



NEUROCOMMUNICATION OF BUILT HERITAGE

Attention anchors on the façade and chapel of Gaudí's palace (Astorga) using mobile eye-tracking (Pilot study)

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ABSTRACT

Pilot in situ mobile eye-tracking assessed visual attention to Gaudí's Episcopal Palace (Astorga). Twenty-eight participants freely viewed the chapel (n=14) or main façade (n=14) for 15 s. AOIs were delineated (18 chapel; 15 façade) on scene images; iMotions exported AOI coverage, TTF, dwell time, fixation and revisit measures, supported by heatmaps. The chapel showed a concentrated pattern on the liturgical central axis: upper stained glass attracted early looks, while the altar sustained processing. The façade showed a more exploratory, multi-node pattern centred on the entrance and main volumes, with weak engagement with crown elements.

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1. Introduction

Built heritage functions both as an aesthetic experience and as a means of communicating a sense of place: visitors do not merely walk through a building, but interpret it through a sequence of perceptual, affective and meaning-making processes. Neuroarchitecture and neuroaesthetics have proposed models explaining how aesthetic appreciation arises from the interaction between perceptual analysis, memory and evaluative judgement (Chatterjee and Vartanian, 2016; Leder et al., 2004), and how, in architecture, the observer's response depends on the form, spatiality and cultural symbolism of the place (Coburn et al., 2017; Chatterjee et al., 2021). In terms of "place branding", this non-verbal dimension is fundamental: iconic architecture constitutes the destination's "primary communication", as it encapsulates identity values and shapes the territorial reputation (Anholt, 2010; Kavartzis, 2004).

However, despite the growth of the theoretical framework, empirical evidence on visual attention in heritage architecture remains limited under ecological conditions. Eye-tracking research has become established in marketing and tourism to study advertisements, packaging, websites or promotional images (Savin et al., 2022; Wedel and Pieters, 2008), but studies using virtual reality headsets applied to historic buildings remain few and far between and methodologically demanding (de la Fuente Suárez, 2020; Mandolesi et al., 2022). This asymmetry is significant because, in complex scenes, gaze is not distributed homogeneously: it is organised around nodes of attentional priority where salience, expectations and meaning converge (Awh et al., 2012; Tatler et al., 2011).

This gap is even more evident in Gaudí's architecture outside Barcelona, where unique structures such as the Episcopal Palace of Astorga function as heritage icons and strategic assets for territorial differentiation. However, it is not precisely known which specific elements of its façade and its sacred interior space first capture attention and sustain visual processing during the visit. In order to provide evidence on this point, the present study records, using mobile eye tracking, the visual exploration of two scenes of the same building: (a) the main chapel (interior) and (b) the main façade (exterior). Using a between-groups design ($n = 14$ per condition) and a 15-second free-viewing task, global eye metrics and those for areas of architectural interest are analysed.

The study contributes, on the one hand, to operationalising visual attention in heritage through areas of interest (AOI) aligned with the building's compositional and iconographic hierarchy; and, on the other, to linking attentional patterns with neuroarchitectural interpretations and with applied implications for heritage communication and place branding.

2. Theoretical framework

2.1. Neuroarchitecture, aesthetic experience and the creative city

Neuroarchitecture emerges at the intersection of empirical aesthetics, cognitive neuroscience and environmental psychology, and is based on the idea that the experience of built spaces can be broken down into identifiable psychological and neural processes. A key model is that of Leder et al. (2004), which conceives of aesthetic appreciation as a sequence of five stages: perceptual analysis, integration with implicit memory, explicit classification (by style, function, etc.), cognitive mastering and evaluative judgement. Within this framework, complex and symbolically charged stimuli—such as Gaudí's architecture—require greater cognitive mastering effort: the observer must invest time in exploring the building to discover patterns, unravel its formal logic and construct meaning.

Neuroaesthetics has systematised these processes in the so-called "aesthetic triad" model. Chatterjee and Vartanian (2016) propose that all aesthetic experience emerges from the interaction of three systems: a sensorimotor system (how we perceive and anticipate moving through space), an affective-evaluative system (pleasure, interest, arousal) and a knowledge-meaning system (memory, expectations, cultural background). Coburn et al. (2017) apply this

triad specifically to architecture and demonstrate that the response to buildings depends not only on “what is seen” in geometric terms, but also on how the body imagines itself occupying that space and on the cultural significance associated with the place. Programmatically, Chatterjee et al. (2021) propose the “neuroaesthetics of architectural spaces” and insist on moving from general descriptions towards controlled experiments on specific features such as ceiling height, curvature or the degree of enclosure.

In parallel, the psychological dimensions that structure the architectural experience have been clarified. Gregorians et al. (2022) show that three dimensions—fascination, coherence and hominess (a sense of home or warmth)—account for much of the variation in valence and activation produced by different spaces, and that fascination is associated with spatial complexity and unusualness, whilst coherence is linked to order and the ease of organising the scene. Weinberger et al. (2021) replicate this framework in both buildings and natural landscapes, and confirm that fascination, coherence and hominess are dimensions widely applicable to the experience of built and natural environments. Within this framework, the façade and chapel of Gaudí’s Palace in Astorga can be interpreted as configurations of high fascination and complexity, with a high degree of compositional coherence centred on a central axis, but with varying levels of hominess: greater institutional distance in the façade and a stronger sense of refuge and seclusion within the sacred interior.

Recent literature has also established the relationship between built environment design, emotion and well-being. Bower et al. (2019), in a systematic review of studies using autonomic and central measures (heart rate, skin conductance, EEG, fMRI, among others), conclude that variables such as form, spatial distribution, materials, colour or lighting systematically modulate emotional states in interior spaces. Karakaş and Yıldız (2020) review the literature under the heading of a “neuroscientific approach to the experience of the built environment” and argue that the contemporary city constitutes the “habitat” of a highly sophisticated mammal, and therefore architectural design must be reconsidered in light of neuroscientific evidence regarding cognitive load, stress and comfort. In this context, Gaudí’s Palace can be understood as an extreme case of “neurosensitive” design, where the combination of formal complexity and strong compositional organisation offers an ideal testing ground for studying the relationship between architectural structure and aesthetic experience.

From the perspective of environmental psychology, Kaplan’s Attention Restoration Theory (1995) adds a restorative dimension: certain environments, particularly those incorporating nature or “gentle fascination” stimuli, promote the recovery of focused attention and a reduction in mental fatigue. Ulrich (1984), in a classic study with post-surgical patients, showed that having a window with a view of trees was associated with shorter hospital stays and lower use of painkillers compared to views of a brick wall. This research gave rise to the concept of restorative environments, in which certain formal patterns, the presence of natural elements and a sense of refuge contribute to reducing stress and improving well-being. Although Gaudí’s Palace is an urban building, the interplay between stone, light, the surrounding vegetation and organic forms can place its perception in continuity with this restorative logic.

Finally, architectural micro-morphology has also been the subject of experimental analysis. Vartanian et al. (2013), using fMRI, demonstrated that curvilinear spaces are judged on average to be more beautiful than rectilinear ones and that this preference is accompanied by greater activation in brain networks involved in aesthetic evaluation, without the curvature clearly modifying approach-avoidance decisions. These results empirically support the intuition that curvature, which features prominently in Gaudí’s architectural language, is not merely a stylistic device, but a significant modulator of the aesthetic experience. Integrated with the models of the aesthetic triad and fascination/coherence/hominess, they suggest that the façade and chapel of the Astorga Palace function as neuroaesthetic devices designed to capture the gaze, organise it along legible axes (centrality and verticality) and, inside, generate an atmosphere of protection and contemplation. This interpretation aligns with the notion of the creative city formulated by Landry (2000), according to which cities committed to creativity do not merely promote cultural

industries, but rather shape urban environments capable of stimulating the imagination and projecting a unique identity. In this sense, the present study interprets Gaudí's Palace in Astorga as a hub of a creative city and uses eye-tracking data to describe how this architectural feature is actually processed in terms of attention, emotion and aesthetic evaluation.

2.2. Visual attention and built heritage: contributions from eye tracking

Contemporary literature on visual attention agrees that the visual system does not process the scene uniformly, but rather prioritises certain areas based on a "priority map" that integrates various factors. Awh et al. (2012) challenge the classic dichotomy between "bottom-up" attention (guided by physical salience) and "top-down" attention (goal-guided) and propose that attentional priority results from the combination of the observer's goals and expectations, the salient properties of the stimulus and the history of previous selection (learning, reward, habit). In the context of heritage architecture, this implies that the gaze is directed as much by contrasts in colour, texture or lighting as by the expectation of finding compositional axes, entrances or religious symbols that are "expected" in a historic building.

Natural vision studies using eye tracking reinforce this integrative approach. Tatler et al. (2011) show that, in ecological tasks, fixations are organised primarily according to the tasks and the semantic structure of the scene, such that low-level salience mainly explains the initial, very short-latency saccades, but loses significance as exploration progresses. Applied to a historic building, the visitor does not merely follow "contrast patches", but reads the façade or interior through their cultural scripts: they identify the central axis, locate the main entrance, recognise familiar iconographic motifs and segment the whole into comprehensible units. Visual attention to built heritage is therefore situated at the intersection between formal structure, cultural scripts and the objectives of the visit (finding one's way, contemplating, photographing, learning).

Against this theoretical backdrop, eye tracking has established itself as a central tool for analysing how heritage buildings are explored. De la Fuente Suárez (2020) conducts a mobile eye-tracking study at the Old Golfo Station (Monterrey), combining eye trajectories, observation times and a visuospatial zoning questionnaire to relate areas of the façade, visual attention and types of subjective experience. Her results show that the regions with the longest observation times tend to coincide with those that participants later identify as the most important, oldest or aesthetically valuable, and that attention is not distributed evenly along the route, but rather concentrates on certain key vantage points. Furthermore, discrepancies are detected between what participants believe they looked at and what they actually fixated on, reinforcing the value of eye tracking over pure self-reporting in heritage contexts.

In a more quantitative approach, Wu et al. (2023) develop a predictive model of visual attention applied to built colonial heritage. Using eye-tracking metrics (total and average fixation duration, saccade amplitude and speed, and pupillary indicators) and 12 subjective evaluation indicators (proportion, decorative refinement, cultural atmosphere, attractiveness, etc.), they construct a neural network model capable of classifying scenes into low, medium or high levels of attention with an accuracy of around 75%. This work validates the use of eye metrics as quantitative indicators of visual value and appeal in complex architectural scenes, and paves the way for their application to unique elements such as historic façades or sacred spaces.

Other studies have focused on how the formal coherence of façades influences the visual and emotional experience. Nédée et al. (2023), as part of the mateMad project, analyse the perception of façades in vulnerable neighbourhoods of Madrid using visual attention simulation (3M VAS), a structured survey and participatory design. Their results indicate that a lack of vertical symmetry, geometric disparity in window size, poor maintenance, low transparency and a lack of chromatic homogeneity are associated with greater subjective discomfort, whilst horizontal and vertical symmetry and a reasonable repetition of the shape and size of openings are linked to more relaxing experiences. Although the study employs simulation rather than actual eye tracking, its conclusions are transferable to the interpretation of historic buildings: the geometric organisation

and compositional coherence of a façade influence both aesthetic judgements and the expected distribution of fixations, as well as the overall emotional tone of the experience.

For heritage interior spaces, the work by Mandolesi et al. (2022) in the “Studiolo del Duca” of the Ducal Palace in Urbino constitutes a direct methodological precedent. Using eye-tracking glasses (Tobii Pro Glasses 2), they record visitors’ free exploration and show which parts of the ensemble (panels, portraits, decorative elements) attract the most fixations and how patterns of “enjoyment” of the space are configured. The study confirms that, even in a highly ornamented interior, attention is organised around a few dominant visual nodes and that the physical context (lighting, visitor position, movement restrictions) strongly determines which elements are practically ignored.

Finally, a number of reviews have systematised the use of eye-tracking in museums and exhibition spaces. Xu et al. (2023) critically review the literature on eye tracking in museum translation studies between 2010 and 2022, showing that the technology has been used primarily to map the distribution of attention between artworks, labels and other media, and to assess patterns of reading and comprehension of museum texts. The authors highlight both the potential of eye tracking to study the perception and reception of exhibition content and the recurring limitations of many studies (small sample sizes, limited triangulation with other measures, predominant use of on-screen images rather than actual artworks). This reflection reinforces the importance of in situ studies using mobile devices in real heritage contexts.

Overall, the available literature converges on three points that directly frame the present study. First, visual attention to built heritage is neither random nor homogeneous, but is organised according to the formal structure of the building (axes, symmetries, compositional hierarchy) and the meaning attributed to its elements (portal, towers, stained-glass windows, altar, vault). Second, eye-tracking metrics—number and duration of fixations, time to first fixation, saccadic trajectories, and pupillary variations—can be interpreted as robust indicators of interest, perceived value and visual quality, to the extent that they allow scenes to be classified into high, medium or low levels of attention (Wu et al., 2023). Thirdly, studies using mobile eye tracking in architectural heritage sites and museums show that this methodology is suitable for capturing visitors’ actual experience provided that significant areas of interest are defined and the physical context of the observation is taken into account (de la Fuente Suárez, 2020; Mandolesi et al., 2022; Xu et al., 2023).

On this basis, the analysis of the façade and chapel of Gaudí’s Palace in Astorga using eye-tracking glasses allows us to identify precisely which architectural elements act as true “attention magnets” and how visual exploration is articulated across two formally and symbolically distinct spaces. These patterns of attention constitute a key empirical input for interpreting the Palace not only as an object of aesthetic contemplation, but also as a device for heritage communication and a central resource in the construction of Astorga’s city brand.

2.3. Gaudí, heritage and city branding

Antoni Gaudí’s architectural legacy is a paradigmatic example of how heritage can function as a strategic resource for city branding. UNESCO recognises the “Works of Antoni Gaudí” as a serial property comprising seven buildings located in Barcelona and its immediate surroundings (Parc Güell, Palau Güell, Casa Milà, Casa Vicens, Casa Batlló, the Crypt of Colònia Güell and the Sagrada Família), highlighting his “exceptional creative contribution” to the development of architecture and building technology between the late 19th and early 20th centuries. Recent reports on Barcelona’s cultural policy note that the city boasts eight UNESCO World Heritage sites, seven of which are works by Gaudí, placing his output at the heart of Barcelona’s heritage imagination.

This heritage significance has been explicitly articulated in terms of place branding. Rius-Ulldemolins (2014) analyses the so-called “Barcelona model” of urban regeneration and shows how culture has become a central competitive resource, with the Raval neighbourhood repositioned as the “brand space” of authentic and creative Barcelona. In this process, Modernist works – and in particular those of Gaudí – function as symbolic shortcuts that encapsulate a

selective version of urban identity. Degen and García (2012) describe the evolution of this model from an initial phase centred on citizenship and social cohesion towards a more functional use of culture as a tool for urban marketing and for attracting investment and tourism, in which the Gaudí landscape becomes a key differentiating asset.

From a tourism perspective, various studies have examined the repositioning of Barcelona as a branded destination. Majhoshev and Koteski (2020), in their analysis of Barcelona as a tourism brand city, highlight that the combination of unique architectural heritage and sustained promotional policies has enabled the city to establish itself as a highly competitive global urban destination. In parallel, Compte-Pujol (2015), in a study involving 300 residents, shows that heritage is the attribute that carries the most weight in the overall image of Barcelona as perceived by its inhabitants, to the extent that it is described as a kind of “DNA” of identity upon which the place brand is built. These empirical findings support the interpretation of Gaudí not only as protected heritage, but as the semantic core of the Barcelona brand.

Theoretically, this process is best understood in the light of the literature on place branding. Kavartzis (2004) proposes that the city brand is constructed through three levels of communication: primary communication, consisting of the physical reality and urban policies (architecture, public space, infrastructure); secondary communication, comprising promotional campaigns and marketing activities; and tertiary communication, made up of narratives from the media, tourists and residents. Within this framework, Gaudí’s works are central to primary communication: unique buildings that non-verbally project values such as creativity, spirituality, technical innovation and tradition. Anholt (2010) emphasises that place branding should be understood, rather than as a graphic exercise, as reputation management based on policies, products, culture and real places; an effective brand is one that is anchored in tangible contributions. The international renown of the Gaudí system fits with this vision of a brand supported by material assets of high symbolic value.

In the same vein, Fernández-Cavia et al. (2018) propose understanding place branding as a networked communication phenomenon: the brand emerges from the continuous interaction between public authorities, the private sector, residents and visitors, and the city’s tangible elements —buildings, landscapes, facilities— act as significant supports that embody the brand narratives. From this perspective, Gaudí’s body of work can be interpreted as a “communicative infrastructure” upon which the image of Barcelona —and, by extension, of other territories linked to the architect— is constructed and negotiated.

Theories of the creative city add a complementary dimension. Landry (2000) argues that cities committed to creativity not only invest in cultural industries, but also shape urban environments capable of stimulating the imagination, fostering social interaction and projecting a unique identity both internally and externally. The density of Modernist heritage in Barcelona – and particularly the concentration of Gaudí’s works recognised as World Heritage sites – has enabled the city to be presented as a laboratory of urban creativity, where architecture functions simultaneously as infrastructure and as a cultural product of high symbolic value. In this context, Gaudí ceases to be merely a canonical figure and becomes a branding device that articulates the narrative of Barcelona as a creative and cosmopolitan city.

In recent years, this logic has been extending to the regions where the few works by Gaudí outside Catalonia are preserved. Recent institutional documentation and media coverage describe how the Episcopal Palace of Astorga, Casa Botines in León and El Capricho in Comillas are being positioned as nodes of a “Gaudí Route” that connects these buildings with Barcelona and the Camino de Santiago, with explicit aims of cultural and tourism promotion. At the same time, several Gaudí buildings – including the Gaudí Palace in Astorga and Casa Botines – are leading an initiative to promote a second extension of the World Heritage listing, which would extend the serial property beyond Barcelona.

In the specific case of Astorga, official sources describe it as one of the few buildings designed by Gaudí outside Catalonia, in the Neo-Gothic Modernist style, which today houses the Museum of

the Pilgrimage Routes dedicated to the Way of St James, reinforcing its role as a symbolic gateway to the historic city.

Furthermore, recent investments in the refurbishment of the gardens and the exterior surroundings of the Palace, linked to the centenary of Gaudí's death in 2026 and the aspiration to secure UNESCO recognition, demonstrate that the building is being deliberately used as a lever for territorial positioning within the context of the Gaudí Year. From the perspective of place branding, the Palace thus operates on the three levels described by Kavatzis (2004): as a physical and spatial reality (primary communication), as a recurring icon in tourism and cultural promotion (secondary communication), and as a protagonist in media narratives, institutional initiatives and visitor testimonials (tertiary communication).

In short, Gaudí's legacy as a heritage resource and city brand provides a solid framework for interpreting the Astorga Palace not only as an object of architectural or neuroaesthetic study, but as part of a broader territorial communication strategy. Analysing, through eye-tracking, how visitors visually explore the façade and chapel of this building allows us to delve into the micro-level of that strategy: identifying which architectural elements effectively hold the public's attention and fascination, and to what extent these perceptual focal points align with the image that Astorga and the "Camino de Gaudí" network seek to project in the context of Gaudí Year 2026 and the World Heritage nomination.

2.4. The role of eye tracking as a tool for neuromarketing and place branding

Neuromarketing and consumer neuroscience are based on the premise that a substantial part of the value of brands, products and destinations is constructed through implicit processes that are difficult to capture using traditional declarative methods. Hubert and Kenning (2008) define consumer neuroscience as the systematic use of neuroscience tools to study how brands and marketing stimuli are represented, evaluated and chosen in the brain, distinguishing this academic field from applied neuromarketing consultancy. Morin (2011) describes neuromarketing as a "new science of consumer behaviour" intended to complement, not replace, traditional surveys through real-time physiological measures of attention, emotion and memory. Building on this, Plassmann et al. (2012) propose the "branding the brain" framework, that is, the application of neuroscience methods – including eye tracking —to study how brand associations are formed and which circuits of value, memory and attention are involved when we evaluate logos, packaging or advertisements. Karmarkar and Plassmann (2019) summarise the subsequent decade by emphasising that the specific contribution of consumer neuroscience is not to "find the buy button", but to improve consumer decision models where it is reasonable to expect discrepancies between the explicit and the implicit.

Within this methodological ecosystem, eye tracking occupies an intermediate position between conventional and neurophysiological research. It does not directly record brain activity, but provides a very precise measure of where visual attention wanders, for how long, and in what order a stimulus is explored. The classic review by Wedel and Pieters (2008) shows that eye tracking has been systematically used to study attention to print advertisements, packaging, supermarket shelves, websites and other visual interfaces, and concludes that eye metrics (number and duration of fixations, trajectories, heatmaps) allow formal characteristics of the stimulus to be consistently linked to recall, attitudes and choice. Along the same lines, Santos et al. (2015) propose a specific agenda for eye tracking in neuromarketing and argue that the technique has direct applications in practically all the "Ps" of marketing (product, price, place, promotion) and in fields such as social marketing.

Beyond their descriptive use, several studies have shown that visual attention metrics are not merely laboratory curiosities, but causal mediators between stimulus design and business variables. Pieters and Wedel (2004), in a study involving over 1,300 print advertisements and more than 3,600 consumers, show that the three main components of an advertisement (brand, image and text) capture attention in different ways: the pictorial element is the most effective at attracting initial fixations, text attracts attention in proportion to its size, and the brand benefits

from attention transferred from the image and text. Attention to the brand, in turn, predicts both brand recall and attitudes towards the advertisement. Chandon et al. (2009) find a similar pattern at the point of sale: the number of brand facings on the shelf increases visual attention, and this increase, measured using eye tracking, fully mediates the effect of shelf space on evaluation and choice. These results validate the use of eye tracking as an indicator of the “communication value” of different visual elements in applied contexts.

In the more strictly neurophysiological realm of neuromarketing, eye tracking is increasingly being integrated into multimodal designs. Guixeres et al. (2017) combine EEG, heart rate variability and eye tracking across eight Super Bowl adverts and show that a set of neurophysiological metrics significantly predicts recall, liking and, in particular, actual views on YouTube. Venkatraman et al. (2015), for their part, integrate various indicators (including eye tracking, biometrics and fMRI) with sales data and demonstrate that activity in value-related regions such as the ventral striatum adds explained variance in advertising elasticity beyond traditional pre-test metrics. Khushaba et al. (2013) illustrate the role of eye tracking as a “bridge” between the brain and behaviour: in a snack-choice experiment, they combine EEG and eye tracking and show that changes in flavour and coating attributes are reflected simultaneously in eye patterns and electrical activity, whilst the shape of the product proves less decisive. Taken together, these studies suggest that eye tracking indicates which parts of the stimulus are actually processed when implicit responses measurable with neurophysiological techniques are generated.

In recent years, this logic has been applied to tourism and place branding. Bastiaansen et al. (2018) introduce a “neurotourism” approach that combines EEG, autonomic measures and subjective evaluation to study how different destination campaigns activate emotion and value networks, and how these activations relate to visit intention. Kim and Kim (2024) use eye tracking on travel websites and show that certain visual configurations – combinations of images, prices and navigation elements – are associated with more efficient eye trajectories and a greater stated preference for the offers. From a destination brand-centred perspective, Calderón-Fajardo et al. (2024) combine eye tracking and skin conductance response to analyse how consumers react to logos and brand combinations of tourist destinations and to images generated by artificial intelligence, and find differentiated profiles of attention and arousal depending on brand personality dimensions and gender. In parallel, studies focusing more on specific communication materials show that the distribution of attention between image and text in tourism photographs (Li et al., 2016) or between visual signs and logos in destination advertisements (Lourenção et al. 2020) influences both the perceived effectiveness of the advertisement and the intention to visit. The systematic reviews by Savin et al. (2022) confirm that eye tracking has become a standard tool for analysing promotional photographs, videos, websites and destination information materials, although studies that directly address the visual experience of the built environment as part of the destination image remain in the minority.

In this context, combining eye-tracking with the analysis of iconic buildings is a logical next step: architectural heritage effectively serves as a brand platform for destinations, and eye-tracking allows us to observe which parts of that platform are actually processed. Gaudí’s Palace in Astorga offers a particularly fruitful case study. From a neuromarketing perspective, the palace’s façade and chapel are brand stimuli in the literal sense: they visually encapsulate Astorga’s promise as a heritage city, a creative city and one linked to the world of Gaudí. From the perspective of place branding, they constitute one of the city’s main vectors of primary communication, in the sense defined by Kavaratzis (2004): the architectural materiality that underpins secondary narratives (campaigns, brochures, websites) and tertiary narratives (media, visitor opinions). Recording on-site, using eye-tracking glasses, how visitors explore the façade and the chapel means directly applying the logic of neuromarketing and neurotourism to the analysis of a place-branding device. Eye-tracking metrics allow us to identify which architectural elements act as attention anchors (central arch, windows, towers, finials, altar, stained-glass windows, vault), how the vertical and central trajectories of the gaze are organised, and to what

extent the pattern of attention is more concentrated (chapel) or more exploratory (façade). In light of the reviewed literature, these patterns can be interpreted as indicators of which parts of the Palace effectively sustain the visitor's aesthetic and emotional experience and, therefore, which components of the "Gaudí Astorga icon" are most relevant when projecting the city brand in the context of Gaudí Year 2026 and the World Heritage nomination.

3. Objectives and research questions

3.1. General objective

To preliminarily characterise and compare, using on-site mobile eye-tracking, the distribution and temporal dynamics of visual attention towards architectural elements defined as areas of interest (AOI) in two scenes of the Gaudí Palace in Astorga (main façade and chapel), with the aim of identifying attentional anchors and exploration patterns relevant to the building's heritage communication.

3.2. Specific objectives

1. To identify the AOIs that act as attention anchors in each scene (façade and chapel), based on capture indicators (e.g., presence/first fixation) and sustained processing indicators (e.g., duration and density of fixations).
2. Compare the distribution of attention between scenes (chapel vs. façade) to explore, on an exploratory basis, whether the interior exhibits a relatively more concentrated pattern and the exterior a more distributed/exploratory one.
3. To explore the spatial organisation of attention (centrality and verticality) using temporal indicators and aggregated visualisations, assessing whether early and sustained attention aligns with the compositional axis of each scene (entrance/volume on the façade; altar/stained-glass windows/vault in the chapel).
4. Assess the feasibility of the on-site protocol (definition of AOI, extraction and aggregation of metrics) as a replicable pilot study in architectural heritage.

3.3. Research questions

RQ1 (Attention anchors): Which areas of interest (AOIs) attract the most visual attention (coverage, time to first fixation (TTFF) and dwell time) in the chapel and on the main façade of Gaudí's Palace?

RQ2 (Focus vs. exploration): To what extent do visual exploration patterns differ between the interior (chapel) and exterior (façade) in terms of AOI dominance, number of fixated AOIs and dwell time distribution?

RQ3 (Order of exploration): What initial sequences and transitions between AOIs emerge in the chapel and how do they relate to the central and vertical organisation of the stimulus?

4. Method

4.1. Design

A between-groups design was employed with two on-site observation conditions: (a) the main chapel (interior) and (b) the main façade (exterior) of the Episcopal Palace of Astorga (Gaudí's Palace). The task consisted of a 15-second free observation, with eye tracking recorded using mobile eye-tracking glasses, in order to compare patterns of visual attention between two architectural scenes of the same building with distinct communicative functions (sacred interior space vs. external urban landmark).

4.2. Participants

Twenty-eight participants took part, divided into two independent groups: $n = 14$ in the interior condition (chapel) and $n = 14$ in the exterior condition (façade). The inclusion criteria were: normal or corrected-to-normal vision, absence of known visual impairments affecting eye fixation, and the ability to complete a valid calibration with the device. Participation was voluntary and informed consent was obtained.

4.3. Equipment and eye tracking

Neon Glasses mobile eye-tracking glasses from Pupil Labs, featuring an integrated scene camera, were used. The system recorded (1) two-dimensional gaze points in scene camera coordinates at 200 Hz, (2) infrared eye video at 200 Hz, and (3) head pose, accelerometer and gyroscope data at 110 Hz. Before each session, a standard calibration was performed and its quality verified.

4.4. Observation scenarios and stimuli

The recordings were made at the Episcopal Palace in Astorga. To ensure comparability, observation was carried out from a fixed viewpoint in each condition. The images used to delineate the areas of interest (AOIs) were obtained from frames of the scene video with a framing equivalent to that observed by the participants during the task (Figures 1 and 2).

4.5. Procedure

Each participant was fitted with the goggles and completed the calibration. They were then positioned at the corresponding observation point and given a standardised free-viewing instruction ("Observe the scene freely for 15 seconds"), with no additional task. In the exterior condition, participants observed the main façade; in the interior condition, the main chapel. Once the time had elapsed, the recording was stopped and the device removed.

4.6. Architectural Areas of Interest

In order to interpret visual attention from the perspectives of neuroarchitecture and heritage communication, areas of interest (AOIs) were delineated on images corresponding to the observed scene. The AOIs were defined a priori based on the compositional hierarchy and spatial prominence of each stimulus, using polygons fitted to the contours of the architectural elements and avoiding overlaps.

In the interior condition (chapel), 18 AOIs were defined (Figure 1): Altar; Central Stained-Glass Window in the Apse; Left Stained-Glass Window, Central Stained-Glass Window and Right Stained-Glass Window (upper triad); columns (Outer Column on the Gospel side, Inner Column on the Gospel side, Outer Column on the Epistle side and Inner Column on the Epistle side); sculptural iconography (Saints 1–4, from left to right); crosses (Crosses 1–4, from left to right); and ribbed vaults. On the exterior (main façade), 15 AOIs were defined (Figure 2): Main façade, Main arch, Coat of arms, Rose window, Staircases, Slate roof, Right façade, Left spire and Right spire, Left tower and Right tower, Left turret and Right turret, and Left chimney; Right chimney:

Figure 1. AOIs Chapel



Source: Own elaboration, 2026.

Figure 2. Heat map Chapel



Source: Own elaboration, 2026

Figure 3. AOIs Main façade



Source: Own elaboration, 2026.

Figura 4. Heat map: Main façade



Source: Own elaboration, 2026

4.7. Eye-tracking metrics

The metrics were extracted from the iMotions software at the AOI level. Fixation-based indicators were calculated: (a) Respondent ratio (%), the proportion of participants who made at least one fixation on each AOI; (b) Fixation count, the number of fixations recorded within the AOI; (c) TTFF AOI (ms), latency to the first fixation in the AOI; (d) Dwell time (ms), total time spent in the AOI; (e) First fixation duration (ms), duration of the first fixation in the AOI; (f) Revisit count, number of returns to the AOI after leaving it. Additionally, metrics based on saccadic movements (Saccade count) were recorded.

4.8. Data analysis

The AOI-specific indicators were obtained using iMotions, software which, based on the eye-tracking signal, detects fixations (brief periods during which the gaze remains relatively stable on a point) and calculates aggregate metrics for predefined areas of interest (AOIs). For each AOI, the following were exported: Respondent ratio (%) (percentage of participants who looked at the AOI at least once), TTFF AOI (ms) (time to first fixation; time elapsed from the start of the stimulus to the first fixation in that AOI, where present), Dwell time (ms) (total time spent in the AOI, summing all fixations and visits), Fixation count (total number of fixations within the AOI), First fixation duration (ms) (duration of the first fixation in the AOI) and, where applicable, Revisit count (number of times the AOI is re-entered after having been left). The metrics per AOI were summarised as means (M) calculated across respondents, i.e. only participants with ≥ 1 fixation in the AOI, so as not to confuse "absence of gaze" (structurally zero value) with "low processing" within the AOI. Given that TTFF is only meaningful when the AOI has actually been looked at, it was interpreted in conjunction with the Respondent ratio, simultaneously providing information on coverage (who looks at it) and latency (how soon it is looked at). For the chapel, furthermore, microdata per participant were used to estimate (1) intra-observer concentration (number of AOIs fixated and proportion of total dwell time concentrated on the dominant AOI) and (2) the sequential dynamics of exploration, identifying the first AOI fixated and transitions between AOIs based on dwell episodes (dwells; consecutive stays in an AOI) and their temporal order (dwell index). Finally, as an exploratory comparison typical of a pilot study, the dwell time of the central axis (Altar + Central Apse Window) was compared within each participant against the peripheral set (columns + statues + crosses) using a signed Wilcoxon rank-sum test, with the statistic and effect size reported via biserial rank correlation (r_{rb}).

5. Results

Descriptive results exported from iMotions are presented. For each AOI, fixation-based metrics (respondent ratio, revisit count, fixation count, time to first fixation (TTFF), dwell time and duration of the first fixation) and saccade-based metrics (respondent ratio and saccade count) were extracted. For the purposes of synthesis, Tables 1 and 2 report the complete set of AOIs and the core metrics (respondent ratio, TTFF, dwell, fixation count and revisit count), calculated as means (M) only for participants who fixated on the AOI (≥ 1 fixation). The aggregated heatmaps (Figures 3 and 4) are used as a visual representation of the spatial distribution.

5.1. Results from the interior (chapel)

Table 1 summarises the metrics by AOI in the chapel. In terms of coverage (response ratio), the Altar achieved the highest value (92.86%), followed by the upper central axis (Central Stained-Glass Window and Central Apse Stained-Glass Window: 85.71%) and the side stained-glass windows (78.57% left; 57.14% right). In terms of capture (mean TTFF, participants with fixation on the AOI), the upper stained-glass windows showed shorter latencies (Central stained-glass window: $M=5138.08$ ms; Left stained-glass window: $M=5967.23$ ms; Right stained-glass window: $M=7092.88$ ms) than the Altar ($M=7846.73$ ms). However, sequential analysis of AOI-tagged fixations indicates that the Altar was the first AOI fixated upon in 50% of participants (7/14) and appeared among the first three AOIs in 57.14% (8/14), suggesting an initial centrality effect alongside early luminance-driven fixations. In sustained processing, the Altar exhibited the highest dwell time ($M=2446.65$ ms) and fixation count ($M=11.69$), surpassing the second AOI in dwell time (Central Stained-Glass Window and Apse: $M=965.88$ ms) by a ratio of ≈ 2.53 . Recursivity (revisit count) was also concentrated on the central axis (Altar: $M=1.54$; Central Stained-Glass Window and Apse: $M=1.50$). In contrast, peripheral elements (columns, sculptures and crosses) showed low to moderate coverage (7.14%–64.29%) and late TTFFs (e.g., crosses: $M=9583.50$ – 16747.00 ms), with lower dwell time and revisits. On the relational level, the most frequent transitions between AOIs were observed between the Altar and the Central Stained-Glass

Window and the Apse (21 bidirectional transitions; 14 Altar→Absidiolo and 7 Absidiolo→Altar) and between the Central Stained-Glass Window and the Left Stained-Glass Window (20 transitions; 14 central→left and 6 left→central), suggesting alternations between the liturgical focus and luminance-driven captures on the upper axis.

Table 1. AOI metrics: Chapel (interior scene)

AOI	Respondent ratio (%)	TTFB	Dwell	Fixation count	Revisit count
Altar	92.86	7846.73	2446.65	11.69	1.54
Central stained-glass window (apse)	85.71	6516.42	965.88	5.00	1.50
Central stained-glass window	85.71	5138.08	957.42	6.50	1.50
Left stained-glass window	78.57	5967.23	830.09	5.27	1.09
Right stained-glass window	57.14	7092.88	571.81	4.62	0.75
Statue of Saint 1	64.29	9071.94	549.44	2.78	0.56
Outer Gospel column	35.71	12695.30	545.70	2.20	0.60
Statue of Saint 3	50.00	13197.79	523.43	3.71	0.57
Inner Gospel column	21.43	6731.83	522.00	2.00	0.33
Statue of Saint 2	28.57	11119.00	487.00	2.25	0.50
Statue of Saint 4	50.00	16184.36	423.86	2.71	0.43
Ribbed vaults	57.14	10217.00	394.00	2.75	0.62
Cross 4	14.29	16747.00	376.00	2.00	0.00
Outer Epistle column	14.29	7088.50	335.50	1.50	0.50
Cross 1	7.14	9583.50	331.00	1.00	0.00
Cross 3	21.43	13370.17	262.00	1.67	0.33
Inner Epistle Column	28.57	8009.00	219.00	1.25	0.25
Cross 2	21.43	12944.50	128.33	1.00	0.00

Source: Own elaboration, 2026.

Note. Mean values (M) exported from iMotions and calculated based on respondents (observers with at least one fixation in the AOI). TTFB should be interpreted in conjunction with the respondent ratio. Dwell indicates the duration of fixation. Revisit count indicates returns to an AOI following the first visit.

5.2. Results for the exterior (main façade)

Table 2 presents the metrics by AOI on the façade. The highest coverage (respondent ratio) was observed on the Main façade, Main arch and Left tower (78.57%), followed by the Left turret (71.43%) and Right tower (64.29%). In sustained processing, the Main façade had the highest dwell time (M=1006.41 ms) and fixation count (M=6.45), followed by the Main arch (M=683.73 ms; M=4.36) and the Left tower (M=628.41 ms; M=3.82). Early fixation (TTFB) was minimal on the Shield (M=4372.50 ms), albeit with low coverage (21.43%), and on the Main façade (M=6107.05 ms). Recursion (Revisit count) was concentrated on the Main façade (M=1.64) and

the Main arch (M=1.18), suggesting returns to the access axis. The crown and roof elements recorded very low coverage (Rosa, Slate Roof and Right Chimney: 7.14%) and short dwell times (M=65.00–276.00 ms). Using microdata per participant, the first AOI fix was distributed among the Main Arch, Main Façade, Right Façade and the turrets (2/14 each), with no single initial anchor; among the first three AOIs visited, the Main Façade and Left Tower appeared in 50% of cases (7/14). At the intra-observer level, each participant fixated on M=6.71 (SD=2.27) AOIs (out of 15) and the dominant AOI accounted, on average, for 35.6% (SD=11.7%) of the cumulative dwell time across AOIs; the dominant AOI was the Main façade in 50% of participants (7/14). At the relational level, the most frequent transitions between AOIs were observed between the Main Arch and the Main Façade (13 bidirectional transitions), the Left Tower and the Left Turret (13), and between the Main Arch and the Staircase (7), reflecting alternations between the entrance and lateral volumetric reading. By compositional grouping, the access axis (Main façade + Main arch + Staircase) accounted for 39.4% (SD=20.2%) of dwell time in AOIs and exceeded the crowning elements (spires, rose window, roof and chimneys; 12.9% SD=14.1%) in an exploratory contrast (Wilcoxon W=3, p<.001, r_{rb}=.94).

Table 2. AOI metrics: Main façade (exterior scene)

AOI	Respondent ratio (%)	TFFF	Dwell	Fixation count	Revisit count
Main façade	78.57%	6107.05	1006.41	6.45	1.64
Main arch	78.57	7692.14	683.73	4.36	1.18
Left tower	78.57	9896.95	628.41	3.82	0.55
Left turret	71.43	8016.50	494.10	3.00	0.90
Right spire	28.57	8177.75	489.00	3.75	0.25
Right turret	57.14	8163.12	395.75	2.88	0.62
Left spire	57.14	7795.88	395.38	3.12	0.62
Right façade	50.00	7312.79	296.64	2.14	0.14
Rose window	7.14	9662.50	276.00	2.00	0.00
Staircase	42.86	7593.50	258.08	2.00	0.50
Right tower	64.29	10236.83	246.44	2.11	0.44
Coat of arms	21.43	4372.50	232.00	1.67	0.33
Left chimney	21.43	6869.50	195.00	1.67	0.33
Slate roof	7.14	8186.50	90.00	1.00	0.00
Right chimney.	7.14	17408.50	65.00	1.00	0.00

Source: Own elaboration, 2026.

Note: Mean values (M) exported from iMotions and calculated for respondents. Dwell refers to fixation duration. Revisit count refers to returns to an AOI following the first visit.

5.3. Descriptive comparison of attentional patterns

Exploratorily, the interior shows greater dominance of a central node (Altar), both in terms of dwell time and fixation count (Table 1), with an advantage over the second AOI in dwell time (top1/top2=2.53). On the exterior, the two main nodes (Main façade and Main arch) show closer values (top1/top2=1.47) and sustained processing is distributed between the central volume, the entrance and the side volumes (Table 2). Using microdata, the chapel showed a pattern of concentration: the dominant AOI for each participant accounted, on average, for 41% (SD=15%) of dwell time across AOIs, and each observer fixated on 8.14±3.21 AOIs (out of 18) throughout the analysed window. Likewise, the central axis (Altar + Central Apse Stained-Glass Window) accounted for 44.6% of dwell time in AOIs and outperformed the peripheral set (columns + statues

+ crosses) in an exploratory contrast (Wilcoxon $W=96$, $p=.002$, $r_{rb}=.83$). On the façade, intra-observer concentration was lower (dominant AOI: $35.6\% \pm 11.7\%$ of dwell time in AOIs) and the distribution of attention was more polycentric, with high normalised entropy ($M=.88 \pm .07$). In compositional terms, dwell time was distributed between the entrance axis ($39.4\% \pm 20.2\%$) and the lateral volumes ($44.9\% \pm 27.5\%$), whilst the crowning elements accounted for the remainder ($12.9\% \pm 14.1\%$).

6. Discussion

The results of the pilot study indicate that visual attention towards Gaudí's Palace is organised around a small set of elements that act as attentional anchors, but with distinct capture (TTFF) and maintenance (dwell time/fixation count) profiles depending on the scene. In the chapel, the combination of (1) lower mean TTFFs in the upper stained-glass windows and (2) maximum sustained processing at the altar (Table 1; Figure 4) is consistent with a coupling between bottom-up salience mechanisms (light and contrast) and top-down control guided by the liturgical significance of the central axis (Tatler et al., 2011; Awh et al., 2012). Sequential analysis reinforces this interpretation: the Altar was the first AOI fixated upon by half of the participants, and the most frequent transitions were concentrated along the liturgical axis (Altar \leftrightarrow Central Apse Stained-Glass Window: 21 transitions), along with alternations within the set of stained-glass windows, suggesting a centripetal and partially vertical exploration consistent with neuroaesthetic approaches that emphasise the interaction between perception, affect and the construction of meaning in architectural spaces (Chatterjee and Vartanian, 2016; Coburn et al., 2017).

On the façade, the microdata reveal a comparatively more dispersed pattern: the first AOI identified is distributed across the entrance, the central volume and the turrets, with no single dominant initial element, and the dynamics of transitions show shifts between the entrance axis (Main Arch \leftrightarrow Main Façade; Main Arch \leftrightarrow Staircases) and the lateral volumetric reading (e.g., Left Tower \leftrightarrow Left Turret). This behaviour is consistent with a recursive exploration typical of complex scenes, in which the gaze alternates between a reference node and peripheral elements to verify the overall structure (de la Fuente Suárez, 2020). Unlike the interior, the crowning elements (rose window, roof, chimneys and pinnacles) receive residual attention: the access axis attracted significantly more dwell time than the crowning elements (Wilcoxon $W=3$, $p<.001$, $r_{rb}=.94$), suggesting that in brief viewings these details fall outside the scope of spontaneous interest despite their potential iconographic value. The early capture of the Coat of Arms (low TTFF) but with limited coverage also points to selective attention to heraldic details among some observers, without constituting a universal anchor in free observation.

From the perspective of heritage neurocommunication, this distinction between spontaneous anchors and peripheral elements provides evidence for designing mediation tools (signage, guides, observation points and photography) aligned with the actual perceptual hierarchy. In terms of place branding, if emblematic architecture acts as the primary communication of the territory (Kavaratzis, 2004), eye-tracking metrics allow for the prioritisation of frames and narratives that coincide with the visitor's natural focus (interior: altar-stained-glass windows; exterior: central volume-entrance-side volumes) and, when seeking to expand the symbolic repertoire, to develop focusing strategies (e.g., micro-narratives, guided approaches or graphic resources) to incorporate less-noticed details (rose window, roof, chimneys) into the heritage narrative (Savin et al., 2022).

The conclusions should be interpreted as exploratory. The sample size is small ($n=14$ per condition) and the between-groups design prevents the comparison of intra-observer changes across scenes. The duration of the gazemapping interval varied between participants, so absolute temporal metrics may be affected by exposure; it is recommended to emphasise proportions (dwell %) and normalised analyses in future replications. Furthermore, the AOIs were defined a priori and, although overlap was avoided, the spatial coverage does not include the entire visual field (e.g., sky/surroundings), which limits the interpretation of attention outside the AOI.

Recording under ecological conditions provides external validity but reduces control over contextual variables (lighting, prior familiarity or tourist motivation). In future replications, it would be advisable to expand the sample, adopt a within-subject design with standardised exposure times, pre-define criteria for handling missing values (especially for TTFF in low-coverage AOIs) and integrate complementary measures (recall, aesthetic/affective evaluation and, if possible, autonomic measures) to assess the communicative efficacy of heritage in terms of experience and memory.

7. Conclusions

This pilot study using mobile eye-tracking in ecological conditions identifies distinct attentional anchors in the chapel and on the main façade of Gaudí's Palace. In response to PI1, the chapel showed a dominant sustained focus on the Altar (coverage = 92.86%; dwell time $M=2446.65$ ms; fixation count $M=11.69$), whilst the upper stained-glass windows and the apse captured the gaze earlier (lower TTFF; e.g., central stained-glass window $M=5138.08$ ms) with secondary fixations. On the façade, attention was primarily anchored on the central volume and the entrance (Main façade and Main arch: 78.57% coverage), with contributions from towers and turrets; in contrast, the crowning elements (spires, rose window, roof and chimneys) recorded low coverage and reduced dwell time. With regard to PI2, the interior showed greater centralisation (top1/top2=2.53; dominant AOI=41%±15% of dwell time in AOIs), whilst the exterior exhibited a more polycentric distribution (top1/top2=1.47; dominant AOI=35.6%±11.7; normalised entropy $M=.88±.07$). In relation to PI3, the chapel showed a centripetal and partially vertical sequence, frequently starting at the Altar (50% of participants) with recurring Altar-Absidiolo transitions, whereas on the façade the first AOI was more heterogeneous and the most frequent transitions alternated between the entrance and the central mass (Main Arch–Main Façade) and between the side volumes (Left Tower–Left Turret). Taken together, these findings provide initial criteria for heritage mediation and communication: capitalising on the access axis in the exterior reading and the liturgical axis in the interior, and applying focalisation strategies to integrate high or low-visibility details into the interpretative narrative. These conclusions will need to be confirmed with larger samples, intra-subject designs and complementary measures of experience and memory.

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