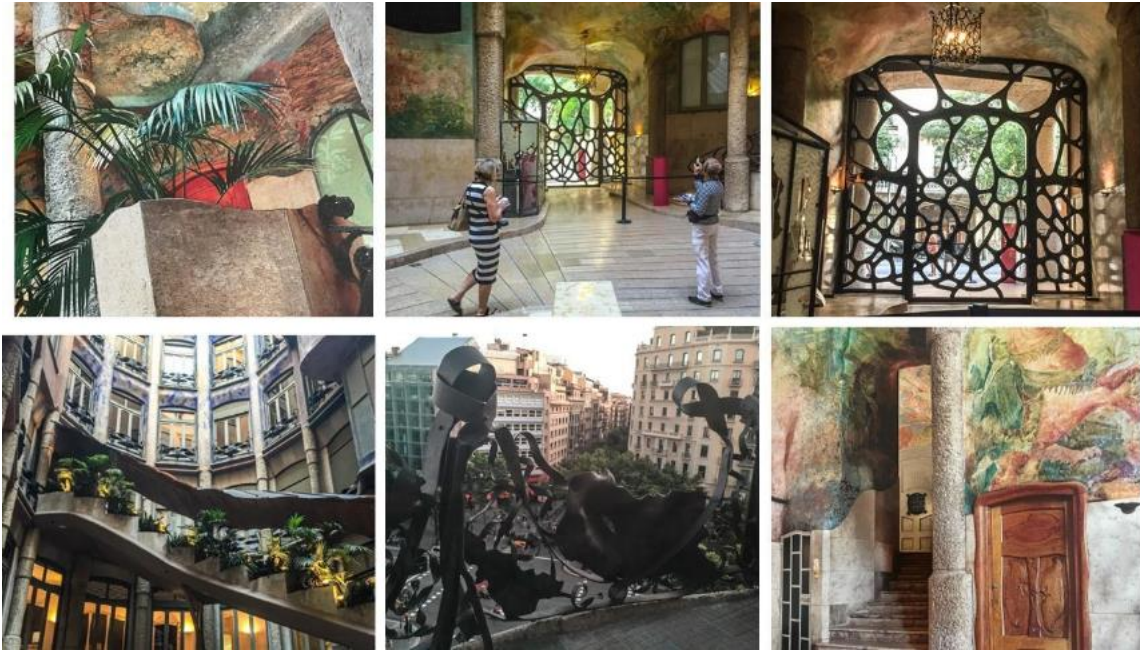
### 2.3. Spatial Complexity and Architectural Memory

From the perspective of neuroarchitecture, Gaudí's designs combine structural coherence with perceptual diversity, creating environments capable of simultaneously activating cognitive, emotional, and mnemonic processes. In contrast to the so-called contemporary "bland-demic"—the global homogenization of urban environments (Hill, 2018)—his work offers a rich multisensory experience, where shifting light, tactile materiality, and organic forms foster emotional attachment and spatial identity. Gaudí's spatial complexity not only stimulates active exploration but also strengthens affective memory through sensory associations. Examples of these include earthy tones, curved surfaces, and light contrasts, which act as perceptual anchors that allow places to be remembered vividly. This architectural memory is constructed from bodily experience—walking, turning, looking up—during which perception and movement intertwine with emotion.

This research positions Casa Milà as a synesthetic space, where visual, tactile, and acoustic stimuli converge to generate an integrated experience, in which the visitor perceives the architecture with their entire nervous system. Its labyrinthine yet coherent structure transforms orientation into an act of discovery and turns every transition—from shadow to chiaroscuro or from the inner courtyard to the exterior—into a lasting sensory memory.

Paradoxically, this expressive intensity can also generate opposing reactions. Rosario Segimon, wife of Pere Milà and the driving force behind Casa Milà, for example, never felt comfortable with the decorative exuberance of her home. She even ordered the partial demolition of the ornate ceiling—more than 500 m<sup>2</sup>—shortly after the architect’s death (Fundació Catalunya La Pedrera, n.d.). This episode illustrates how the aesthetic and emotional complexity that fascinates some may seem excessive or jarring to others. It thus reinforces the idea that the architectural response is constructed at the intersection of perception, memory, and individual sensibility. In this regard, several studies have shown that architectural preferences are related to different personality traits (Cook & Furnham, 2012; Dehghani Tafti et al., 2024; Vartanian et al., 2021).

**Figure 4.** Spatial complexity and architectural memory in the interiors of Casa Milà.



Source: Prepared by the authors based on field documentation and photographic material (2025).

The examples in Figure 4—a succession of stone columns, mural frescoes, metal lattices framing the urban landscape, or the integration of natural vegetation—constitute an environment where light, color, and texture stimulate bodily and emotional perception. These elements activate the visitor’s affective memory and interoceptive orientation systems, generating a profound sensory relationship between body and space. Casa Milà can thus be conceived as a laboratory of sensory experience, where the boundaries between the aesthetic, the cognitive, and the emotional intertwine. It is evident here how Gaudí’s complex and symbolic architecture can modulate brain activity and behavior, a central idea in much of the research on neuroarchitecture (Mirikia et al., 2022).

Among the visual stimuli that form part of this integrated experience, one must not overlook the symbolic elements employed by Gaudí and the impact they can have on perception. The selected areas of study—communal spaces for collective use and those visible from the street or the rooftop—are replete with religious symbolism. This symbolism is more or less explicit, such as the reliefs of the letter “M” for Mary and the words “Hail Mary,” or the stylized cross that coexists with other strange, semi-abstract sculptures on the rooftop. On the other hand, the reliefs of doves, roses, and shells can be appreciated on one level as decorative elements typical of Art Nouveau’s organicism, or interpreted on another level as religious symbols of peace, the Virgin of the Rosary, or the pilgrim (Dosde Publishing, 2023).

### **3. Methodological Proposal: From the Floor Plan to the NEURO Lab**

This section describes how the spatial and sensory complexity of Casa Milà is transferred to a controlled experimental environment through immersive experiences in Virtual Reality (VR), Augmented Reality (AR), and in-person visits. The proposed methodology allows for the objective and subjective measurement of physiological, cognitive, and emotional responses to variations in spatial complexity, while preserving the architectural fidelity and sensory richness of the building. Based on this foundation, a series of specific objectives, experimental conditions, instruments, and measurement variables are defined in order to establish a solid empirical framework that allows for a quantifiable link between Casa Milà's architectural parameters and the participants' neurophysiological, cognitive, and emotional responses.

#### **3.1. Objectives**

The spatial complexity of Casa Milà will be analyzed using geometric, topological, and visual metrics, taking into account its formal richness, the layout of floors and sections, as well as the interaction between characteristic architectural elements—stairs, interior courtyards, moldings, reliefs, windows, and built-in furniture— (Berlyne, 1971). Based on this analysis, immersive environments will be constructed in virtual reality (VR/360°) and augmented reality (AR) that faithfully reproduce both real-world tours and manipulated versions of the building. These scenarios will preserve the natural and artificial lighting observed on-site; furthermore, synchronized visual events—such as lighting transitions, spatial movements, rotations, and close-ups of ornamental details—will be incorporated to produce a coherent and controlled sensory experience.

During the tours of the immersive environments, participants' physiological and cognitive responses will be continuously recorded using EEG, fNIRS, skin conductance (EDA/GSR), heart rate (HR/HRV), pupil dilation and eye-tracking (ET), facial biometrics (BF), peripheral temperature (PT), and salivary biomarkers (SB) associated with the stress axis (Gregorians et al., 2022; Tawil and Kühn, 2024). These measures will allow us to characterize patterns of activation, attention, cognitive load, and spatial orientation, integrating neurophysiological data with the subjective perception of visual and spatial complexity.

We will also evaluate how architectural complexity modulates the emotional experience (valence/arousal), perceived orientation, and the sense of agency, understood as the visitor's capacity for active exploration and spatial decision-making (Vartanian et al., 2021). The AR and VR environments will preserve key architectural features, enabling a detailed characterization of spatial perception and neurophysiological responses. A comparison will also be conducted between real, augmented, and simulated conditions. Furthermore, an analysis of physiological synchrony among participants during joint sessions in virtual environments will be conducted to examine social cohesion and the interindividual consistency of emotional and cognitive responses to the architectural tours.

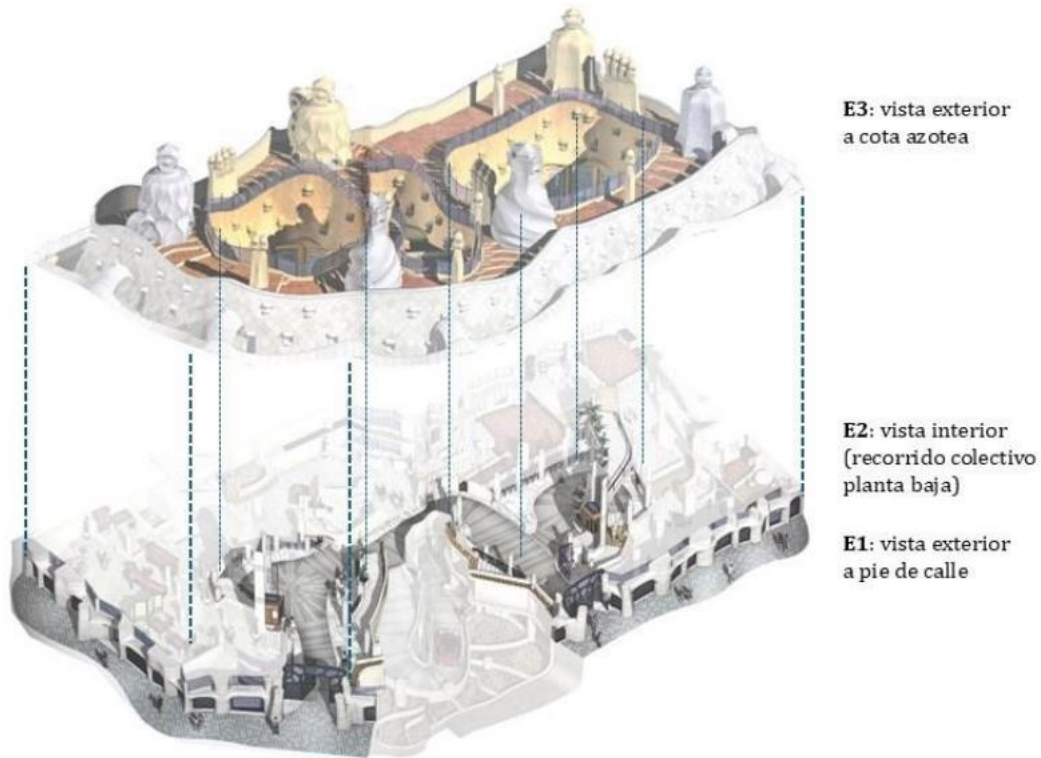
Finally, a real-time multimodal analytical model will be implemented to link specific aspects of Casa Milà with participants' physiological and behavioral records. This integrative approach provides a robust empirical framework for understanding how spatial complexity, sensory integration, and environmental dynamics influence neurocognitive activity and emotional regulation.

#### **3.2. Experimental Scenarios and Conditions**

The scenarios that will serve as stimuli (Figure 5) are the façade and the rooftop—connectors between the building and the urban environment—as well as common spaces—thresholds, entrances, and spaces linking the interior and exterior. As shown in Figure 5, based on this approach, three main scenarios are defined: the first (E1) corresponds to the exterior view from the street, which will allow for the evaluation of the façade's impact on the passerby's perception; the second (E2) focuses on the collective interior circulation of the ground floor, considering

interaction with the space and movement; and the third (E3) is located on the rooftop, where the perception of the building is analyzed in relation to the roof's topography and its connection to the surrounding urban landscape.

**Figure 5.** Three-dimensional reconstruction of the three analysis scenarios for Casa Milà (E1, E2, E3).



Source: Compiled by the author based on documentation from Dosde Publishing (2023)

Each scenario and condition is experienced through first-person virtual tours lasting approximately ten minutes, at a constant speed of one meter per second. In addition, predefined points of interest—including turns, changes in lighting, and interactions with moldings, windows, and other architectural details—are established to precisely synchronize and analyze participants' physiological and behavioral responses during the immersive experience.

For each scenario, three conditions of decreasing complexity are implemented. The first, called Original Gaudí, maintains maximum fidelity to the building, including organic geometry, reliefs, textures, variations in height, and dynamic lighting changes, as well as the fractal richness that characterizes the work. The second, Simplified Gaudí, preserves the general geometry of the space but reduces decorative details and reliefs, standardizes the lighting, decreases porosity, and minimizes distracting elements. The third condition, orthogonal control, transforms the pathways into a rectilinear space with smooth surfaces, uniform colors, and constant luminance, maintaining equivalence in floor plans and sections to allow comparisons with the previous conditions. Figure 6 shows simulations of these three levels of complexity, applied to the entrance to one of the portals and to a passerby's view of the façade. As seen in the images, the building will be evaluated with its current characteristics and qualities (images on the left), with a simplification that preserves Gaudí's essence (images in the center), and with a more orthogonal and rectilinear proposal (image on the right).

**Figure 6.** Simulations of the three levels of complexity to be studied in the laboratory, illustrating two views of Casa Milà.



Source: Own elaboration based on authors' photographic material (2025)

### 3.3. Instruments, measurements, and procedure

The study incorporates a set of neurophysiological, cognitive, and behavioral metrics designed to analyze how the spatial and sensory complexity of Casa Milà modulates users' perceptual and emotional experience. Table 1 lists the techniques proposed for the trials, the variables to be recorded, and the architectural dimension to which they relate—that is, what we measure and how. Each technique was selected for its ability to capture bodily and cognitive responses associated with architectural perception, establishing a direct correspondence with the physical stimuli of the environment (light, form, texture, acoustics, temperature, and spatial orientation).

**Table 1.** Correspondence between techniques and sensory dimensions of the environment

| Type               | Technique              | Variable to be recorded                   | Architectural dimension                                    |
|--------------------|------------------------|---|--|
| Neurophysiological | EEG                    | Cortical activity, activation, attention  | Formal complexity, visual contrast, spatial rhythm         |
|                    | fNIRS                  | Cortical hemodynamic changes (HbO/HbR)    | Light-shadow interaction, cognitive load during navigation |
|                    | EDA/GSR                | Autonomic activation, emotional response  | Unexpected stimuli, texture, spatial transitions           |
|                    | HR/HRV                 | Heart rate and variability                | Anticipation, orientation, perceptual effort               |
|                    | Peripheral temperature | Cutaneous microvascular changes           | Autonomic balance and emotional state                      |
|                    | Salivary biomarkers    | Cortisol, alpha-amylase, oxytocin         | Environmental stress, well-being, socialization            |
| Neurosensory       | ET                     | Fixations, trajectories, visual attention | Guiding elements, spatial hierarchy, natural light         |
|                    | Facial biometrics      | Microexpressions, valence, and arousal    | Visual and symbolic stimuli, ornamentation                 |
| Behavioral         | Motion tracking        | Trajectories, decision latency            | Spatial fluency, route legibility                          |

---

| Subjective  | Questionnaires (SAM, Likert) | Emotion, attractiveness, orientation, agency, mental load | Perceptual synthesis of multisensory experience |
|---|------------------------------|---|---|
| Source: Adapted from Altamura et al. 2018[SD12.1]; Gregorians et al., 2022; Johnson & Kellogg, 2010; Passarelli et al., 2018; Pinti et al., 2020; Tawil & Kühn, 2024. |                              |   |   |

Regarding neurophysiological measures, those based on the recording of electrical and hemodynamic signals are particularly noteworthy. These allow for the mapping of cortical activation patterns associated with the processing of form, light, and space in Casa Milà. EEG is used to record relative power in the alpha, beta, and theta bands, as well as frontal asymmetry, indicators of positive or negative emotional orientation toward architectural stimuli. Complementarily, fNIRS estimates changes in oxy- and deoxyhemoglobin as a marker of superficial cortical activity, particularly useful for evaluating the sustained response to the light and spatial rhythm of the environment. EDA/GSR measurements allow for the quantification of emotional intensity and surprise generated by elements such as the undulation of walls or the sudden opening of courtyards. Meanwhile, HR/HRV reflects physiological modulation during spatial decision-making or movement through narrow or illuminated areas. Finally, peripheral temperature and salivary biomarkers—which provide information on the autonomic and neuroendocrine nervous systems—indicate environmental or social stimulation.

Among the neuroendocrine measures, salivary biomarkers—cortisol, alpha-amylase, immunoglobulin A (IgA), and oxytocin—will be analyzed. These indicators allow for the assessment of physiological responses to stress and well-being, linked to interaction with the architectural environment (Altamura et al., 2018). Cortisol and alpha-amylase levels reflect activation of the hypothalamic-pituitary-adrenal axis, while oxytocin and IgA are associated with states of calm, affiliation, or comfort. The analysis of these biomarkers provides a complementary biological dimension, helping to interpret how spatial conditions—lighting, form, or the presence of natural elements—influence emotional regulation and autonomic balance.

Perceptual-sensory and behavioral measures provide essential information on how users perceive and explore space. The combination of eye-tracking and facial biometrics allows for the recording of both visual attention and the immediate emotional response to architectural stimuli. Eye-tracking identifies the architectural elements that capture the gaze. It also provides information on the visual exploration of the facade or the routes taken. Facial biometrics analyzes micro-expressions and muscle patterns that reflect pleasure, surprise, or interest. Decision latency, route choice, or micro-stops—behavioral indicators—will provide clues about the spatial legibility and perceptual fluidity of the route. These are essential aspects if we wish to understand how architecture guides visitors’ movement and interaction within the space. All of this will allow us to construct a map that integrates the multisensory experience—visual, tactile, and motor perception—with emotion and cognition, reflecting the actual sensory and spatial complexity of Casa Milà.

Subjective measures complement physiological and behavioral data and provide a more conscious dimension of the architectural experience. We will use self-reported scales, where participants can evaluate how they feel within the space (for example, whether a room feels pleasant, stimulating, or confusing). These types of instruments allow us to quantify variables such as emotional valence, arousal level, clarity of orientation, sense of control, or perceived mental load. Together, these subjective responses will help interpret how the spatial and sensory complexity of Casa Milà translates into distinct emotional and cognitive experiences.

Finally, individual variables will allow us to identify and contextualize differences in each participant’s response. We will administer measures of personality (Cook & Furnham, 2012) and familiarity with Gaudí’s work. Both factors may influence sensitivity to the building’s formal and symbolic complexity. These variables will help us understand why the same environment can be stimulating for some and overwhelming for others, introducing the human component into the interpretation of the neuroarchitectural experience.

### 3.4. Methodological Rationale

The multidimensional study presented in this article combines cutting-edge technology with neurophysiological, behavioral, and subjective metrics. This will enable us to capture the multisensory experience of complex architectural environments while integrating physical, cognitive, and emotional responses. When applied to Casa Milà, this methodology will enable the study of the correlation between architectural properties—such as light, texture, or spatial rhythm—and brain processes related to attention, memory, and emotional regulation. This approach proposes a highly innovative bridge between architectural research and applied neuroscience. The objective of this work is to provide a reproducible methodology for analyzing how design materializes experiences that involve the entirety of the human sensory system.

## 4. Discussion

The theoretical and methodological-experimental framework presented in this work offers a broader reflection on the architectural experience as a cognitive and bodily phenomenon, extending beyond the case study itself. The hypotheses proposed and the expected results could position Gaudí’s architecture and Catalan Modernism as benchmarks for physical and mental well-being. Casa Milà, presented in this article as an urban sensory organism, will allow us to explore how architecture can activate brain, physiological, and behavioral patterns that shape the spatial memory and emotional response of its users. Table 2 below relates architectural properties to sensory processes and expected neurophysiological responses. This sheds light on how the multisensory experience at Casa Milà activates perception, emotion, and memory.

**Table 2.** Correspondence between sensory aspects and expected brain responses

| Level of analysis                            | Variables or measures            | Sensory aspects involved   | Expected brain response or function  |
|--|----------------------------------|--|--|
| <b>Architecture and space</b>                | Organic form and geometry        | Visual and tactile stimulation<br>Multisensory integration<br>Perception of spatial rhythm | Cortical activation<br>Increased positive activation<br>Sustained attention and curiosity                |
|  | Natural light and shadows        |  |  |
|  | Textures and materials           |  |  |
|  | Spatial sequences and pathways   |  |  |
|  | Acoustic contrasts               |  |  |
| <b>Perceptual and cognitive processes</b>    | Visual attention                 | Visuospatial coordination<br>Active exploration<br>Anticipation and recall of routes       | Synchrony between frontal and parietal areas<br>Activation of memory and navigation networks             |
|  | Spatial orientation              |  |  |
|  | Interoception and proprioception |  |  |
|  | Perceptual memory                |  |  |
| <b>Physiological and emotional responses</b> | Autonomic activity               | Emotional regulation<br>Stress and well-being<br>Reaction to complex or harmonic stimuli   | Modulation of the limbic system<br>Positive or negative emotional response<br>State of calm or alertness |
|  | Facial expression                |  |  |
|  | Salivary biomarkers              |  |  |
| <b>Subjective perception</b>                 | Questionnaires                   | Conscious evaluation of spatial experience   | Cognitive-emotional integration<br>Assessment of the environment as stimulating and coherent             |
|  | Aesthetic appeal                 |  |  |
|  | Mental load and agency           |  |  |

Source: Own elaboration, 2025.

There are numerous expected outcomes and hypotheses. First, it is reasonable to expect that Gaudí’s spatial complexity—organic geometry, a sequence of thresholds, and the interplay of light, texture, and sound—will elicit higher levels of positive arousal and aesthetic pleasure than simplified simulations or adaptations, or orthogonal and rectilinear designs. This expectation is based on the principle of optimal complexity discussed in point 2 (Berlyne, 1971; Ellard, 2015), according to which environments rich in stimuli—in addition to being coherent in their organization—arouse greater curiosity and sustained attention.

Another expected result is that peaks in physiological activation (EDA, HRV, EEG) will coincide with moments when the user has spatial decision-making power. This is based on the idea that architecture is not only perceived but also induces agency—that is, a sense of control and active participation in the environment. This cognitive dimension reinforces the hypothesis that Gaudí's spaces can promote exploratory movement as well as sensory engagement. Both responses are essential elements for environmental memory and well-being—both physical and mental (Abbas et al., 2024; Condia et al., 2020; Farrow 2024).

A heightened sense of orientation and emotional identification within the Gaudí environment, due to its fractal coherence and symbolic richness that articulates multiple levels of interpretation, is another expected outcome. This could be explained in terms of pathways, spatial organization—of courtyards, staircases, and portals—visual continuity between interior and exterior, and the use of biomorphic patterns. These elements could act as perceptual references that facilitate the legibility of the space and reduce the anxiety associated with disorientation, as noted in multiple studies (Robinson & Pallasmaa, 2015).

Finally, it is reasonable to expect that individual and cultural factors—such as familiarity with Modernism or a particular sensitivity to complexity—might modulate the emotional intensity of the experience. The contrast between contemporary fascination with Casa Milà and the initial rejection by people such as Rosario Segimon illustrates the tension between overstimulation and emotional attachment. Different study subjects or users, depending on specific personal qualities, preferences, or sociocultural context, may express rejection or admiration in response to the same sensory richness.

Taken together, these hypotheses and expected results suggest that Gaudí's architecture functions as a catalyst for sensory and cognitive states, capable of stimulating brain activity, attention, and emotional response in a manner analogous to the visual arts or music, but within an architectural and urban framework. The study of Casa Milà, from the perspective proposed in this article, allows us to observe Gaudí's work from the intersection of art, science, and architecture. This highlights a symbolic, yet also emotional, reading of Gaudí's spaces, where perception is not limited to form. It also opens up a range of meanings regarding the icons and ornamental motifs—inspired by nature, spirituality, or geometry—depending on the observer's origin, religion, or cultural context. This reveals an interpretive and subjective dimension of the architectural experience, applicable to Gaudí's entire body of work.

## 5. Conclusions

This article, which proposes an innovative, interdisciplinary methodological model, links applied neuroscience with architectural and urban analysis, applying cutting-edge technology—AR, VR—and neuroscientific analytical tools to the study of the user experience. Casa Milà, presented as a case study, offers ideal characteristics that can be transferred to a laboratory setting to investigate how form, light, and materiality influence perception and well-being. This neuroarchitectural perspective allows us to discuss spatial and sensory complexity not merely as an ornamental feature, but as a structural component of human well-being. Environments that stimulate the senses—vision, touch, hearing, and proprioception—in a balanced manner favor the activation of brain circuits associated with emotion, memory, and autonomic regulation, promoting states of mindfulness and cognitive satisfaction.

The experimental and methodological approach described in this work—which integrates the measurement of neurophysiological, behavioral, and perceptual responses—offers a way to objectify and ground in scientific evidence the subjective experience of a user who traverses or inhabits a given space. This approach opens the possibility of redefining architectural and urban design practice toward a system grounded in neuroscientific evidence, where spatial parameters are considered part of a system of sensory communication between the environment and the senses.

Furthermore, this work and the proposed methodology contribute to situating Gaudí's legacy within a contemporary multidisciplinary debate, in which urban creativity, multisensory

perception, and collective memory converge, allowing us to explore and understand his work as an essential part of the city, of the architectural discourse, but also of the user's bodily experience, all of which interact in the construction of multiple meanings.

## **6. Acknowledgments**

This article is part of the project "Neuro-Creativity Co-Lab: Building Collaborative Convergence in the Design of Everyday Spaces" (INC-UDIT-2024-PRO20), funded by the University of Design, Innovation, and Technology (UDIT). This work is part of the research lines of the NEURO-COLAB research group, focused on the application of neuroscience to interior design, creativity, and sensory experience in architectural environments.

## References

- Abbas, S., Okdeh, N., Roufayel, R., Kovacic, H., Sabatier, J.-M., Fajloun, Z., & Abi Khattar, Z. (2024). Abbas, S., Okdeh, N., Roufayel, R., Kovacic, H., Sabatier, J.-M., Fajloun, Z., & Abi Khattar, Z. (2024). Neuroarchitecture: How the Perception of Our Surroundings Impacts the Brain. *Biology*, 13(4), 220. <https://doi.org/10.3390/biology13040220>
- Altamura, M., Iuso, S., Balzotti, A., Francavilla, G., Dimitri, A., Cibelli, G., Bellomo, A., & Petito, A. (2018). Salivary alpha-amylase and cortisol responsiveness to stress in first episode, drug-naïve patients with panic disorder. *Neuroscience Research*, 137, 49–56. <https://doi.org/10.1016/j.neures.2018.03.003>
- Azzazy, S., Ghaffarianhoseini, A., GhaffarianHoseini, A., Naismith, N., & Dobarjeh, Z. (2020). A critical review on the impact of built environment on users' measured brain activity. *Architectural Science Review*, 64(4), 319–335. <https://doi.org/10.1080/00038628.2020.1749980>
- Berlyne, D. E. (1971). *Aesthetics and psychobiology*. Appleton-Century-Crofts.
- Blázquez, J. L. (2023, 13 de abril). *Disseny biofílic i neuroarquitectura a la Casa Vicens de Gaudí*. Josep Lluís Blázquez entrevista a Ana Mombiedro y Alba Méndez [Emisión de radio]. *Perspectiva*. <https://www.3cat.cat/3cat/disseny-biofiliic-i-neuroarquitectura-a-la-casa-vicens-de-gaudi-amb-ana-mombiedro-i-alba-mendez/audio/1168647>
- Bolli, A. (2016). Gaudí – A legacy of craft. *Journal of Architecture and Urbanism*, 40(1), 56–67. [https://www.researchgate.net/publication/301500764\\_Gaudi\\_-\\_A\\_Legacy\\_of\\_Craft](https://www.researchgate.net/publication/301500764_Gaudi_-_A_Legacy_of_Craft)
- Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry*, 25(1), 49–59.
- Casa Vicens. (2023). *Taller de Ana Mombiedro y Alba Méndez*. Casa Vicens Barcelona.
- Condia, B., Arbib, M., Ellard, C., Chamberlain, B., & Rooney, K. (2020). *Meaning in Architecture: Affordances, Atmosphere and Mood*.
- Cook, R., & Furnham, A. (2012). Personality and aesthetic preferences. *Psychology of Aesthetics, Creativity, and the Arts*, 6(3), 257–266.
- Dehghani Tafti, M., Ahmadzad-Asl, M., Memarian, G., Fallah Tafti, M., Rajimehr, R., Soltani, S., Mirfazeli, F. S., Vahabie, A.-H., Moein, S. T., & Mozaffar, F. (2024). Personality traits can predict architectural preferences: A machine learning approach. *Psychology of Aesthetics, Creativity, and the Arts*, 18(5), 750–761. <https://doi.org/10.1037/aca0000519>
- Dosde Publishing. (2023). *La Pedrera. El último proyecto residencial de Antoni Gaudí*. Dosde Publishing.
- Eberhard, J. P. (2009). *Brain Landscape: The Coexistence of Neuroscience and Architecture*. Oxford University Press.
- Ellard, C. (2015). *Places of the Heart: The Psychogeography of Everyday Life*. Bellevue Literary Press.
- Farrow, T. (2024). *Constructing Health: How the Built Environment Enhances Your Mind's Health*. University of Toronto Press
- Freixa Serra, M. (2020). Dibujos, proyectos y maquetas. En Artika (Ed.), *Gaudí en primer plano* (pp. 161–239). Artika.
- Fundació Catalunya La Pedrera. (s. f.). *Historia de la Casa Milà*. La Pedrera – Casa Milà. <https://www.lapedrera.com/es/casa-mila/historia>
- Gibson, J. J. (1979). *The ecological approach to visual perception*. Houghton Mifflin.
- Gregorians, L., Fernández Velasco, P., Zisch, F., & Spiers, H. J. (2022). Architectural experience: Clarifying its central components and their relation to core affect with a set of first-person-view videos. *Journal of Environmental Psychology*, 82. <https://doi.org/10.1016/j.jenvp.2022.101841>
- Hill, D. (2018, 9 de julio). The “bland-demic”: Global homogenisation and the end of distinctiveness. *CityLab*. <https://www.bloomberg.com/news/articles/2018-07-09/the-bland-demic-of-global-architecture>

- Johnson, J. M., & Kellogg, D. L. Jr. (1985). Local thermal control of the human cutaneous circulation. *Journal of Applied Physiology*, 109(4), 1229–1238. <https://doi.org/10.1152/jappphysiol.00407.2010>
- Makanadar, A. (2024). Neuro-adaptive architecture: Buildings and city design that respond to human emotions and cognitive states. *Research in Globalization*, 8, 100222. <https://doi.org/10.1016/j.resglo.2024.100222>
- Meirelles, F., Mendes, P., & Pereira, J. (2019). Geometric shape, structure and material in Antoni Gaudí's work. *Journal of Civil Engineering and Architecture*, 13(11), 595–604. <https://www.davidpublisher.com/Public/uploads/Contribute/5dd4f7aa863ac.pdf>
- Mirkia, H., Nelson, M. S., Abercrombie, H. C., Thorleifsdottir, K., Sangari, A., & Assadi, A. (2022). Recognition Memory for Interior Spaces with Biomorph or Non-Biomorph Interior Architectural Elements. *Journal of Interior Design*, 47(3), 47-66. <https://doi.org/10.1111/joid.12224>
- Nasir, O., Akhtar, W., Iqbal, M. F., & Kamal, M. A. (2022). Analyzing the architecture of Antonio Gaudí with reference to Art Nouveau style: An inspiration from nature. *Architecture Engineering and Science*, 3(4), 309–319. <https://doi.org/10.32629/aes.v3i4.1100>
- Negami, H. R., & Ellard, C. G. (2023). How architecture evokes awe: Predicting awe through architectural features of building interiors. *Psychology of Aesthetics, Creativity, and the Arts*, 17(1), 3. <https://doi.org/10.1037/aca0000394>
- Pallasmaa, J. (2005). *The Eyes of the Skin: Architecture and the Senses* (2nd ed., illustrated). Wiley-Academy.
- Passarelli, M., Masini, M., Bracco, F., Petrosino, M., & Chiorri, C. (2018). Development and validation of the Facial Expression Recognition Test (FERT). *Psychological Assessment*, 30(11), 1479–1490. <https://doi.org/10.1037/pas0000595>
- Pinti, P., Tachtsidis, I., Hamilton, A., Hirsch, J., Aichelburg, C., Gilbert, S., & Burgess, P. W. (2020). The present and future use of functional near-infrared spectroscopy (fNIRS) for cognitive neuroscience. *Annals of the New York Academy of Sciences*, 1464(1), 5–29. <https://doi.org/10.1111/nyas.13948>
- Robinson, S., & Pallasmaa, J. (2015). *Mind in Architecture: Neuroscience, Embodiment, and the Future of Design*. MIT Press.
- Sharpe, C., Beltrán Rodríguez, M., Pichel, M., & Josa, M. (2024). *Memory and space: Rethinking lecture hall design through the principles of neuroarchitecture*. En *Actas del Congreso Internacional de Diseño, Innovación y Nuevas Tecnologías (CIDiNova 2024)*. <https://cidinova.org/ponencia/memory-and-space-rethinking-lecture-hall-design-through-the-principles-of-neuroarchitecture/>
- Srikantharajah, J., & Ellard, C. (2025). The physiological and psychological impact of boring buildings: Field studies of the effects of architectural façade complexity.
- Tawil, N., & Kühn, S. (2024). The built environment and the brain: Review of emerging methods to investigate the impact of viewing architectural design. En B. Leupen, C. Grafe, N. König, M. Lampe, & P. de Zeeuw (Eds.), *Environmental Neuroscience* (pp. 169–226). Springer. [https://doi.org/10.1007/978-3-031-64699-7\\_9](https://doi.org/10.1007/978-3-031-64699-7_9)
- Vartanian, O., Navarrete, G., Palumbo, L., & Chatterjee, A. (2021). Individual differences in preference for architectural interiors. *Journal of Environmental Psychology*, 77, 101668. <https://doi.org/10.1016/j.jenvp.2021.101668>