210: Daylighting Museums – a survey on the behaviour and satisfaction of visitors

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Abstract

Lighting in art galleries is central to the buildings' function and it impacts directly on the visual experience, the preservation of art and the energy used. Daylighting is also the 'ideal' form of light in terms of colour rendering and variability.
This paper investigates the roles of lighting in Art Museums, with the hypothesis that the more varied and exciting the daylighting characteristics of the museum space are, the more likely visitors will stay longer, have an enjoyable experience and be willing to return.
Two case-studies of Art Museums in Lisbon, Portugal were considered and the data collection was carried out in the summer and winter of 2007. The methodology consisted of firstly, making illuminance measurements. Then, a survey was carried out regarding the degree of satisfaction of visitors in those rooms, focusing on the quality of light in museums. Finally, direct observation of the routes followed by visitors in those rooms was registered, in terms of the time spent at each stop and also the total time in the room.
The conclusions of this study aim to contribute towards the understanding of the relationship between lighting characteristics and visitor satisfaction within a museum space.

Keywords: lighting; daylight; museums; user behaviour

1. Introduction

Lighting in art galleries is central to the buildings' function and impacts directly on the visual experience, the preservation of art and the energy used. On the other hand, daylighting is the 'ideal' form of light in terms of colour rendering and variability.
This paper investigates the roles of lighting in Art Museums, considering the hypothesis that the more varied and exciting the daylighting characteristics of the museum space are, the most likely visitors will stay longer, have an enjoyable experience and be willing to return.
Generalizations about museum visitors are, however, very difficult to make. What dominates visitors' behaviour may be the quality and content of the exhibition, the visitor's past experience and interests, or even large-scale social and environmental constraints that enforce the way visitors behave inside a museum to well-defined and socially acceptable norms. Nevertheless, museum visitors, despite their heterogeneity, seem to follow reasonably predictable patterns. The better the understanding of what controls these behaviours is, the easier it will be to provide a pleasant experience for visitors in museums.
Two case-studies of Art Museums in Lisbon, Portugal were considered and the data collection was carried out in the summer and winter of 2007. The methodology consisted of firstly, making quantitative measurements of light (illuminance) inside four types of rooms selected according to their daylighting characteristics. Then, a survey was carried out regarding the degree of satisfaction of visitors in those rooms, focusing on the quality of light in museums. A total of 200 visitors characterized and qualified the natural and artificial light according to a set of selected adjectives, testing the possible relationship between daylight variation inside these spaces and user satisfaction. Finally, direct observation of the routes followed by visitors in those rooms was registered, in terms of number of stops and time spent in each room.
The results of this study show correlations between lighting characteristics and visitors' satisfaction.

2. Light and architecture

2.1 The physical light

Light has always been claimed to be the most important element in architecture.
Light is modified firstly by its physical surroundings; colours are added, intensity is diffused, and directions changed. Light is then subjected to a mental modification: the same light when perceived by someone in a happy mood or in a sad mood also appears to be very different [1].

2.2 Psychological characteristics of light

The use of light to influence human physiology and behaviour is not yet a priority of general lighting in buildings. However, increased use of daylight and careful tailoring of the lighted environment has potential for health benefits, increased safety and productivity [2]. Additionally, almost anything becomes monotonous when we are exposed to it for long enough periods, as the

human organism is not adapted to steady stimuli or to the complete lack of stimuli. Monotony may lead to visual efficiency, but it also leads to emotional fatigue. The eye is used to a continuous change, and due to the eye's adaptation mechanism, each scene is viewed differently depending on the relationship between the brightness of the focus point and its surroundings. The complexity of the perceptual mechanism is mainly the cause of the great difficulty to quantify daylight perception and thus design a perfect day lit interior [3].

Fig 1. Metropolitan Museum of Art in New York and Asian Art Museum in San Francisco. Daylight brings variety and diversity to the exhibition spaces.

Also, people are subconsciously frustrated when they are not able to sense what is happening with the weather outside or do not have any sense of time. One of the strongest elements in the establishment of a sense of orientation and well-being is the presence of direct sunshine in buildings. In the northern climates, where there are fewer sunny days, there is an almost overwhelming desire to go south. Those in the more tempered southern climates may find the sun uncomfortable or monotonous. However, experience indicates that the southerner who is moved to northern latitudes will soon come to miss the presence of sunshine [2].

2.3 Quality of light

The aim of a good daylight design is, apart from providing sufficient levels of light, to ensure a comfortable and pleasing environment. In order to produce a satisfactory space in daylight terms, the user must be pleased, first of all with a good level of visual comfort, then providing visual acuity and then with the avoidance of glare [5]. However, visitors are not completely aware of the lighting characteristics that affect their perception of the artworks, especially with conditions of high luminance backgrounds [4].

3. Lighting Art Museums

3.1 Evolution of the role of museums

There are two schools of thought on the role of architecture in the museum environment. The first states that the museum building should not dominate, remaining a quiet background, in order to allow artefacts to speak for them; the second argues that architecture should heighten the experience of perceiving the artefacts and contribute to the visual field. Both reckon that it is not enough for the artefacts to be seen, as it is equally important to ensure that their inherent meaning can be conveyed through visual interaction.

Conservation has remained as the most important concern for display lighting in the museum environment. Being vision the most important sense which allows a constant dialogue between the artefacts and the beholder, the foremost purpose of light should be to allow this dialogue to take place [1].

3.2 Visitor expectations and behaviour

According to Tregenza and Lawson [6], expectations about room brightness are related to people's prior experience of similar places and these are predominantly of day lit interiors. Our memory sets up expectations not only of the physical environment but also the social one. These depend on our prior experience and our cumulative memory of similar spaces; they are also determined by the physical environment, and its social setting is culturally dependent and related to climate.

Generalizations about museum visitors are difficult to make. Falk's study in the Florida State Museum of Natural History [7] found out that the behaviour of adults over the initial 30 to 45 minutes of their visits appeared to be constant and relatively predictable. Initially, visitors spend the first minute or two finding direction. Then, once the exhibits are found, a high degree of attention was focused on them. This high level of attention appeared to be constant and persisted for about 30 minutes. After 30 to 45 minutes, "museum fatigue" seemed to set in. The primary change was from moving slowly from exhibit to exhibit and reading labels to "cruising" through the halls, stopping occasionally and only very selectively. Therefore, visitors to museums, despite their heterogeneity, behave in reasonably predictable patterns.

The better the understanding of what controls these behaviours is, the easier it will be to provide the best possible experience for visitors.

3.3 Museum fatigue

The total capacity of the attention reserve is limited, based on the physical energy available to the individual, condition of health, mental attitude and so forth. However, several design factors may reduce this attention decrement. First, the exhibitions display should be mainly heterogeneous rather than monotonous displays with similar objects all in a row. Second, varying the display in terms of content and appearance also maintains a greater interest. Finally, the mental effort should be minimized as possible. It is known that visitors behaviour show a gradual inverse ratio in the frequency of stopping and the amount of time spent per each exhibit as the time at the museum is extended [8].

4. Research methodology

The literature review presented before illustrates the complex relationships between light, architecture, museum objects and visitors' behaviour, comfort and satisfaction. The following study attempts to investigate how these factors combine in the experience of a Museum.

The research methodology can be divided into three parts: illuminance measurements, survey to visitors and observation of visitors' behaviour. The data collection was done in July and December 2007, corresponding to summer and winter conditions.

4.1 Case-study selection

Two case-studies on the most important Lisbon Art Museums were studied - Arte Antiga Museum (AAM) and Gulbenkian Museum (GM), chosen for their importance as being representative of Art Museums, as well as for their architecture.

Located in a southern European country, they were chosen for their privileged solar conditions when compared to northern European countries, conditions which also may result in excessive illuminance and summer overheating. A recent project coordinated by A. Tombazis also focused on Mediterranean countries museums [9].

Four room types were chosen in each museum, according to their lighting characteristics. Room 1 (R1) has no daylight; Room 2 (R2) has upper daylight only and no views; Room 3 (R3) has lateral daylight only, and also no views; and finally Room 4 (R4) has both daylight and views.

AAM was founded in 1884, being the first great public museum dedicated to Art in Portugal. Its vast collection spans from the Middle Age until the beginning of the 19th century.

Fig 2. Arte Antiga Museum exhibition rooms chosen for this study: Rooms type 1, 2, 3 and 4.

This museum is the most important Portuguese representative of Ancient Art museums using daylight in the main display rooms.

Table 1: Arte Antiga Museum - room types selected and their characteristics in terms of lighting and area

Room type	Daylight	Views	Area (m^2)
1	No	No	132.85
2	Lateral	No	91.75
3	Superior	No	161.40
4	Lateral	Yes	118.55

GM is a defining mark in Portuguese museum architecture. Founded in 1969, the building is organised around two gardens with numerous tall windows that enable the visitor to enjoy Nature and Art.

Fig 3. Gulbenkian Museum exhibition rooms chosen for this study: Rooms type 1, 2, 3 and 4 (left to right).

Table 2: Gulbenkian Museum - room types

Room type	Daylight	Views	Area (m^2)
1	No	No	110.30
2	Lateral	No	264.60
3	Superior	No	415.37
4	Lateral	Yes	297.05

This museum was selected because of its varied collection of artworks and the presence of lateral daylighting and exterior views through the entire museum.

4.2 Physical measurements

Although the illuminance measurements are not measures of user perception, they allow to present data with the conventional format to curators and also to compare physical data with the visitors' perception of space. Therefore

illuminance measurements were taken in both overcast sky in winter and clear sky in summer, under display conditions, in order to gather information about the lighting characteristics in extreme weather conditions. They consisted of measuring environmental light with a portable luxmeter within a horizontal grid inside the display rooms, complemented with vertical light measurements parallel to the artworks at eye level. The following graphs present the means of illuminance measurements in all four rooms in summer and winter, in both museums.

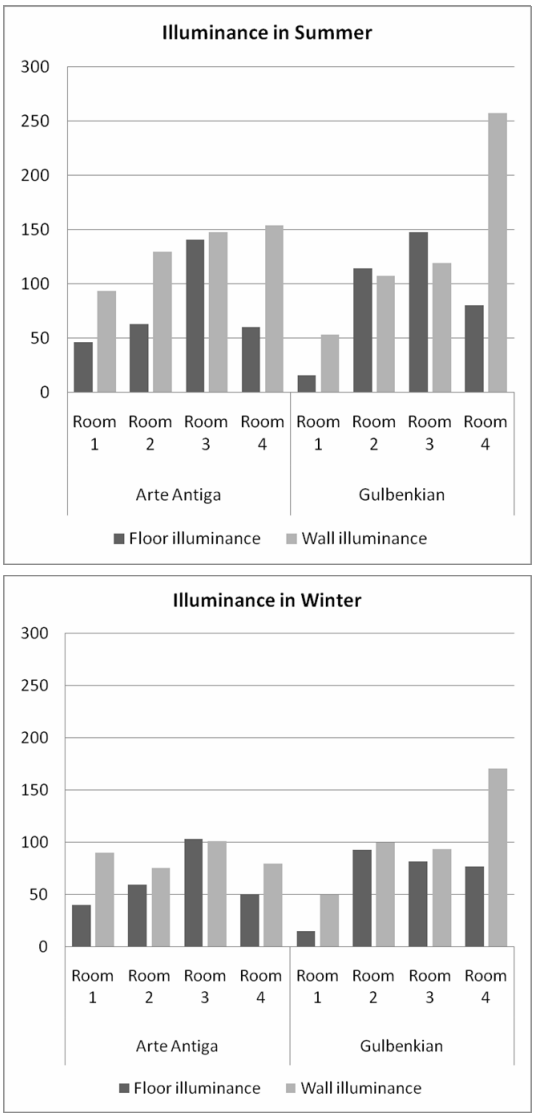

Figure 4: Illuminance measurements in all four rooms, in summer and winter.

These graphs show that the illuminance levels were considerably lower in winter with overcast sky in all rooms but R1. AAM R3 presents the greater difference between seasons while in GM R4 is the one that shows the greater gap.
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These values were considered as reference to curators to understand the visitor answers to the survey, although luminance might be a better measure of visitor light perception than illuminance.

4.3 Survey and interviews

A visitors' survey, as a self report method, allows assessing the quality of light by comparison with the fieldwork measurements and visitor observation. The questionnaires were designed focusing on the quality of light in museums, where visitors had to characterize and qualify the natural and artificial light according to a set of selected adjectives. The questionnaire includes general Semantic Differential (SD) scales, which aim to characterize the visitors' state of mind (satisfaction and fatigue) and more specific SD scales to characterize each of the four room types selected.
The following graphs present the general perception of their visit to the museum. The purpose of these questions was to understand if fatigue could affect their impression of the museum.

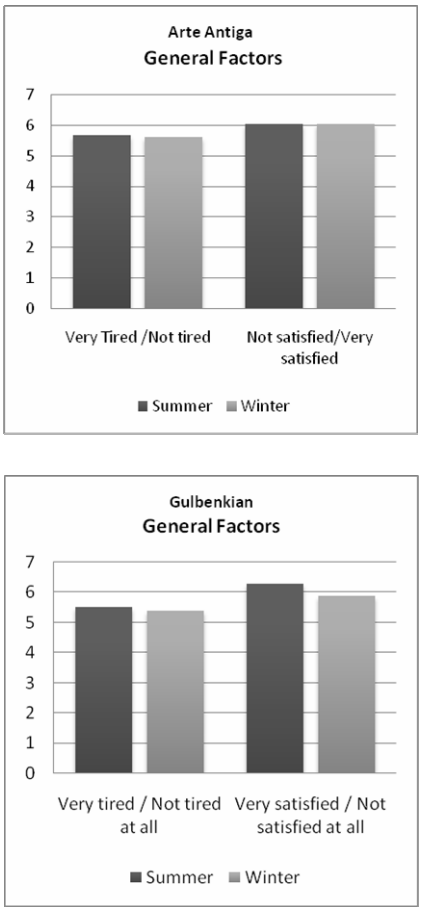
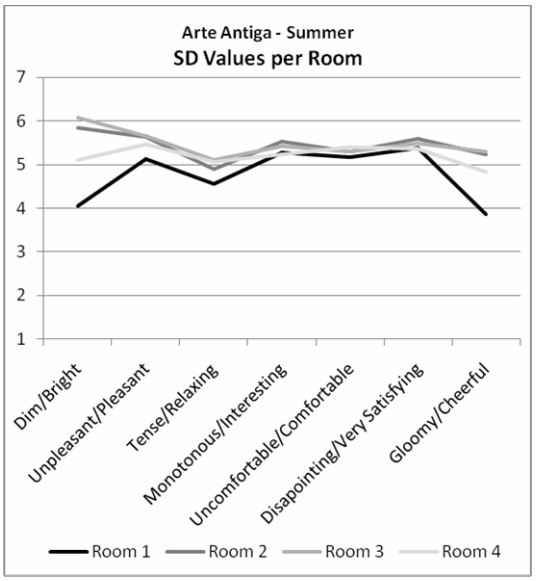


Figure 5: Graph of General Semantic Differential scales results.

In AAM the visitors' answers were very consistent in both seasons, with visitors reporting that they were not very tired (on a scale of 0 to 7, being 0 very tired) and they were quite satisfied with their visit.

In GM, on the other hand, visitors reported to feel slightly more tired than in AAM, and clearly less satisfied in winter than in summer.
The following graphs present the results of the specific SD scales applied to the four room types. Again, lower scores are closer to the "darker/least comfortable" end of the scale from 0 to 7.



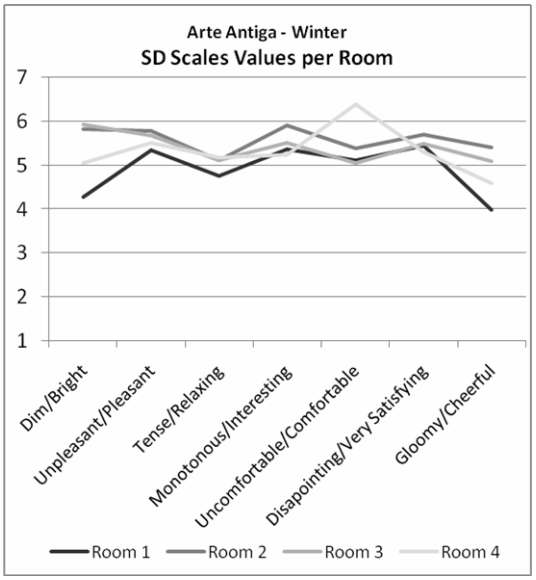
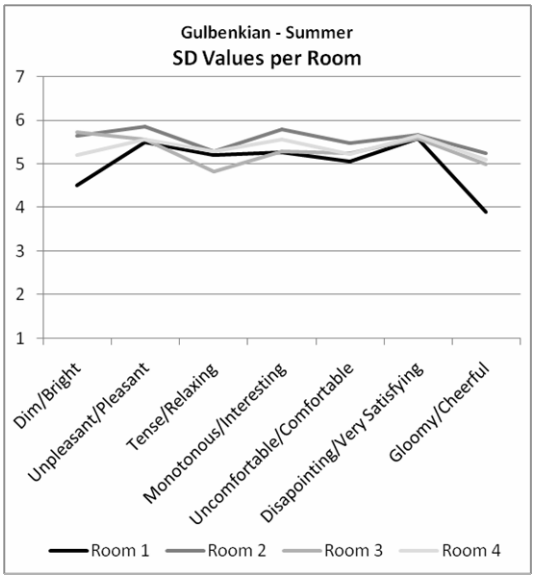


Figure 6: Graph of Semantic Differential scales results in Arte Antiga Museum, for Summer and Winter.

In AAM it is clear that R1 (the room lit only with artificial light) presents the lowest results.
On the other hand, R4 (the room with views) has generally the second lowest scores, presents an interesting peak in winter being considered very comfortable. Additionally, R2 and R3 present consistently high scores in both seasons.
The following graphs correspond to the same SD scales in GM, also in summer and winter.
We can see that, again, R1 presents the lowest scores and R2 and R3 the highest.
This result is very consistent with the AAM surveys, revealing that visitors seem to agree when qualifying the different types of rooms.



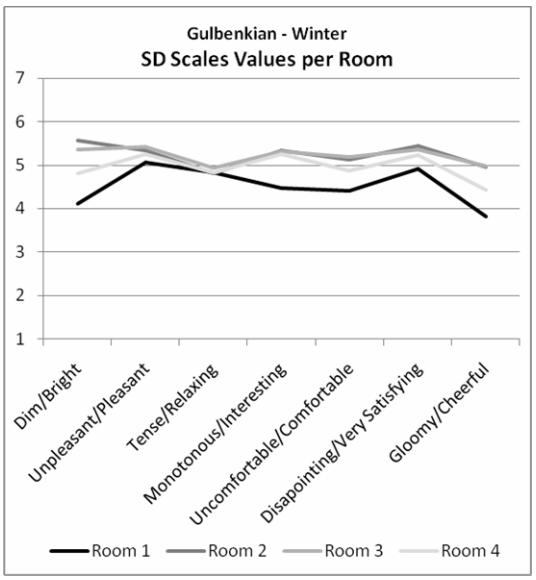


Figure 7: Graph of Semantic Differential Scales results.

Also, R4 presents the second lowest scores, showing that the least favourite rooms are rooms with no daylight, followed by rooms with views (probably related with the excessive contrast between lit and unlit areas that these rooms present).

4.4 Observation of visitors

The visitors were observed when visiting the museums during the two seasons, in order to understand their behaviour patterns. This analysis did not interfere with their visit, in order to gather data about the visitors' natural behaviour inside the display rooms. The aim of this observation was to understand if the time spent and the numbers of stops inside each room related with the light properties and the survey responses.
30 visitors were considered in each room, and their paths recorded. The following graphs show the average time spent in each room per museum and per season.

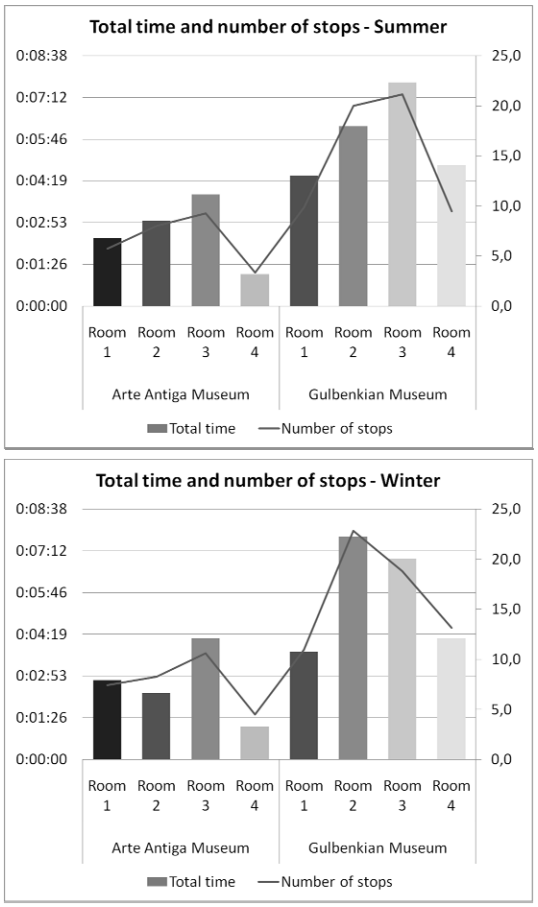


Figure 8: Time spent and number of stops per room and per museum, summer and winter.

Rooms in AAM are considerably smaller than the rooms in GM, which also reflects on the time spent in each museum. The first thing that strikes our attention is that R4, despite being the larger room in both museums, is the one that presents the lowest time spent in AAM and the second lowest in GM. This fact relates with the lower scores that this room presents in the SD scales, showing that visitors do not get the best impression of a room with views.

On the other hand, R2 in AAM presents the lowest time spent in winter but not in summer. This room was quite dark in winter due to the very limited daylight from an overcast sky (as vertical illuminance was lower in the winter), and this seems to reflect on visitors' time spent inside the room, but not on their opinions about it, as we can see on the graph of the SD scales.

An inverse trend can be seen in GM, with R2 presenting higher times in winter than in summer. However, this also correlates with the fact that the illuminance values were considerably higher in winter in this room, due to the fact that the windows had they blinds semi-closed in summer in order to control light and overheating.

5. Conclusion

It is interesting to see that self-reported satisfaction not always corresponds to the visitors' experience, but it gives important leads to their experience in the museum.

From the simple analysis of the general SD scales we can see that visitors do not report fatigue at the end of their visit, although the average time spent of 2 hours would most likely lead to some tiredness. The overall impression of the museum also seems to be very good, although GM presents a slight lower score in the winter, which goes against the common conception that museums as spaces of controlled temperatures are perceived as more satisfying in the summer in countries where temperatures are higher. Therefore, lower daylight levels seem to affect visitors' perception of their environment inside the museum space.

Analysing the more specific SD scales related with the four types of rooms, it is understandable that the room with artificial light is rated with the lowest scores, followed by the room with views.

Finally, from observing the illuminance graphs and time spent in each room, we can see that the rooms with higher illuminance tend to attract longer stays, except if they also have views. Therefore, daylight is an important factor in museum environment, and its presence is crucial for general well-being and satisfaction.

Nevertheless, views and the consequent high contrast between adjacent surfaces are not as well accepted inside the rooms as top or lateral light with filters. Visitors seem to appreciate the presence of daylight and the contact with the outside world but only when it does not disturb their appreciation of the artworks.

6. Acknowledgements

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7. References

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