

illuminating Museums. From Design to Experience

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Introduction. Lighting in Museums

- 1 In the field of museology, talking about lighting in museums is often seen as a concern solely for curators, specifically in terms of preventive conservation (Thomson, 1978; Brill, 1980; Ambrose & Paine, 1993; Cuttle, 2007)—lighting is here understood as the technique or art of mastering natural and artificial sources of light to respond to an expressed need (Ezrati, 2014, p. 156). Rarely have museologists delved into the question of lighting as a distinct and autonomous object of interest, carrying meaning and emotion (Gabus, 1965; Rivière, 1989; Gob & Drouguet, 2003).
- 2 In the 1960s, a marginal interest emerged in lighting as a communication device (Borhegyi, 1963; McLuhan, Parker & Barzun, 1968; Miles, 1988). These aspects are more generally linked to other contexts such as architecture and exhibition design (Chaumier, 2012; Schielke, 2019, 2020). In recent years, researchers in the technology field have been developing in-depth studies of visitor preferences for colour temperature for light (Nascimento & Masuda, 2014; Boust & Ezrati, 2010), colour rendering (Viénot *et al.*, 2008; Feltrin *et al.*, 2020; Liu *et al.*, 2013) and light intensity (Ajmat *et al.*, 2011). Professionals have also established a specialised and technical knowledge of museum lighting to the point of establishing lighting designers and lighting engineers as reference specialists since the 1960s in the United States and the 1990s in Europe (Lehmbruck, 1974a, 1974b; Lam, 1986; Lemaigre-Voreaux, 1991). Some of them have worked on the theorisation of their practice, which is also reflected in the definition of a language and semiotics of lighting (Cellerier, 1931; Coleman, 1948; Ezrati, 2010). The technical aspect is thus intertwined with the signifying and communicative considerations made possible by this device.

- 3 Issues relating to conservation and visibility are certainly fundamental and deserve all the attention they can get. What seems to be missing in the field of museology is, however, a theoretical structure that considers and discusses other possible purposes for museum lighting within the exhibition space. From the perspective of Falk and Dierking (2000, p.113), spatial design—such as space, shape, volume and colour— influences learning in museums. The visitors thus seem to be constantly dependent on the spatial environment to extract information and better understand the museum and its exhibition. But little interest has been shown in lighting and atmosphere, maybe because of the difficulties of assessing these sensitive elements using traditional survey methods (Falk & Dierking, 1992, p. 100). Could we, therefore, consider museum lighting as an exhibition element that also contributes to the reception and the understanding of artworks, the overall atmosphere and, still more, the sense of wellbeing? And if so, how?
- 4 This paper investigates the other possible functions of museum lighting in terms of design and visitor experience—specifically as applied to art museum collections. It raises the hypothesis of a possible form of museum lighting which would address the intellectual, bodily and sensory construction of meaning through information about the illumination. We will refer to this as the potential of lighting to function as a mediation device capable of stimulating and guiding the understanding, emotional and sensory experience of visitors. The term “mediation” is understood here in accordance with the following definition:
- “A range of interventions carried out in a museum context to establish connections between what is exhibited (the seeing) and the meanings that these objects and sites can have (the knowing) [. . .] in other words, an educational communication strategy that employs various technologies around the exhibited collections to provide visitors with means to better understand certain aspects of the collections and share their own interpretations.”
(Montpetit, 2011, p. 216) ¹
- 5 Based on our assumption, lighting as a tool for ‘mediation’ could have three functions: (i) an ostensive function, structuring the exhibition space and participating in the formal appreciation of the artwork, or even its visual restoration; (ii) a cognitive function, supporting the construction of meaning through reasoning; (iii) an aesthetic function, stimulating states that are understood as contemplative, sensitive and emotional.
- 6 To address this question, we posited that the answers lay in both the design and reception aspects, as design intentions may differ from the experience of the audience during their visit. Therefore, it was necessary to conduct broader investigations into these two components: design and experience. This approach aimed to move away from a strictly technical and functional view of museum lighting and to explore alternative perspectives in museology and information and communication sciences (Gobbato, 2022a).

Materials and Methods

- 7 This study involves three areas of research and therefore complementary methods of investigation. These are (i) the development of knowledge in the field of lighting,

(ii) the study of museum lighting designs, and (iii) the analysis of the influence of museum lighting on the construction of meaning and the experience of visitors.

A Survey of Lighting Designers

- 8 Firstly, we carried out a qualitative study with thirty designers, lighting engineers and lighting consultants based in Europe and the United States.
- 9 The interviews were conducted online between December 2020 and March 2021 (videoconference recorded and transcribed). They dealt with several questions related to their career trajectory, the definition of their practice, its evolution over time and considerations regarding museum lighting (natural and artificial light and lighting, shadows, exhibition space, artworks and visitors' experience). The study of the professional field, therefore, sought to understand the approach in museums, philosophy and principles, according to the training, the region of activity and the projects carried out. It was also based on examples from their experience within other lighting fields.
- 10 For a better understanding of the technological and technical challenges of lighting and its specificities in art museums, we attended a private training course of about thirty hours with a lighting designer in Paris from October to December 2020. This covered a basic programme on general and applied lighting for museums (photometric measurements, composition of luminaires, characteristics of luminaires, applications and lighting design). We also carried out a participant observation study which lasted four months, from September to December 2021. It involved a research hosting agreement with a lighting design agency in Paris. During this period, we were involved in the design and delivery of lighting for five museum exhibitions.

A Culture of Museum Lighting

- 11 Secondly, we defined a corpus of European museums on which to focus our study. This part of the research was more challenging to conduct because of the Covid-19 pandemic. Hence, we restricted the observation to thirty institutions that we could visit and study *in situ*. These were 9 museums in France, 7 museums in Italy, 4 museums in Germany, 4 museums in the United Kingdom, 3 museums in Spain, 1 museum in Portugal, 1 museum in Sweden and 1 museum in Belgium.²
- 12 The choice of these sites was closely related to the exhibition of their art collections: museums of antiquities, Renaissance museums, fine art museums, modern art museums and contemporary art museums. It was, moreover, associated with four lighting-related factors: (i) their museum lighting systems characterising a historical period; (ii) the choice of a lighting system marking a moment in their past or present development; (iii) the signature of the lighting project by a referenced and recognised architect or lighting designer (see literature); and (iv) the application of innovative lighting-related museum principles and practices. Although a historical perspective has been adopted, the period chosen for this study remains the contemporary period, which therefore sets its temporal limit at the latest technological advent brought about by the LED.
- 13 This research required a model for the objectification of lighting assessment parameters. In the absence, to our knowledge, of such a method, we adopted an experimental observation and analysis protocol in line with the theoretical frameworks

of the museum and exhibition design articulated by Gharsallah-Hizem (2008), Chaumier (2012) and Tzortzi (2015), as well as with the principles of museum lighting put forward by Ezrati (2014) and Schielke (2019, 2020). Our protocol is therefore based on an understanding of the conceptual intent and underlying structure that makes up the space and lighting for the organisation of museum spaces and exhibitions. The protocol also fits more broadly with the research methods in museology recently formulated by Mairesse and Van Geert (2021).

- 14 The inventory of this corpus required *in situ* observation, study and survey of the architectural modulations and lighting installations for each museum. The observation was limited to the spaces of the collections. On the one hand, the reference data concerned the identification of the situational plan of the museum: orientation of the building, rooms chosen for the study, dimensions, architectural and exhibition layout, nature of the artworks/objects shown and their sensitivity, among others. The observation aimed to describe the natural and artificial lighting installation: lateral and zenithal natural light sources (clerestory, windows, skylights, canopies, etc.) and artificial lighting installations (general lighting, accent lighting, dynamic lighting, floodlights, colour temperature, total lighting dose, aesthetic effects, etc.). The study was also based on the use of light meters and rangefinders to precisely objectify a series of discussed data such as illuminance level or room size.
- 15 The data were supplemented by bibliographical references and archive material and, where possible, information obtained from museum staff (managers, curators). We also interviewed twenty-four institution managers (curators, curatorial staff, stage managers, lighting designers), as well as professionals who had been involved in lighting projects in these institutions (lighting designers, lighting engineers, architectural firms). The data collected made it possible for us to draw up thirty museum sheets for each lighting system, which served as an aid to the analysis.

Experience in Dynamic Lighting

- 16 Thirdly, we conducted an experimental survey of the audience visiting the Dufy Room at the Museum of Modern Art in Paris. This research was created for *La Fée Électricité* by Raoul Dufy (1937) and took place from 21 to 28 June 2021, with preparation beginning in February 2020. The painting consists of two hundred and fifty plywood panels, each measuring two metres high and one metre twenty centimetres wide. It was executed for the International Exhibition of Art and Technology in Modern Life, which took place in Paris from May to November 1937. Today, the artwork is lit by fifty-one compact fluorescent tubes with a power of 55 W and a cold white colour temperature (4,000 K). The light sources are arranged in asymmetrical luminaires embedded in the floor and covered by a railing. The lighting reaches up to about eight out of the ten metres of the artwork, leaving the last two metres at the top in shadow.
- 17 The experimental lighting system we designed was based on a light installation conceived as a mediation device. The aim was to observe the effects of artificial light on visitors and their perception of the exhibition and the painting. This involved dynamic lighting—referred to hereafter as a “lighting scenario”—overlaid on the existing installation, lasting approximately three minutes. The lighting scenario consisted of twelve LED spotlights placed on the floor (focus spotlights, 34 W, tunable white). It aimed to focus the visitor’s attention on high points of the artwork (currently in semi-

darkness) that represent major scenes for understanding, in terms of the evolution of human activity and the progress of electricity—also highlighted by a mediation podcast about the artwork produced by the museum (Bartoli, 2020).

- 18 To address this, we opted for the REMIND research programme as our chosen approach (Schmitt & Labour, 2022). This methodology stems from the epistemology of enaction (Varela, 1979, 1989; Varela, Thompson & Rosch, 1991), and takes up the contributions of Theureau's self-confrontation (1992; 2010), while insisting on its filiation with the stimulated recall methods initiated by Bloom (1953) and Nielsen (1962). It records and retraces the course of action to identify the elementary sequences of meaningful activity from the visitor's point of view to reconstruct the cognitive and bodily dynamics (Schmitt & Labour, 2022)—in our case related to lighting. This approach emphasises the importance of visitors' past and present emotions during their visit and focuses on the sensory, imaginative and interactional microdynamics within the space.
- 19 Visitors were equipped with an eye tracker in the hall before the Dufy room and then began the tour. Their field of vision was recorded by the glasses, as was the point of focus of their gaze. They were not aware of the object of the research (lighting scenario). When the visitors naturally left the room, the experiment ended. After the tour, the researchers interviewed them in another room, which was recorded simultaneously with the video of the tour (used as a support for the interview) by means of screen capture software on a computer. The viewpoint appeared on the screen as a red circle. The researchers used this to guide the visitor to tell, describe and comment on their experience. The researchers asked for details and additions (depending on the gaze point) but did not spontaneously refer to the object of the research, i.e., the lighting. During the analysis, the interviews were transcribed and synchronised with the researchers' annotations using the ADVENE software (Auber, Prié & Schmitt, 2012).

Results and Discussion

- 20 These three complementary fields and methods have made it possible to draw up a panorama of the reality of museum lighting, from the point of view of both design and reception. Firstly, the findings shed light on the creative process of lighting designers, a facet of museology that is often overlooked. This includes exploring their techniques, technologies and operational methods. Secondly, the results offer valuable insights into the lesser-known practices of museums concerning lighting. This encompasses their equipment, installations, standards and considerations. Thirdly, these findings enable us to evaluate and characterise the impact of lighting on the construction of meaning and to comprehend the challenges associated with a lighting project aimed at facilitating sensory interpretation and mediation.

Museum Lighting and Design

- 21 Defining the process of creating contemporary lighting was the first question our research faced. The results also helped to describe the background of the professionals involved, which are not well recognised in museum studies.
- 22 The professionals interviewed occupy, with their agencies, different geographical regions. To be consistent with the museum corpus, we have identified designers based

mainly in Europe. However, some designers who also work in this region are based in the USA, Russia or Japan. Their perspectives allowed us to cross-reference different lighting cultures. As a result, 13 designers are French, 5 are British, 3 are Italian, 2 are German and 2 are North American, 1 is Belgian, 1 is Spanish, 1 is Finnish, 1 is Japanese and 1 is Russian. There is no representativeness as regards practice for the countries concerned, but this corpus has opened other non-French realities. It should be noted that the variables marking the different approaches depend mainly on the training and generation of the lighting designers.

- 23 These designers come from different sectors. Architecture appears to be the preferred field of training for the British, Italians and Americans (7). Engineering and technology characterise German, Spanish and French training (7). Art, design, and scenography studies cover all fields without predominance (6). Finally, live performance is a French and Belgian characteristic (7), as is cinema (3). Furthermore, five designers, who claim technical and theatrical training, refer to self-taught training based on professional experience. This specific trajectory is an essentially French phenomenon which describes the careers that began in the 1970s and 1980s—at the beginning of lighting design in France. It should also be noted that the technical paths are generally distinguished by a second area of expertise, linked to the professions or the practice of the performing arts or the plastic arts. This distribution highlights a general tendency to combine technical and artistic training.
- 24 As mentioned, the profession in France emerges particularly from the performing arts, while the British, Italian, German and American approaches are characterised by a background in architecture or engineering. This has one main consequence for practice. The former developed a particular specialisation in artificial lighting, while the latter dealt with mixed projects involving the control of natural and artificial lighting. In all cases, these designers work in a wide variety of fields, such as performing arts, public buildings, interior architecture and urban planning. Museum lighting is therefore part of multidisciplinary know-how. It is also interesting to classify career paths into three generations. Twelve lighting designers have been working for forty years or more, i.e., since the 1970s and 1980s. Thirteen have been working for twenty or thirty years, i.e., since the years 1990–2000. Finally, five belong to a younger generation, who have been working since the 2010s. It appears that the first and second generations have developed a philosophical and paedagogical approach that has matured with experience (publications, teaching).
- 25 Another relevant element is the ambition of the museum or exhibition design, which is the guiding principle for lighting. This variable determines the lighting system and depends, as discussed below, on several other factors, such as the nature of the collections, the architectural atmosphere, the artistic period, the curator's conceptual wishes and teamwork. Therefore, studying the process of creating museum lighting means unravelling the components that constitute the lighting of art in the permanent exhibition. The interviews revealed four keys to the expressive dimension of museum lighting design: (i) the scope, with its culture of international, regional and museum culture; (ii) the concept, the approach to the project thought out by the clients (museum managers, curators and conservators), but also distinguished by a form of intuition specific to the designers; (iii) the purpose, incorporating the visitor's experience; and finally (iv) the components that intervene in the creation, such as the technical values (all the means and parameters, initially fragmented, that characterise

the sources, luminaires and lighting accessories), the plastic values (the aesthetic results, global or fragmented) and the semantic values (the significant results, global or fragmented).

- 26 This is consequently a complex and mutable process, closely linked to the context of the permanent exhibition—i.e., to the nature of the collection, the scientific purpose, the exhibition design, and even the participation of living artists. From this point of view, the strategies described can be assimilated into some mediation intentions—although this is not formulated in these terms. It involves a form of interpretation which goes beyond enhancement and conservation and implies light as a communicative and mediating intention. This seems to fulfil the functions we have attributed to sensory mediation through lighting: cognitive (participating in a purpose), ostensive (constructing and prioritising the visual space, formally enhancing the artworks, participating in a visual restoration) and aesthetic (supporting emotional and contemplative perspectives). It might be an ongoing potential to be further explored by museum managers, lighting designers and manufacturers, but also by researchers in the museum field.
- 27 The narratives collected converge on a common path: lighting requires the development of a concept, a philosophy and a form of sensitivity. This starting point links the backgrounds of the thirty lighting designers who agreed to share their experiences. These results then allowed us to define the concept of “museum lighting design.” Museum lighting is not just a technical device. We propose to define museum lighting design as the purpose, concept and expression of spatial composition through natural or artificial light. It is a reflective process that incorporates the sensitivity of the lighting designer and the capabilities of lighting technology. Additionally, it can be seen as a form of mediation. This concept is in line with the exhibition theories of Falk and Dierking (2000) and the theories of information and communication sciences applied to the museum context mentioned by Blondeau, Chemenska and Schmitt (2020). These theories consider the sensitive role of the environment and its influence on the visitor’s experience, learning and sense-making. Based on our results, museum lighting design may now be recognised as another component of this whole.
- 28 Considering these results, the profession of lighting designer, along with the broader field of lighting design, deserves greater recognition in the field of museology. Just like the roles of architects, exhibition designers, graphic designers or digital designers, their contributions to museums are vital for the successful realisation of exhibitions. Their technical and creative skills are unique and cannot be easily replaced by other related professions (although some professionals may possess similar skills). These professionals bring important expertise in areas such as preventive conservation, creating immersive atmospheres, activating artworks, engaging visitors and even participating in mediation projects. Including them as part of the museum and exhibition planning process from the outset would enhance the understanding of the needs and challenges faced by the design team.
- 29 The concept of considering lighting as an independent element is not widely embraced by lighting designers, who tend to regard it as one component of the overall exhibition design. As mentioned earlier, the museum space operates as an ecosystem consisting of various elements, including exhibition design, graphics, mediation and more. However, based on our observations, when the lighting design process is carried out by a separate

entity, it does exhibit a certain degree of autonomy. This autonomy grants it a connected yet distinct dimension within the broader context of exhibition design.

A Light Sensory 'Index'

- 30 The examination of the environments in the thirty chosen museums helped to elucidate these elements further. Consequently, our research specifically concentrated on the architectural and technological apparatuses from a comprehensive standpoint, encompassing everything from the exterior of the museum to the direct encounter with the artwork. The objective was to perceive lighting devices not merely in terms of their technical functionalities but also from the perspectives of their demonstrative, cognitive and aesthetic roles.
- 31 The results of this second study confirm that, as in the museum literature, light is still largely understood as a technical constraint in museums by their managers. The challenges relate primarily to the need for flexibility to ensure the conservation of exhibits. Thus, lighting is mainly controlled to slow down the ageing and degradation of the artworks, while at the same time allowing easy handling of lighting systems. Museums tend then to be less day-dependent institutions than in the past. However, there is a dependence on artificial systems.
- 32 Other issues have emerged, albeit at the margins, concerning the possibility of interpreting, transmitting and experiencing the museum and its collections through light. A minority of museum professionals consider lighting as a possible mediation device. This leads to the ambiguity that contrasts the act of conservation with one interpretation—although the two are inseparable. Indeed, it is impossible to choose lighting strictly for conservation purposes. It inevitably leads to immediate consequences for the performance of the characteristics of the lit object, the space and the ambience. Colour temperature, beam spread, shape, rendering index and movement are all parameters that undeniably modify the atmosphere and appearance of an exhibition, and consequently its perception. However, according to our methodology, we have identified several lighting devices that are like light sensory mediation strategies. These are not only to be found in the rooms of the permanent collections but are broadly related to three successive spatial and symbolic dimensions: (i) the natural and urban landscape and architecture, (ii) exhibition design, and (iii) the artworks.
- 33 We have identified at least two typologies for landscapes and architecture. Outside the museum, lighting design configurations use natural luminance with reflective, white or transparent surfaces to accentuate the connection with the surrounding landscape (e.g., Insel Hombroich Museum, Louvre-Lens, Serralves Museum). Within the museum, lighting design configurations use openings such as bay windows, variations in natural light, and luminance through reflective surfaces, or transmission through transparent surfaces, to accentuate this dialogue (e.g., Fundació Miró, Insel Hombroich Museum, Maison La Roche, Museum Ludwig, Stockholm Nationalmuseum, Serralves Museum). The same devices are valid for urban landscapes, both outdoor and indoor (e.g., Fundació Miró, Guggenheim Bilbao, MACBA, MAXXI, Museum Ludwig, Museo di Castelvecchio, Nationalmuseum Stockholm, Punta Della Dogana).

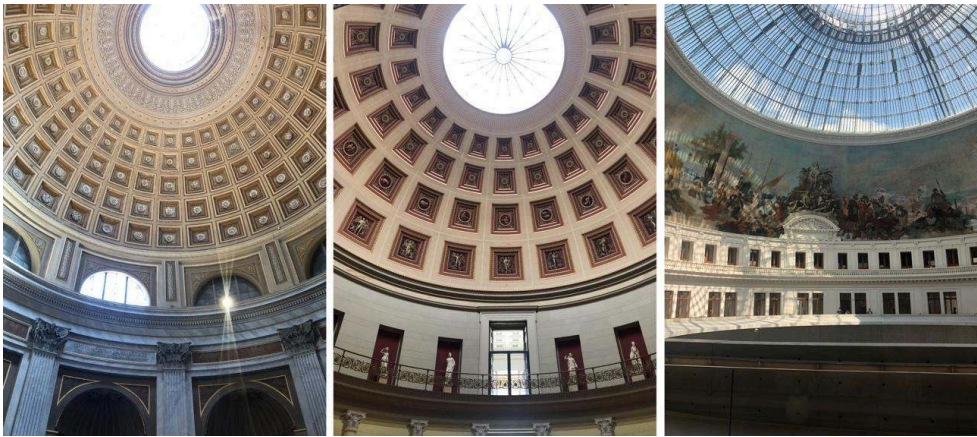
Figure 1. MAXXI (Rome, Italy). Gallery V, *Giò Ponti. Loving architecture exhibition* (27.11.2019-27.09.2020).



Photo credits: Crossed perspectives between the museum and the Flaminio neighbourhood. 2020. Viviana Gobbato.

- 34 For architecture, the results then identified symbolic and traditional devices that evoke a neoclassical past and thus act as a medium to communicate this past dimension, such as the oculus (e.g., Altes Museum, Bourse de Commerce, Pio-Clementino Museum). Then, dynamic lighting also emerges as a technology to create light scenarios, and therefore different ways of interpreting, telling and showing the space (Scuola Grande di San Rocco). Finally, the use of different colour temperatures can contribute to the visual structuring of the environment, and thus contribute to the signage of the built heritage in museums (e.g., Bourse de Commerce, Fondation Pinault). These lighting designs seem to favour ostensive, cognitive and aesthetic functions, contributing to the identity of museums. They also participate in the reinvestment of their collections, structuring and punctuating the itinerary, and allowing a sensitive, even contemplative experience, as was recently studied (Gobbato, 2022b).

Figure 2. The oculus as a device that refers to the neoclassical museum.



From left to right, Museo Pio-Clementino (Vatican), Altes Museum (Berlin, Germany), Bourse de Commerce-Fondation Pinault (Paris, France). 2020–2021. Photo credits: Viviana Gobbato.

- 35 The results also highlighted features specifically designed for exhibition spaces. Ambient lighting schemes can evoke a geographical region through natural lighting, artificial lighting simulating naturalness, coloured lighting or very cool colour temperature lighting (e.g., Ashmolean Museum, Egyptian Dynasty and Sudan, room 23; British Museum, Albukhary Foundation Gallery of the Islamic world, room 42; Sir John Soane’s Museum). These features may also simulate a sacred dimension with natural clerestory lighting, subdued lighting and accent lighting to recall the sacred ‘aura’ of the artwork (e.g., Uffizi Gallery, Hall of the Primitives and Leonardo Hall). Lighting also creates an ambience that fosters the sense of timelessness and suspension of space-time through wall lighting, overhead lighting, black box lighting, ‘light bath’ luminance effects and lighting scenarios (e.g. Insel Hombroich Museum, Tadeusz Pavillon; Musée du Louvre-Lens, Galerie du Temps; Scuola Grande di San Rocco, Salle Capitulaire). The lighting design also favours the organisation of the space and thus stimulates the reading of the paths and the layout of the exhibitions (e.g., the hanging). In terms of space, this can be achieved through accentuation effects and contrasts, coloured lights, and colour temperature (e.g., Altes Museum; Fundació Miró; Uffizi Gallery, Botticelli rooms, rooms 10 and 14). The lighting devices are then designed according to emphasis, contrast, colour and colour temperature (e.g., Altes Museum; Centre Pompidou, levels 5 and 4; Uffizi Gallery, Hall of the Florentine painters, hall 83). They contribute to the ostensive, cognitive and aesthetic functions, as they stimulate the understanding of and relationship to the setting, but also to the collections.

Figure 3. Natural light evokes architectural atmospheres of the Middle East, much like the moucharabieh.

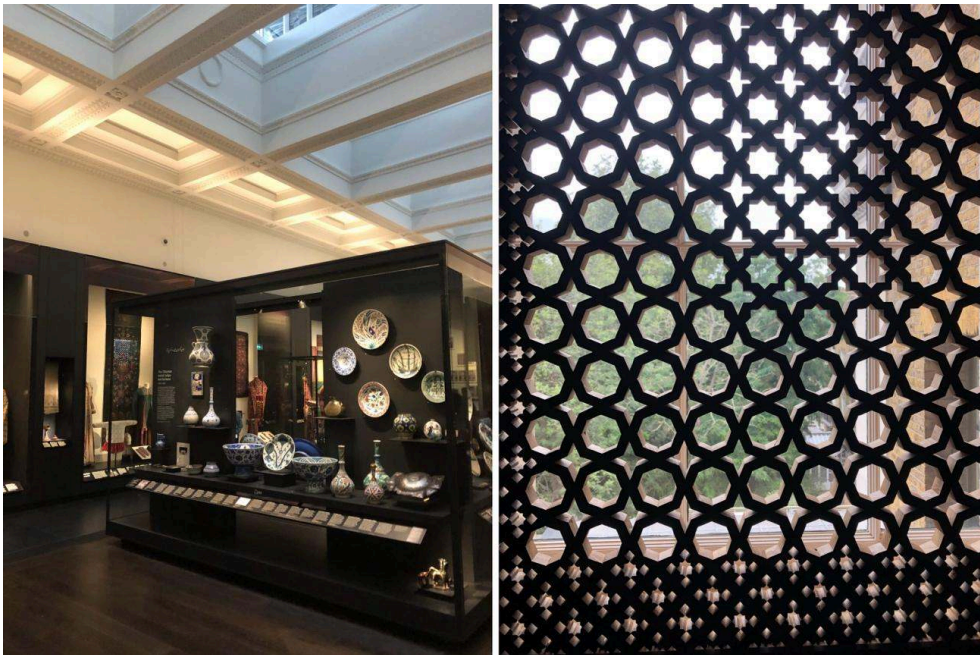
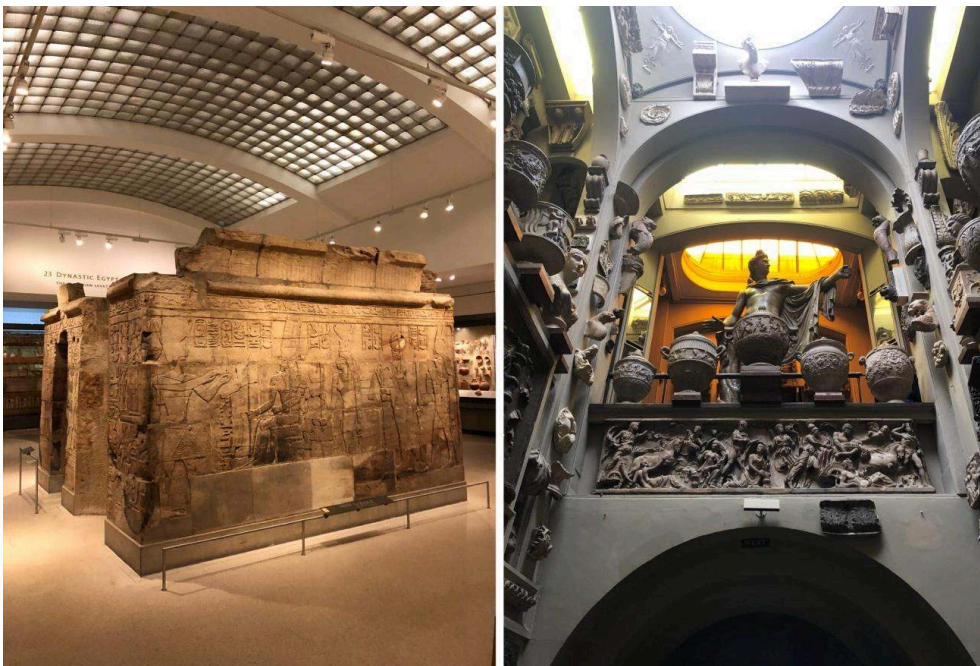


Photo credits: British Museum, Albukhary Foundation Gallery of the Islamic world (London, United Kingdom). 2021. Viviana Gobbato.

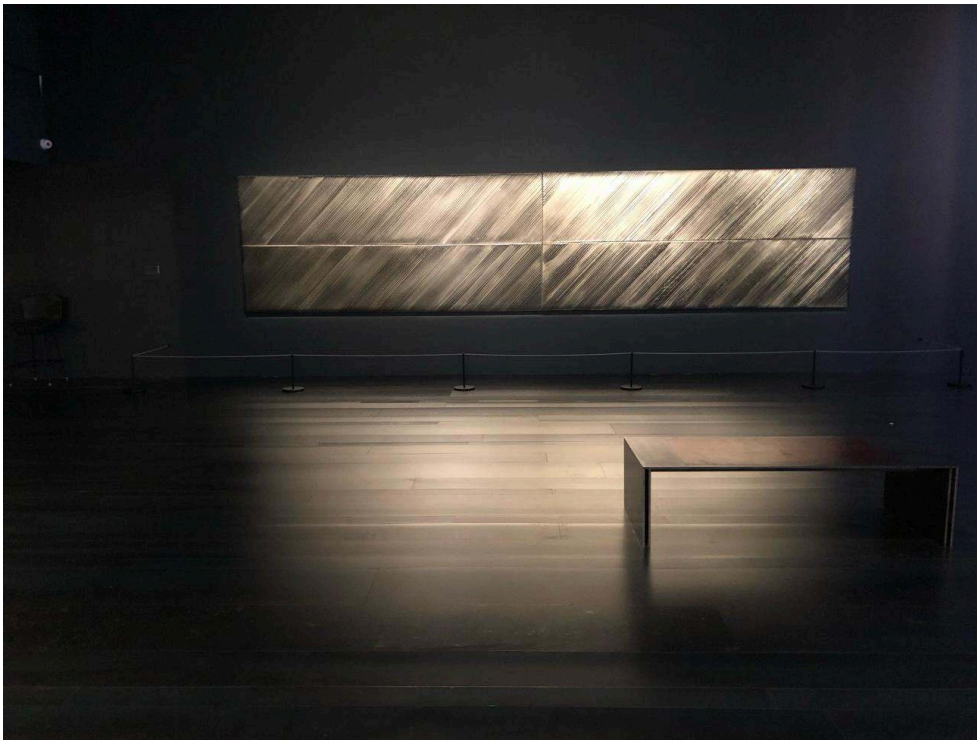
Figures 4 and 5.



At left, Ashmolean Museum, view of room 23 dedicated to the Egyptian dynasty and Sudan. The room houses the sanctuary of Taharqa (680 BC), the Kawa temple complex in Nubia (ancient Sudan), successively restored by Pharaoh Taharqa (690-665 BC). The temple is placed under an artificial skylight that evokes a natural zenithal atmosphere. 2021. At right, Sir John Soane's Museum. Sepulchral Chamber: The crypt is open to the Dome Area and benefits from its only zenithal lighting. Coloured glass alters the ambience's colour. Several mirrors are used to create perspectives in the room. 2021. Photo credits: Viviana Gobbato.

- 36 Finally, the results also raised specific designs for artworks. For painting, for instance, we identified parameters such as accentuation, colour, daylighting, dynamic lighting, intensity and combination of colour temperatures as variables to enhance, contextualise or resituate the artist's creation and creative gesture (e.g., Claude Monet, *Les Nymphéas*, 1914-1926, Musée de l'Orangerie). For sculptures in the round, other lighting configurations were taken into consideration, such as accentuation, colour, direction, dynamic lighting, colour temperature and texture to highlight the depth of the relief and material, as well as to suggest a reading of the artwork, or even contextualise it (e.g. Antonio Canova, *Three Graces*, 1814-1817, Antonio Canova Museum; Khmer Angkor Thom, Insel Hombroich Museum, 12th and 13th centuries; sculptures by Hans Arp, Antoine Pevsner, Otto Freundlich, Ludwig Museum). In addition, the research reflected on the question of contemporary art which involves the figure of the living artist—beyond the traditional white cube (O'Doherty, 1986). The artist's wish to have a choice of lighting, as well as the lack of such a choice, could be interesting information to consider when documenting the artwork, to present it in a setting that conforms to his or her vision. Lighting designs could in this sense be based on colour, direction, distribution, texture, colour temperature, as well as variation and movement (e.g., Anselm Kiefer, Mark Rothko, Alain Séchas, Ettore Spalletti, Pierre Soulages).

Figure 6. The artificial lighting designed by the artist to contribute to the formal and aesthetic expression of his work.



Musée Soulages. View of room 5, "Outrenoir II." Pierre Soulages, painting 162 × 724 cm (November 1996), oil on canvas, diptychs A and B of 162 × 362 cm juxtaposed, composed of two elements of 81 × 262 cm superimposed. 2021. Photo credits: Viviana Gobbato.

- 37 These museum lightings thus appear to support the idea of cognitive, ostensive and aesthetic functions. Such approaches encourage interpretation, contemplation and

hence understanding and experience of artworks. This perspective is connected to the academic work of Katzberg (2009) in the field of museum studies. He considers a “formative function” of museum lighting, meaning that in some cases, museum lighting helps to form the artwork. From our point of view, this also specifically relates to the concept of the “sensory index” raised by Parker, a precursor of the non-linear, multi-sensory museum in the 1960s (McLuhan, Parker & Barzun, 1969). Parker suggested determining to which sensory profile an artwork belongs and then correlating it with specific sensory media to help understand the artefact (McLuhan, Parker & Barzun, 2008, p. 141). Regarding our results, this raises the possibility of a particular light sensory index—i.e., a light incidence related to the artist’s creative design — which can be reproduced at the exhibition stage for sensory art mediation. Such a challenge arises today with the close collaboration between lighting designers and living artists in museums. Artists may directly define the type of lighting desired for their work. This would perhaps provide a form of coherence for the exhibition.

- 38 Movement, colour and extent become variables of light conducive to a form of interpretation. The relationship with both natural and artificial light is of great importance for these notions of luminous sensory index and sensory mediation, since they are an instrument for the artist’s creation—a medium that can radically change the appearance of an object without it being distinctly perceived by visitors. In this sense, the question of aesthetic ‘accuracy’ arises when lighting does not align with the artist’s intentions. Perhaps the key to defining museum lighting that is both true to the artist’s concept and enhances the experience through a sensory and sensitive approach lies in close collaborations between curators and lighting designers. Spacing out the layout and installing comfortable furniture could encourage slowing down, prevent museum fatigue, promote wellbeing, and thus encourage the attentive study of the artworks, even contemplation, under the ‘right’ light.
- 39 But can we draw the same conclusions for contemporary art? Contrary to what one might think, sensory luminous mediation finds a major advantage in contemporary art. Indeed, living artists can testify in various ways to the exhibition conditions and, therefore, the lighting of their work: through interviews with curators, scenographers, lighting designers, as well as through their writing about the work. Some contemporary artists seek different, specific lighting that harmonises with their work, recalling the environment of its creation or producing different formal effects. The sensory index is then directed toward questions of internal and external light to the work. The logic of interchangeable white cube lighting is thus insufficient for some artists. This suggests the existence of artworks with a higher luminous sensory index than others. Establishing the conditions for this type of lighting would then be valuable information for understanding the subsequent lighting conditions for exhibition. Some other artists may certainly reject the notion of a luminous sensory index, just as they might reject the luminous sensory mediation of their works. In such cases, documentation about the work could include descriptions of lighting conditions not desired by the artist (focus, variations, colours), or even their complete disinterest. This would also be valuable information for establishing subsequent presentation and mediation conditions.
- 40 Through these considerations and examples, we have proposed a reconsideration of museum lighting as a potential sensory mediation. In our view, these issues cannot be separated from technical lighting designed to meet preventive conservation and

visibility functions. Indeed, depending on the characteristics chosen, all lighting will necessarily have a visual and formal impact on the work. Therefore, the work is not immune to these issues, whether it is natural or ambient artificial lighting, wall grazing, or homogeneous. Such lighting may seem neutral, but it is not. It will have a subliminal influence on the reception of the work. Museum lighting thus contributes to the assertion, constitution and existence of the work itself. In this sense, it carries a formative function (Katzberg, 2009).

- 41 Certain limitations arise from this research, however. It is primarily restricted to art museums and a corpus of artworks, specifically paintings and sculptures, with only a limited focus on contemporary art. These case studies are therefore not representative, although it can be assumed that there is a correspondence between these typologies of lighting devices for art museums and other existing typologies of museums. For example, science museums are more likely to inform dramatic atmosphere scenarios (Hatt, 1960; Borhegyi, 1963; Gobbato *et al.*, 2020). This will require the application of the proposed model to a larger corpus, to detect the components that would distinguish the applications according to the typology of the museum (architecture, exhibition design, nature of the collections, target audiences, permanent or temporary exhibitions).

Towards a Luminous Sensory Mediation

- 42 The consideration of light design strategies also involved the study of the reception and experience of correlated devices. For this purpose, we designed an experimental lighting scenario for a painting: Raoul Dufy's *La Fée Électricité* (1937, Museum of Modern Art of Paris, France). This experiment aimed to study the impact and influence of dynamic lighting on the embodied and situated cognition of the public during a natural visit (without the supervision of a researcher and knowledge of the research object). This part of the research, therefore, sought to better identify the functions of our hypothesis from the audience's point of view: cognitive, ostensive and aesthetic functions.

Figure 7. Light tests on the cinema sign painted by Raoul Dufy, 2021.



On the left, a detailed wall-wash illuminated by the permanent installation. In the centre, a colour temperature test of 3,500 K. On the right, a colour temperature test of 5,000 K (the chosen colour temperature for the experiment). These lighting tests demonstrate how the colour of the painting can change under different artificial lights. In this case, we chose the coolest temperature as it allowed us to best capture the white and cool tones in this detail of the painting. Photo credits: Viviana Gobbato.

- 43 Over four days, the survey conducted in June 2021 resulted in twenty-six stimulated recall interviews of 17 women and 9 men, 19 of whom were visiting the Dufy room for the first time. The analysis was based on the representaments identified and considered by the visitors: the general atmosphere, the colours, the points of light and the chiaroscuro of the work. When a visitor described a representament related to the lighting, we identified the expectations, the knowledge mobilised, the nature of the engagement, the meaning construction produced, and the experience embodied. The declaration of emotional valence allowed the visitors to name and define the intensity of the relationship and the researchers to deepen the most significant sequences. Note that the visitors were only informed of the purpose of the research at the end of the interviews. Four key areas of response emerge from this experience.

Figure 8. View of the illuminated Dufy Room during a user test. Survey at the Museum of Modern Art in Paris. 2021.

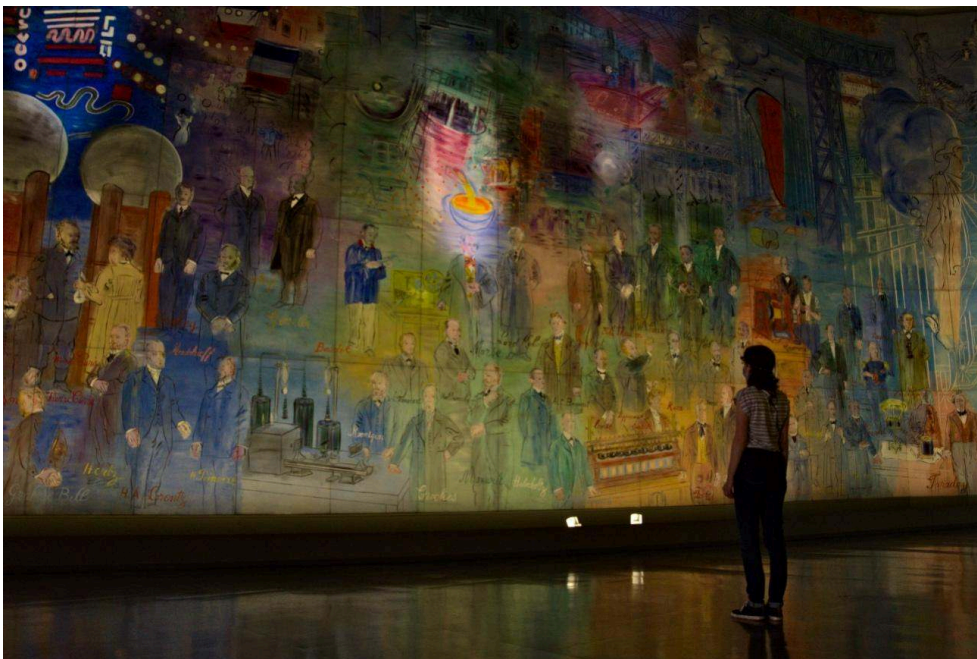


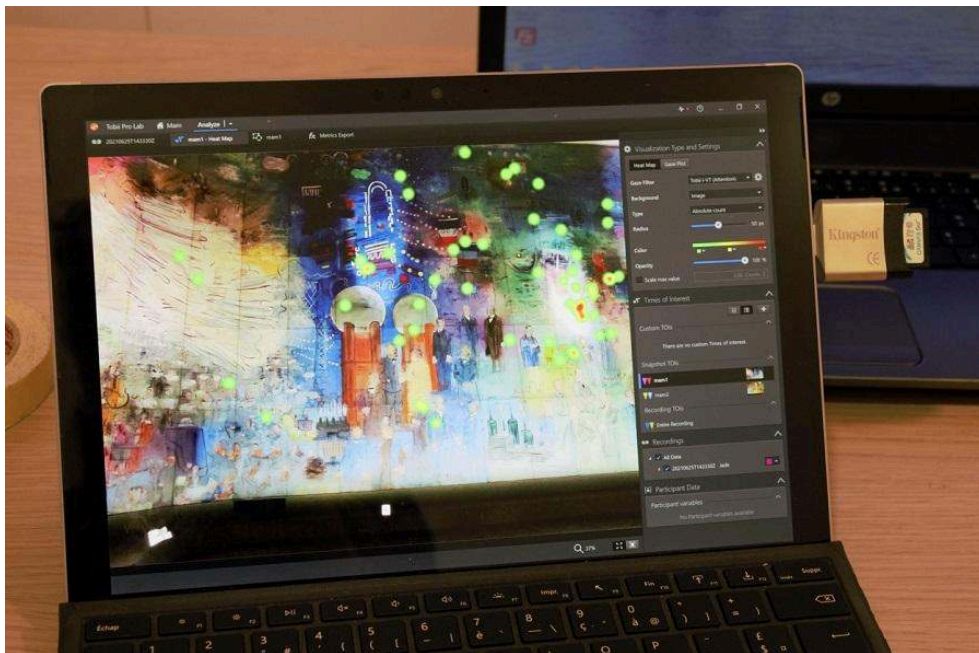
Photo credits: Jade Nijman.

- 44 Firstly, the lighting system helped to construct narrative sequences. Visitors connected the illuminated parts and created meaning between them. This facilitated their understanding of the artwork, even for those who were looking at it for the first time and had not read the text. When the visitors' narratives did not encompass the complete meaning of the work, some of them utilised lighting to concentrate on a specific illuminated scene, thereby enhancing their understanding of the significance of one or more sequences.
- 45 Secondly, the lighting system provided visitors with a close aesthetic experience or sequences related to the contemplation of the details and colours, and the atmosphere of the room. The contrast between light and shadow attracted the eye, guided and focused attention. As a result, visitors spent more time in the lit areas and saw more detail and colour. The device then assisted visitors to study areas that they would otherwise have been quick to ignore—as some visitors stated. In addition, it allowed visitors to study details close to the illuminated scenes. The atmosphere also

contributed to a state of wellbeing. The experience then awakened sensations, emotions and even feelings. This was induced on the one hand by the subdued atmosphere, and on the other hand by the monumentality of the work, its colours and lights.

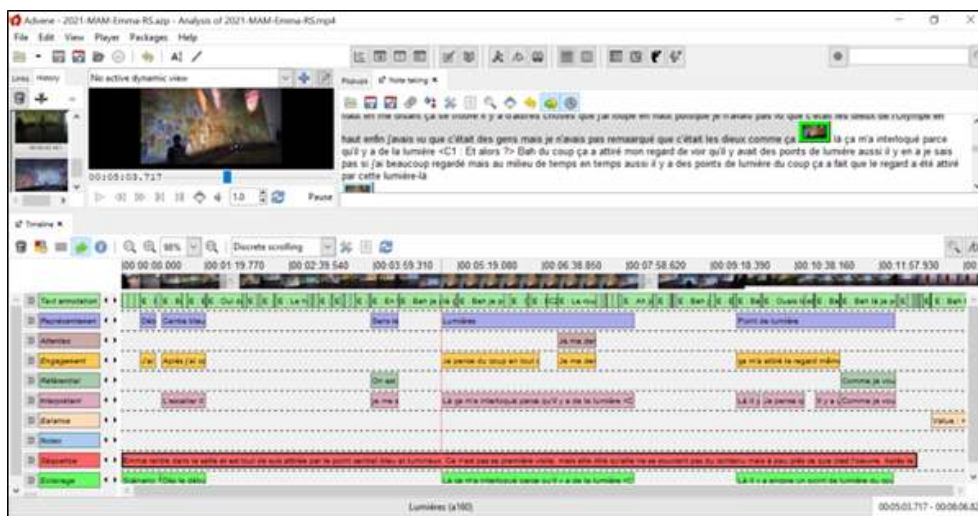
- 46 Thirdly, the lighting scenario acted as a catalyst for experiences. It helped to shape a new experience during the visit. Some visitors perceived the installation as a positive event that enriched their visit. In this way, the installation encouraged the discovery of the artwork and the movement in the room and stimulated the creation of meaning, helping the visitors to understand the connection between the lit scenes. The lighting device also stimulated curiosity about how the installation worked. Visitors then tried to understand where the light came from and how the installation worked. Some associated it with wearing eyeglasses (although the glasses were not coupled to the installation). The lighting was also a tool that encouraged forms of interaction between visitors who tried to stabilise their perception of reality by relying on third parties.
- 47 Fourthly, the analyses showed that sometimes the device influenced visitors without them identifying, evoking or distinguishing its presence. Cognitive and aesthetic dynamics were manifested in the visitor experience, without them noticing the lighting device at the same time. Visitors stopped, observed and read lit scenes without verbalising about the lighting at the same moment. The lighting device also stimulated the creation of a form of 'conceptual map' of the artwork. Visitors remembered and recalled the previously illuminated parts, without noting the lighting. Finally, in two cases, visitors used the scenes that were illuminated (but not perceived as such) to stabilise their perception of reality on elements of the text that they remembered. These results indicate that the lighting attracts the eye, physically guides the visitor's path through the navigation, participates in a 'conceptual map' of the artwork and contributes to the visitors' understanding, even if they do not perceive the illuminated areas at the time. The light seems to become part of the artwork.

Figure 9. View of a visitor's sequence when the lighting scenario is triggered.



The green points indicate all the focal points of the visitor's gaze for this sequence. Survey at the Museum of Modern Art in Paris. 2021. Photo credits: Viviana Gobbato.

Figure 10. Ergonomics of the Advene software.



At the top left, video of the tour; to its right, transcription of the interview; and at the bottom, annotations in the form of a timeline. The software was developed by the LIRIS laboratory at Claude Bernard University Lyon 1 (Olivier Aubert, Yannick Prié, Pierre-Antoine Champin). Photo credits: Viviana Gobbato.

- 48 Based on these results, the lighting we have designed appears to effectively interact with the visitors' construction of meaning on the ostensive, cognitive and aesthetic levels. This also raises the question of the impact on the subliminal and implicit level of reception. The lighting scenario contributed to their reasoning, the comprehension of the artwork, and thus the construction of narrative sequences. It focused the visitor's attention and encouraged a connection with the points of light and the attentive study of the work. It stimulated sensory, emotional and aesthetic spheres. This brings into

focus the question of an embodied cognitive experience, stimulated by lighting, which invests the intellect, reasoning, memory, body and emotions. Because of these results, this experiment opens up the potential for a wide research programme on dynamic lighting in museums. This could rely on a theoretical framework of luminous sensory mediation in museology and information and communication sciences. This would be necessary to conduct further studies on the construction of embodied meaning stimulated by lighting, to establish a dialogue between design and reception. For example, the inclusion of visually impaired people should be further explored in the future (CIE, 2017), with a view to universal lighting design (Lebat, 2018; Ciaccheri, 2022).

- 49 These results are more aligned with a broader perspective of the museum experience that emphasises sensitivity and sensory aspects. Some museum researchers have called these “bodily mediations” (Verhaegen, 2008) or “formal mediations” (Chaumier & Mairesse, 2013, p. 55). This also relates to broader museological approaches that consider the museum as a multi-sensory site (Liu & Lan, 2021), such as the museology of the sensitive (Lebat, 2022), or the museology of emotions (Varutti, 2020, 2022). For this research, however, we prefer to describe this luminous mediation that has been observed with the term “sensory.” This term emphasises above all the corporeal dimension of the influence of museum lighting—whereas the term “sensitive” also highlights its emotional and sentimental approach. This is because light-sensory mediation seems to stimulate the transmission, reception and interpretation of a museum reality through light information (cognitive and ostensive functions), but only in certain cases can it include a sensitive dimension (aesthetic function). In brief, not all visitors feel emotions or experience contemplative states. So, there is no proven bijective relation between the sensitive design intention and the experience lived by the visitors.

Conclusions

- 50 According to Henri Verne, former director of the Louvre Museum, the masterpieces of art were created in light, for light, and need light to come alive (Verne, 1937, p. 21). His view reflects a deep understanding of how lighting activates experience, alters perception and influences the understanding of works of art—which seems more broadly related to the *cosa mentale* conveyed by the artefacts on display. An alternative way of experiencing museums and comprehending artworks was thus considered with the advent of artificial lighting in the past, yet it seems to have been overshadowed by conservation functions.
- 51 Our research aimed to reconsider these matters. The results identified at least three possible key elements: (i) museum lighting design radically changes the visitor experience; (ii) light sensory index contributes to the form of artwork; and (iii) luminous sensory mediation participates in sense-making, learning and contemplation. Lighting emerged as much more than a technical necessity for preservation and visibility. Its design when applied to museum architecture, layout, exhibition and collections can radically transform the visitors’ experience. Lighting serves other functions that reshape the museum atmosphere and contribute to its identity. It visually organises the environment and shows the exhibits (ostensive function). It

encourages and incites reasoning (cognitive function). It stimulates emotional states and wellbeing (aesthetic function).

- 52 Museum lighting indeed promotes learning—as much as space, form, volume and colour, i.e., the basic elements mentioned by Falk and Dierking (2000). It enriches the experience and understanding of an exhibition, as a tool of “silent pedagogy” (Eisner & Dobbs, 1988). For these reasons, it may be a valuable medium in designing sensory museum experiences for visitors’ emotional responses (Jelinčić, Šveb & Stewart, 2022). Findings also seem to enrich the literature on the sensory interpretation of art collections (Bertelli Pagotto, 2022), as well as on the impact of the museum atmosphere on visitors (Vallo Madsen 2019; Piancatelli, Massi & Vocino, 2021). The method applied to the study of lighting could also extend the tools of research on museum space, such as Atmospherics (Forrest, 2013) or Space Syntax (Tzortzi, 2015). The results contribute to a broader reflection on reception museology in the sense evoked by Mairesse (2014). From the perspective of Gilman (1918) and, more recently, Chaumier (2018), the functions studied could be rooted in the bodily experience one has within museums.
- 53 It would now be appropriate to discuss these aspects more widely in the field of museum studies. To do this, it seems essential for us to continue investigating the contemporary development of lighting in relation to new technologies, the creative process of designers, and the effects on reception from an embodied cognition perspective. As mentioned earlier, these axes are not separate from each other. On the contrary, they feed into each other within an organised structure like a complex, explicit and implicit system. This domain could perhaps in the future form the basis of two specific research and teaching frameworks, both in design and reception, inherent to museum lighting and ambience: one dedicated to theoretical reflection, a ‘luminology’ (with the history of museum lighting and the theory of museum lighting), and the other dedicated to practice, a ‘luminography’ (studies of the design and reception of light).

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NOTES

1. Personal translation of the original text: *Toute une gamme d'interventions menées en contexte muséal afin d'établir des ponts entre ce qui est exposé (le voir) et les significations que ces objets et sites peuvent revêtir (le savoir) [...] [c'est-à-dire] une stratégie de communication à caractère éducatif qui mobilise autour des collections exposées des*

technologies diverses, pour mettre à la portée des visiteurs des moyens de mieux comprendre certaines dimensions des collections et de partager des appropriations.

2. The selected museums are the Musée d'Orsay (Paris, France), the Musée de l'Orangerie (Paris, France), the Centre Pompidou (Paris, France), the Musée du Louvre (Paris, France), the Bourse de Paris (Paris, France), the Musée d'art de Nantes (Nantes, France), the Musée Soulages (Rodez, France), the Louvre-Lens (Lens, France), the Musée des Beaux-Arts Antoine Lécuyer (Saint-Quentin, France), the Scuola Grande San Rocco (Venice, Italy), the Fondazione Pinault-Punta della Dogana (Venice, Italy), the Gipsoteca Antonio Canova (Possagno, Treviso, Italy), the Museo di Castelvecchio (Verona, Italy), the Galleria degli Uffizi (Florence, Italy), MAXXI (Rome, Italy), the Musée Pio-Clementino (Vatican), the Altes Museum (Berlin, Germany), the Bode Museum (Berlin, Germany), the Museum Insel Hombroich (Neuss, Germany), the Ludwig Museum (Köln, Germany), the British Museum (London, United Kingdom), the National Gallery (London, United Kingdom), the Sir John Soane's Museum (London, United Kingdom), the Ashmolean Museum (Oxford, United Kingdom), MACBA (Barcelona, Spain), the Fondation Mirò (Barcelona, Spain), the Guggenheim Museum (Bilbao, Spain), the Serralves Museum (Porto, Portugal), the National Museum of Stockholm (Stockholm, Sweden), and the BOZAR (Brussels, Belgium). Note that the BOZAR in Brussels is not strictly a museum as it primarily hosts temporary exhibitions. Nevertheless, the layout designed by the architect Victor Horta was interesting since he originally designed the lighting based on the typologies of the artworks (1929).

ABSTRACTS

This paper raises the possibility of museum lighting as a tool for 'mediation' within museums. It studies its functions in the process of interpreting, transmitting and receiving collections. Based on a comprehensive approach to design and experience, the author focuses specifically on three possible functions: ostensive function (to show space and artworks), cognitive function (to influence the construction of meaning and reasoning), and aesthetic function (to stimulate sensitive and contemplative states). To explore the mediating functions of lighting in both design and experience, she discusses the findings from several case studies (30 European museums), interviews with lighting designers and museum managers (54), as well as participant observations (4 months) and surveys on embodied cognition and experience (26). Three concepts emerge that could contribute to new research studies in the field of museology, specifically focusing on exhibition design and the visitor experience: 'museum lighting design,' 'light sensory index' and 'luminous sensory mediation.'

Cet article soulève la possibilité de concevoir l'éclairage muséographique comme outil de « médiation » dans les musées. Il étudie les fonctions de ce dernier dans le processus d'interprétation, de transmission et de réception des collections. S'appuyant sur une approche

globale de la conception et de l'expérience, l'auteure se concentre spécifiquement sur trois fonctions possibles de l'éclairage muséographique : la fonction ostensive (pour montrer l'espace et les œuvres d'art), la fonction cognitive (pour influencer la construction du sens et du raisonnement) et la fonction esthétique (pour stimuler les états sensibles et contemplatifs). Pour explorer les fonctions médiatrices de l'éclairage dans la conception et l'expérience, elle analyse les résultats de plusieurs études de cas (30 musées européens), d'entretiens avec des concepteurs d'éclairage et des responsables de musées (54), ainsi que d'observations participantes (4 mois) et d'enquêtes sur la cognition et l'expérience incarnées (26). Trois concepts émergents pourraient contribuer à de nouvelles études de recherche dans le domaine de la muséologie, en se concentrant spécifiquement sur la conception des expositions et l'expérience du visiteur : « conception de l'éclairage muséal », « indice sensoriel de la lumière » et « médiation sensorielle lumineuse ».

INDEX

Mots-clés: musée, collections, éclairage, médiation, scénographie.

Keywords: museum, collections, lighting, mediation, exhibition design.

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