Research on the Emotional Response Level of Museum Visitors Based on Lighting Design Methods and Parameters

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Abstract. This study is based on the survey data of Zhongshan Art Museum in Dalian. To investigate changes in the emotional response of visitors to various lighting conditions. The museum is divided into two areas: display space and non-display space. The optical parameters of each space and space are measured. Data analysis was used to evaluate the impact of museum interior lighting on visitors' mood in different lighting environments. It is pointed out that the light intensity and the contrast of CCT, environment are the main viewpoints of the evaluation index. The degree of comfort of visitors in each space was discussed according to the scores of 11 emotional indicators. At the same time, the influence of illumination parameters on the mood of visitors was analyzed by investigating the illumination and color temperature in different scene modes, visual psychology of observer evaluation and so on. The range of illumination and color temperature that is most suitable for visitors is obtained.

Keywords: Emotional response level · Lighting design · Visual factors

1 Introduction

Lighting is one of the essential life elements in nature. The reason why human eyes can see this colorful world is also because of light. It can be said that all human activities are inseparable from light. The natural sunlight irradiation has provided the condition for people's normal life, but now more and more artificial light source has brought more colorful world to people. In the present exhibition activities, how to make better use of light effect has become one of the most important issues for designers. Whether it is a museum or an exhibition, the light effect directly determines the effect of the exhibition. Today's society advocates environmental protection and energy saving, so more and more new energy saving lamps and lanterns have been used in the exhibition.

The lighting in the museum not only meets the visual requirements of tourists, but also makes tourists feel comfortable and enjoy during the visit of the museum. The environmental condition of the museum is a key factor in creating an appropriate

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exhibition space for tourists and museums. Lighting design plays an important role in museum design, and it is even more important in exhibition hall. Different kinds of museums should have different display themes, which also means different lighting techniques [1].

Light is arguably one of the greatest causes of deterioration in museum collections, on one hand it can be destructive and thus conflicts with the museum's role in preserving our heritage; on the other it is essential to vision, the principal means of communicating the information held within and around the objects in the museum's collection [2].

The environmental space of the museum is divided into two types of Spaces, the main spaces of the museum are defined as the display space, and the secondary space is defined as the non-display space. The lighting modes of different Spaces are divided into environmental lighting and booth lighting. According to the lamps and lanterns of lighting the way of the bottom of the top lighting, lighting, side lighting and mixed lighting, test types and power LED lamps and lanterns, lighting design and layout of space is analyzed. The display space and the non-display space have their own evaluation indexes, and for different emotional response evaluation indexes.

This research refers to the data analysis during the investigation of Zhongshan museum of art, and discusses various factors affecting visitors' emotional response in two aspects of objective experimental data and subjective evaluation. The objective experimental data is mainly to analyze when the display area detects the illumination of its exhibits, it also tests the illumination of the surrounding environment space and calculates the ambient contrast with its illumination. The colour temperature, colour rendering and colour tolerance parameters of the lamps in the display area are tested, and the parameters are classified and analyzed. Display the ambient temperature and temperature test to ensure that the temperature of the exhibit and the ambient temperature meet the requirements of the exhibition while not damaging the exhibit [3]. Compare and analyze the ambient temperature and display temperature to ensure that the physical properties of the exhibit are not damaged while providing more suitable lighting conditions. The subjective evaluation is carried out by inviting the audience to fill in the questionnaire, which is convenient for statistics. A total of 240 groups of data were collected from over 40 people. The exhibition area includes calligraphy works, painting works and sculpture exhibits [4].

In this article, we studied the main types of museum lighting design and the technical indicators used by the led light source in museum lighting environment. Through the analysis of psychophysical experiments and questionnaire survey data, we discussed what kind of lighting design and lighting can create the most suitable light environment for the audience to visit. The research project aims to explore the influence of lighting methods on visitors' emotional response level. Analysis of Zhongshan art museum's investigation through objective measurement results and subjective evaluation results. As shown in Fig. 1.

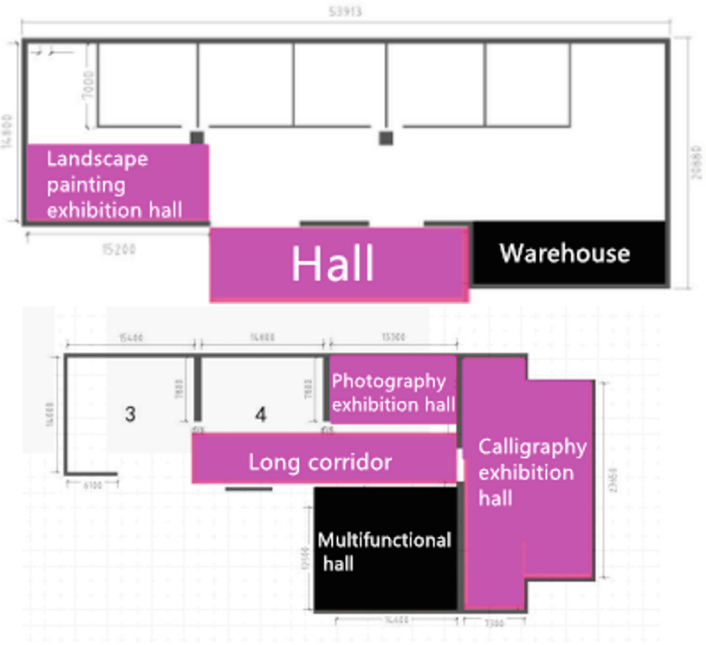

Fig. 1. Floor 1 and floor 2 plan of Dalian Zhongshan art museum

2 Environmental Space

2.1 Display Space

The display space includes calligraphy work area, photography work area, painting work area and three-dimensional exhibit area.

The purpose of exhibit lighting is to make the exhibit attractive and can be fully appreciated and studied by people. In order to achieve this truth, the lighting design should enable the exhibits to fully display their shapes, colours and textures [5].

The illuminance measurement is performed on each partial area to obtain an illuminance distribution map.

An objective measurement of a calligraphy work in the exhibition hall was carried out. The average value of the reflectance is 71.1%, and the ground uniformity and light colour test are taken by the central point method to take the point 3 * 12, and the average value is taken (Eq. 1). As shown in Fig. 2. The objective measurement of the photographic works in the exhibition hall was carried out. The average value of the reflectivity was 62.5%. The ground uniformity and light colour test were taken by the central point method to take 2 * 10 and averaged. As shown in Fig. 4. An objective measurement of a painting in the exhibition hall was carried out. The reflectance takes the average of 3 points as 62.3%. The ground uniformity and light colour test use the central point method to take the point 2 * 6 and take the average value. As shown in Fig. 6. An objective measurement of a three-dimensional exhibit in the exhibition hall

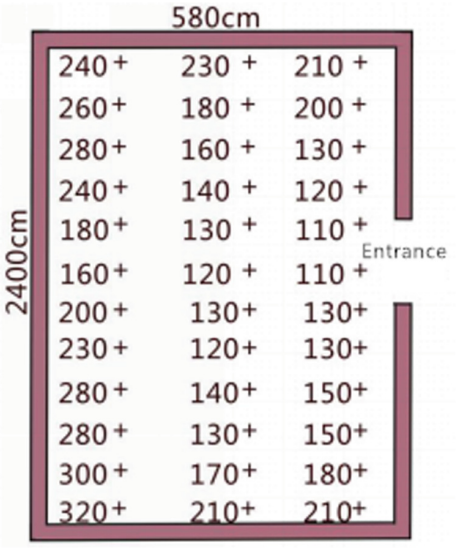

Fig. 2. Local ground illuminance Distribution map of calligraphy exhibition hall (Eav 185.0 lx, Uniformity 0.595)

Fig. 3. Calligraphy exhibition hall

was carried out. Ground uniformity and light colour test using the central point method to take the point 1 * 4, take the average. As shown in Fig. 8. The illuminance uniformity of each group was calculated respectively (Eq. 2) (Figs. 3, 5, 7 and 9).

$$Eav = \frac{1}{M \bullet N} \sum Ei \tag{1}$$

Formula:

Eav—Average illumination, The unit is lx;
Ei—Illuminance at point I, The unit is lx;
M—Longitudinal measuring points;
N—Lateral measuring points.

$$U0 = Emin/Eav \tag{2}$$

What kind of lighting source is used in the museum is a major problem for lighting designers to adopt lighting methods. Different types of light emitting sources should be given enough attention in terms of luminous ability, and the appreciation of the displayed objects should be reflected in appropriate lighting conditions. The illuminance spectrum of each region was analyzed, and the results are shown in Fig. 10 below.

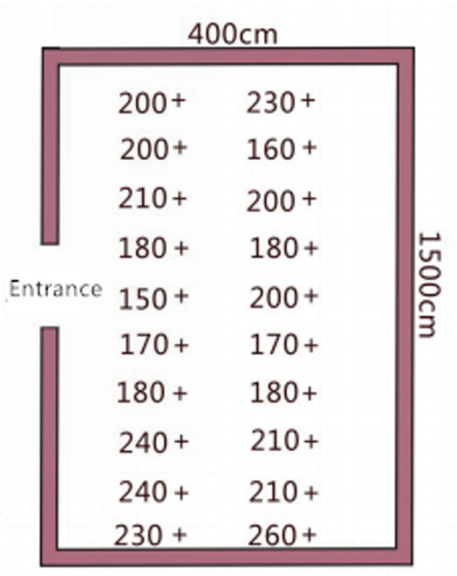

Fig. 4. Ground illuminance distribution hall in exhibition hall of photographic works (Eav 200.0 lx, Uniformity 0.80)

Fig. 5. Photography exhibition hall

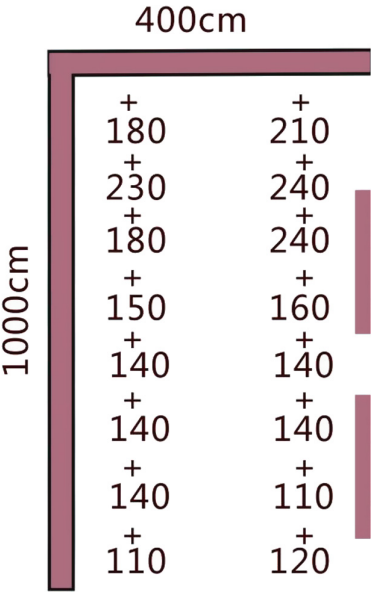

Fig. 6. Illumination distribution of local floor in exhibition hall of painting works (Eav 165.0 lx, Uniformity 0.667)

Fig. 7. Painting exhibition hall

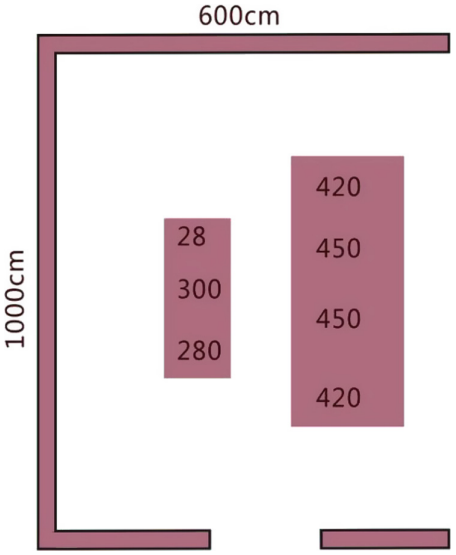

Fig. 8. Illumination distribution of local working face in exhibition hall of three-dimensional exhibits (Eav 317.43 lx, Uniformity 0.759)

Fig. 9. Three - dimensional exhibition hall

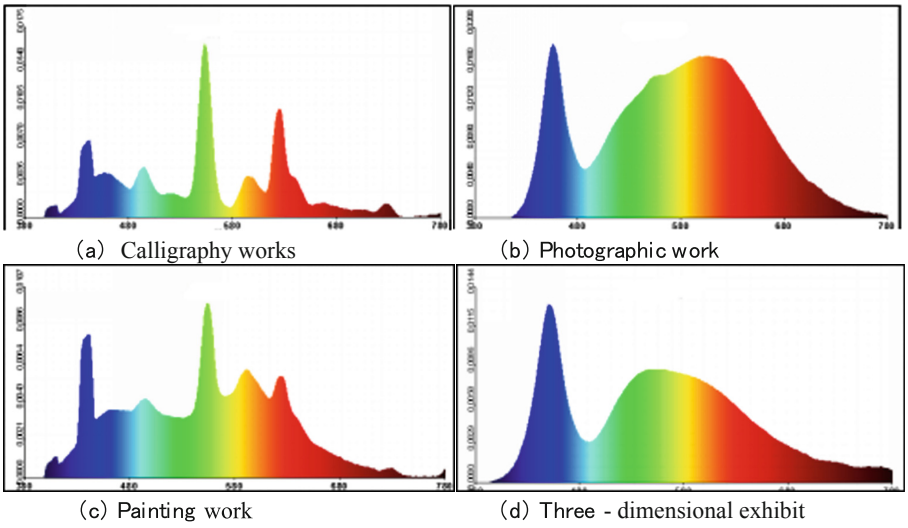

Fig. 10. Shows the spatial illuminance spectrum

2.2 Non-display Space

For the non-display space, the illumination, brightness distribution and spectral distribution of the lobby area and corridor are mainly targeted. Some areas of the lobby rely on natural light for illumination, and the glass wall is designed so that sunlight can penetrate through the glass and enter the stadium. The roof of the shed is equipped with downlights as auxiliary lighting for night visits. The hall (Fig. 12) uniformity and light colour test uses the central cloth method to take the average value of 4 * 4 points.

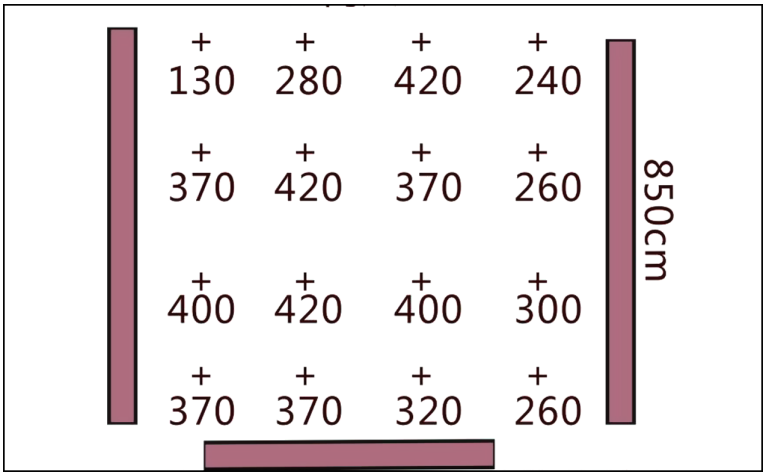

Fig. 11. Illuminance distribution in lobby (Eav 333.13 lx, Uniformity 0.390)

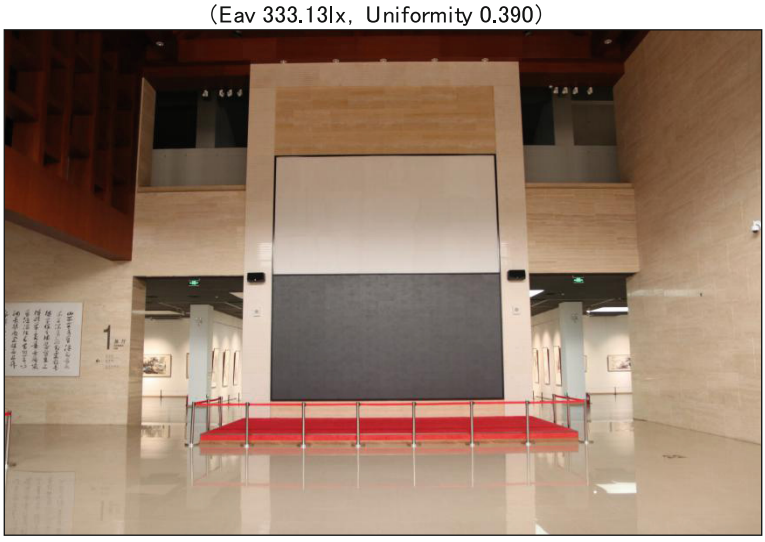

Fig. 12. Dalian Zhongshan art museum lobby

The colour temperature of artificial lighting in the lobby is 5406 k, the average horizontal illuminance is 333.13 LX, and the uniformity of horizontal illuminance is 0.390. As shown in Figs. 11 and 13.

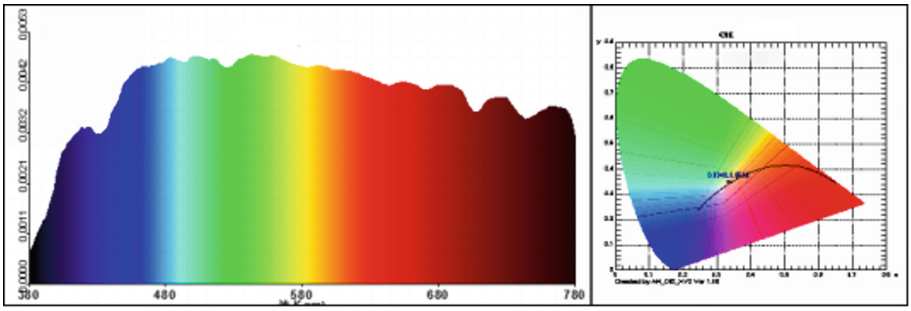

Fig. 13. Lobby illuminance spectrum

The corridor (Fig. 15) relies on led guideway spotlights to illuminate the light reflected by the lighting of the exhibits on both sides. The reflectivity of each wall surface is 62.5% of the average value of the sampling points, and the uniformity and light colour test uses the central point distribution method to take point 1 * 17 and take the average value. The colour temperature of artificial light illumination is 3862 k, the horizontal average illumination is 161.77 LX, and the horizontal illumination uniformity is 0.68. As shown in Figs. 14 and 16.

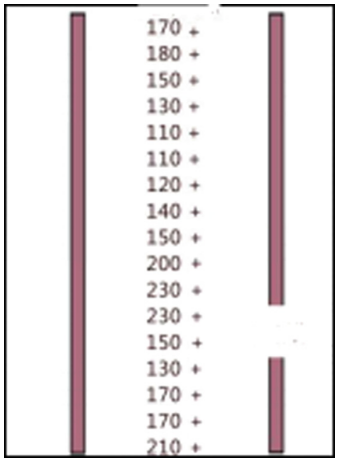

Fig. 14. Illuminance distribution in illuminance corridor (Eav 161.77 lx, Uniformity 0.68)

Fig. 15. Dalian Zhongshan art museum corridor

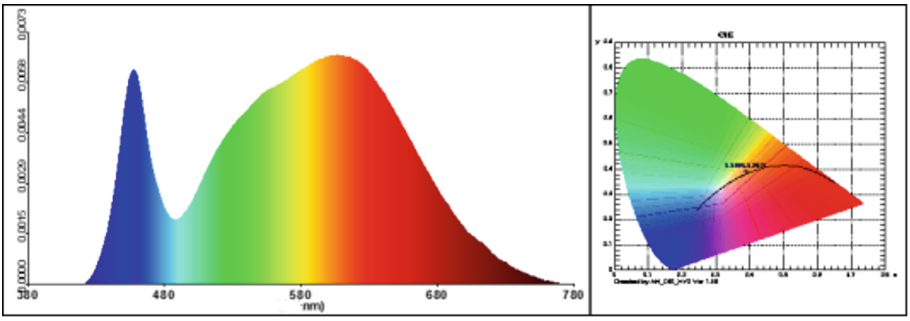

Fig. 16. Corridor illuminance spectrum

2.3 Summary

No matter where the light source is in the spectrum, it is an energy. And energy will drive the chemicals on the object, causing the object to fade and damage [6]. From the two parts of the environment space, the display space and the non-display space, it can be seen that white led lamps are the most suitable choice of lamps and lanterns. Illuminance values, colour rendering index, brightness uniformity and data deviation are measured on different artworks or historical relics. For this kind of situation, it is

suggested to solve the problem of visitors' experience based on the standard of adapting to tourists' light level. Through this investigation, we understand the distribution of lighting sources, the types of light sources and the optical parameters of the light sources for the museum lighting, and analyze its exhibition lighting and working lighting. Judging from the light effect alone, led is the main light source, which is easy to adjust. Compared with the original heat radiation light, it is more protective to the exhibits and reduces the exposure. However, due to the uneven selection of led, some exhibits' lighting performance will not be robbed. In addition, there are some halogen lamps. According to the optical parameters of each exhibit, we can know that the infrared radiation of halogen lamps is very strong, so the amount of infrared radiation will be relatively increased, especially the lighting of display cabinets [7]. The Table 1 below for Summary of objective measurement results.

Table 1. Summary of objective measurement results.

Type	Surface temperature/°C	Ra	Colour tolerance adjustment	Brightness/cd/m^2	Brightness uniformity	Illuminance/lx	Illuminance uniformity
Calligraphy exhibition hall	5.4	93.5	9.4	27.34	0.732	933.33	0.857
Photography exhibition hall	5.8	83.4	0.7	15.5	0.839	855	0.866
Painting exhibition hall	10.0	76.2	9.1	36.5	0.767	536.3	0.836
Exhibition hall for three-dimensional works	20.0	83.3	4.0	—	—	1623.33	0.431
Lobby	—	98.6	5.1	—	—	333.13	0.390
Corridor	—	82.7	4.6	—	—	161.77	0.68

Through the use of the measuring instrument, the illuminance spectrum, temperature, color rendering index, color tolerance, brightness, brightness uniformity, illuminance and illuminance uniformity of each space area of the museum reflected in the table can be obtained. It can be seen that the color rendering index of each area of the museum is high, and the illuminance in the display area will be relatively high, and the illuminance uniformity will reach an ideal level.

3 Emotional Response Level

3.1 Subjective Evaluation Survey

The subjective evaluation is carried out by inviting the audience to scan the QR code on site to fill in the questionnaire, which is convenient, efficient and convenient for statistics. A total of 113 sets of data were collected for more than 40 people. The display areas are photographic work areas, oil painting areas and oil painting areas, while the non-display areas are lobby, corridor and leisure areas. The questionnaire is shown in Table 2. The subjective evaluation is carried out by inviting the audience to

scan the QR code on site to fill in the questionnaire, which is convenient, efficient and convenient for statistics. A total of 113 sets of data were collected for more than 40 people. The display areas are photographic work areas, oil painting areas and oil painting areas, while the non-display areas are lobby, corridor and leisure areas. The questionnaire is shown in Table 2 [8].

Table 2. Emotional response levels evaluate.

Index/Score	Excellent		Good		Normal	
	6	5	4	3	2	1
Pleasant	11	8	9	12	0	0
Comfortable	10	8	10	12	0	0
Bright	13	7	13	7	0	0
Colourful	15	6	7	1	1	0
Clear	9	13	10	7	1	0
Natural	12	12	11	4	1	0
Active	14	8	7	8	3	0
Relaxing	12	9	9	10	0	0
Soft	8	14	8	9	1	0
Classical	16	8	14	2	0	0
Warm	8	14	12	5	1	0

The emotional index were find into 11 items index, will each index go to rated, construct different illumination environment experimental conditions. Though to change the parameters of illumination, environmental luminance contrast, colour temperature and colour rendering index [9].

The goal of this study was to define the relationships among visual perceptions for different combinations of CCTs at various illuminances. The uncertainty of the experimental rating data was examined with the root mean square (RMS) value on emotional scales by means of intra- and inter-observer variability. The intra-observer variability indicates how well an observer's responses can be repeated under the same evaluation conditions. The inter-observer variability indicates how well the observers' responses agree with the mean within the group. 19 In addition, the RMS value could determine how well the two data sets agree with each other (Eq. 3). Smaller RMS value shows more agreement between two data sets. Higher RMS value means poorer intra- or inter-observer agreement. The variation of RMS depends upon the scale range of the data sets.

$$RMS = \sqrt{\frac{\sum_{il}^{n}(y_i - x)^2}{n}} \tag{3}$$

For intra-observer variability, x i and y i represent the first score and the second score of the individual observer for the ith stimulus, respectively. For inter-observer

Table 3. Root-mean-square (RMS) values of inter- and intra-observer variability.

Emotional scale	Inter-observer variability	Intra-observer variability
Pleasant	0.92	0.38
Comfortable	0.92	0.37
Bright	0.89	0.38
Colourful	0.92	0.36
Clear	0.88	0.33
Natural	0.96	0.38
Active	0.92	0.36
Relaxing	0.90	0.37
Soft	0.83	0.34
Classical	0.85	0.35
Warm	0.84	0.35
Mean value	0.89	0.36

Table 4. Conversion relation table of grading grades.

Rating scale	Excellent		Good		Normal	
Score grade	A^+	A^-	B^+	B^-	C^+	C^-
Corresponding score	6	5	4	3	2	1

variability, y i is the individual observer's score for the ith stimulus; x i is the mean score of all observers for the ith stimulus; and n is the total number of stimuli [10]. The grading scale is shown in the Table 4.

The specific calculation is as follows Table 3:

In the survey questionnaire, for the testees, the psychological and visual acceptance of cultural relic - grade calligraphy and painting exhibits after lowering the illuminance, the change of light and shade in the light environment, the adaptation in visual perception, the coordination of the overall space light and shade and space colour of the art gallery exhibition hall, the psychological feeling, the visual fatigue after the visit, the absence of comfortable shadows on the floor and wall surfaces of the exhibition space, and the feeling of shadows that are too strong to be compared. In terms of artistic expression of light, evaluating whether the overall artistic effect of lighting and the wonderful lighting performance effect have achieved a sense of comfort to the tested person, and whether they have achieved a unified and coordinated overall with the exhibition content by using light forms, which can convey good effects and have deep-level performance, contrast and deduction effects on the exhibition site [11].

3.2 Emotional Response

Emotion is an experience of subjective consciousness, which is a kind of emotional or emotional feeling different from cognition or will. The human eye will automatically adjust the amount of light in order to adapt to the angle level of the scene, and the

brightness of the scene will also affect the brightness adaptation level of the person. Generally speaking, it is related to the illuminance on site. The illuminance in different parts of the museum will deviate from the average illuminance to varying degrees, which may make it difficult for visitors' eyes to adapt to the difference in illuminance. Glare sources will often be formed in places where illuminance is too high, making visitors unable to see the exhibits clearly. Uneven illumination distribution on the exhibits and even uncomfortable dark areas or spots will affect the mood of the visitors. The difference in colour temperature of the light source can enhance the display effect. It is usually hoped that the difference in colour temperature is neither large nor small so as not to distract the visitors from the exhibit. The final result of lighting is to create a good visual environment for the audience, so that visitors can feel the cultural relics and painting breath while also keeping a comfortable and comfortable atmosphere in their hearts under the current lighting environment [12].

4 Main Observation Review

Subjective evaluations are all evaluated by means of inviting viewers to scan the QR code to fill out the questionnaire, which is convenient, efficient and convenient for statistics. A total of 121 sets of data were collected from about 20 people. The exhibition area is the calligraphy work area, the photography work area, the painting work area, and the three-dimensional exhibit area. The non-display area is the lobby and the corridor.

Calculate the weight: mean * weight, used to evaluate the lighting design of its venue.

According to the data in Table 5 and the on-site research report, the subjective evaluation results of each display space are obtained. Then calculate the score of each

Table 5. Subjective evaluation index system.

Secondary indicators	Weights	Examination points
Exhibit color realism	20%	(a) Meet the daily testers' true judgment on the color of the exhibits
Light source color preference	5%	(a) The tester can recognize the choice of the cold-warm color of the light source (b) The color of the light source is highly compatible with the psychological expectation of the evaluator
Exhibit detail expression	10%	(a) The light environment clearly shows the details of the exhibit (b) The light environment is accurate and satisfactory for the exhibits
Three-dimensional expressive power	5%	(a) The three-dimensional effect of the exhibits is obvious, and the contrast of light and color is just right (b) The three-dimensional effect of the exhibits is rich in expression, which can improve the aesthetic effect of the art

(*continued*)

Table 5. (*continued*)

Secondary indicators	Weights	Examination points
Exhibit texture clarity	5%	(a) The details of the material of the exhibits are clearly expressed (b) The material of the exhibits is rich in texture and landscaping
Exhibit outline	5%	(a) Whether the overall outline of the exhibit can be clearly seen (b) Whether the performance of the exhibit outline is easy to identify
Bright acceptance of exhibits	5%	(a) After the cultural relics and paintings and exhibits reduced the illumination, the subjects were highly psychologically and visually accepted (b) The light environment meets the requirements for the protection of exhibit lighting and has a rich artistic appeal
Visual adaptability	5%	(a) The tester changes the light environment in a light and dark manner, and adapts to the visual perception of the project (b) The tester has a psychologically effective scoring project for the light and dark changes in the light environment
Visual comfort (subjective)	5%	(a) The degree of psychological feeling in the overall spatial light and shadow of the exhibition hall and the coordination of spatial color matching (b) The degree of visual fatigue of the tester after the visit
Psychological pleasure	5%	(a) It is uncomfortable for the presence or absence of the brightness distribution in the field of view in the evaluated space, or the presence of extreme brightness contrast (b) A scoring item for the presence or absence of uncomfortable shadows on the floor and walls of the display space, as well as visual effects that are too strong for contrasting shadows or for reducing the ability to observe details or targets
The preference of using light art	20%	(a) The overall artistic effect of the lighting is outstanding, and the tester has high visual comfort (b) There are wonderful lighting effects, which are fascinating and memorable (c) The use of light design to add color to the entire building environment has become a classic case
Infective preference	10%	(a) It conforms to the positioning and collection features of the museum itself (b) The light form of the exhibition is closely related to the theme, forming a unified and coordinated whole with the exhibition content, and it can convey good effects in the form of light (c) The exhibition has deep performance, dedication and interpretation

Table 6. Basic display subjective evaluation results.

Project/Sample| number	A+: 10	A−: 8	B+: 7	B−: 6	C+: 5	C−: 4	D+: 3	D−: 0	Mean value	Secondary weight	Weighting × 10
Exhibit color realism	9	12	0	1	3	0	0	0	8.3	20%	16.6
Light source color preference	10	5	6	2	2	0	0	0	8.2	5%	4.1
Exhibit detail expression	10	7	4	3	1	0	0	0	8.3	10%	8.3
Three-dimensional expressive power	9	6	7	1	2	0	0	0	8.1	5%	4.1
Exhibit texture clarity	9	11	3	1	1	0	0	0	8.4	5%	4.2
Exhibit outline	9	9	4	2	1	0	0	0	8.3	5%	4.2
Bright acceptance of exhibits	10	7	5	2	1	0	0	0	8.3	5%	4.2
Visual adaptability	9	9	4	2	1	0	0	0	8.3	5%	4.2
Visual comfort (subjective)	9	10	4	1	1	0	0	0	8.4	5%	4.2
Psychological pleasure	10	4	7	3	0	1	0	0	8.1	5%	4.1
The preference of using light art	9	10	2	2	0	1	1	0	8.1	20%	16.2
Infective preference	11	6	5	2	0	0	1	0	8.3	10%	8.3
Total										100%	82.7

space, basic displays are shown in Table 6, temporary exhibitions in Table 7, halls in Table 8, corridors in Table 9, and auxiliary spaces in Table 10.

According to each evaluation, the corresponding score is 80 points or more, 70 points or more, 60 points or more, and 60 points or less. Divided into 4 levels, excellent, good, average, and poor. From the above four tables, we can see that the basic display, temporary exhibition, and the scores of the three areas of the hall are all above 80, which is a good grade, and the score of the corridor is above 70, which belongs to the general level.

According to the evaluation index system of art museum, the weight of basic display space is 40%, that of temporary exhibition area is 20%, that of lobby is 20%, and that of corridor and auxiliary space is 10%. The final score for the summary is shown in Table 11 below.

It can be seen from the above table that the total score reached 81 points and above 80 points, which was considered as excellent lighting quality for the environmental experience of visitors.

Table 7. Temporary exhibition subjective evaluation results.

Project/Sample| number	A+: 10	A−: 8	B+: 7	B−: 6	C+: 5	C−: 4	D+: 3	D−: 0	Mean value	Secondary weight	Weighting × 10
Exhibit color realism	7	10	3	1	0	1	0	0	81	20%	16.6
Light source color preference	7	5	8	2	0	0	1	0	7.9	5%	4
Exhibit detail expression	7	8	5	1	1	0	0	1	7.8	10%	7.8
Three-dimensional expressive power	7	7	6	6	3	0	0	0	8.1	5%	4.1
Exhibit texture clarity	7	4	9	1	2	0	0	0	7.9	5%	4
Exhibit outline	7	8	4	4	0	0	0	0	8.1	5%	4.1
Bright acceptance of exhibits	7	9	3	3	1	0	0	0	8.1	5%	4.1
Visual adaptability	6	8	6	2	1	0	0	0	8	5%	4
Visual comfort (subjective)	7	10	3	1	2	0	0	0	8.1	5%	4.1
Psychological pleasure	7	9	4	2	1	0	0	0	8.1	5%	4.1
The preference of using light art	7	9	4	2	1	0	0	0	8.1	20%	16.2
Infective preference	7	5	8	2	1	0	0	0	8	10%	8
Total										100%	80.7

Table 8. Hall subjective evaluation results.

Project/Sample| number	A+: 10	A−: 8	B+: 7	B−: 6	C+: 5	C−: 4	D+: 3	D−: 0	Mean value	Secondary weight	Weighting × 10
Bright acceptance of exhibits	8	9	5	3	0	0	0	0	8.2	10%	8.2
Visual adaptability	8	4	13	0	0	0	0	0	8.1	10%	8.1
Visual comfort (subjective)	9	9	5	1	1	0	0	0	8.3	10%	8.3
Psychological pleasure	7	6	9	3	0	0	0	0	8	10%	8
The preference of using light art	8	8	5	3	1	0	0	0	8.1	40%	32.4
Infective preference	7	10	3	3	2	0	0	0	8	20%	16
Total										100%	81

Table 9. Corridor subjective evaluation results.

Project/Sample| number	A+: 10	A−: 8	B+: 7	B−: 6	C+: 5	C−: 4	D+: 3	D−: 0	Mean value	Secondary weight	Weighting × 10
Bright acceptance of exhibits	8	5	7	3	0	0	0	0	8.1	10%	8.1
Visual adaptability	7	6	8	2	0	0	0	0	8.1	10%	8.1
Visual comfort (subjective)	8	7	5	3	0	0	0	0	8.2	10%	8.2
Psychological pleasure	7	6	7	2	1	0	0	0	8	10%	8
The preference of using light art	7	6	6	2	2	0	0	0	7.9	40%	31.6
Infective preference	7	5	5	3	3	0	0	0	7.7	20%	15.4
Total										100%	79.4

Table 10. Auxiliary space evaluation results.

Project/Sample| number	A+: 10	A−: 8	B+: 7	B−: 6	C+: 5	C−: 4	D+: 3	D−: 0	Mean value	Secondary weight	Weighting × 10
Bright acceptance of exhibits	8	6	7	4	0	0	0	0	8	10%	8
Visual adaptability	6	7	8	2	2	0	0	0	7.8	10%	7.8
Visual comfort (subjective)	8	7	4	3	3	0	0	0	7.9	10%	7.9
Psychological pleasure	7	6	8	2	1	0	0	0	7.6	10%	7.6
The preference of using light art	8	6	7	2	2	0	0	0	8	40%	32
Infective preference	7	5	5	1	2	1	0	0	7.7	20%	13.2
Total										100%	76.5

Table 11. Summary of subjective evaluation results

	Space category	Sample size	Score	Weight	Final score	Total points
Display space	Basic display	25	82.7	40	33.1	81
	Temporary exhibition	23	80.7	20	16.1	
Non-display space	Hall	25	81	20	16.2	
	Corridor	23	79.4	10	7.9	
	Auxiliary space	25	76.5	10	7.7	

5 Conclusion

Through a series of investigations and data analysis of Dalian Zhongshan art museum, we can see the influence of environmental contrast on visitors' emotional response level. Data analysis method was used to evaluate the lighting design of museum interior space under different ambient lighting.

In today's society, museum lighting can no longer be considered alone, respecting the specifications of some lighting quality and lighting parameters. Neither a single architectural configuration nor a single lighting technology can well achieve the final lighting effect. The design must follow the principles conducive to viewing and protecting exhibits, and strive to better apply modern new technologies and new concepts to museum lighting design, and integrate lighting technology, exhibition theme, artistic effect and visitors' psychology into a comprehensive design.

The choice of lighting parameters and light sources should be carefully designed and strictly controlled so as to protect sensitive exhibits and provide comfortable exhibition conditions for tourists. Led technology seems to have completed most of the required tasks. Proper temperature and humidity can preserve the comfort level in the museum, but there are still suggestions to exist in some museums. In the lighting design method, white led lamps with minimal damage to cultural relics are preferred. At the same time, considering the comfort level of visitors, the illuminance selection is about 300 LX, while the colour temperature range is about 3500 K. The influence of visitors' emotional response needs to be studied and discussed by the professional knowledge of various professionals with "museum experience" so as to further explore and discuss.

Similar to the concept of the Kruithof's pleasing zone, perception zone maps for museum indoor lighting were established. The analytical results indicated that the pleasant zone found in this study partially agreed with Kruithof's rule. These new experiments will be performed again to examine higher illuminances and a wider CCT range in future work.

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