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Influence of Artificial Light on Visitors' Emotional Arousal in Memorial Space: A Case Study of the Nanjing Massacre Memorial Hall

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Abstract: Memorial spaces, vital for humanity's survival and a nation's spiritual continuity, serve as focal points for commemorating cultural heritage and transmitting ideology. Despite their key role in urban development, a considerable deficit exists in emotional design within memorial halls, notably in China. Artificial light design seldom aligns with emotional considerations, and limited research necessitates a logical framework for integrating emotional design. Due to the distinctive cultural and spiritual connotation of memorial halls, their artificial light design differs significantly from other interior spaces. Therefore, this study aims to explore the critical role of artificial light in shaping visitors' emotional experiences within memorial spaces, using the Nanjing Massacre Memorial Hall as a case study. The objectives of this paper are to (a) assess the influence of diverse artificial lighting forms on visitors' emotions in memorial halls and (b) formulate a comprehensive design framework for artificial lighting based on empirical findings. Employing an exploratory methodology, the study engaged 300 respondents through survey questionnaires, field observations, and photographic recordings. The results indicate that thoughtfully designed artificial lighting positively influences visitors' emotional arousal in memorials, contributing to the distinct atmosphere and capable of evoking diverse emotions.

1. Introduction

Memorial space is a space with the main purpose of memorial[1] (Attwa et al., 2022) , which is used for remembering something or passing down the history of the material or psychological environment. Memorial space can be divided into memorial architectural space and non-architectural memorial space[2] (Broudehoux & Cheli, 2022), memorial museums, churches belong to memorial architectural space; memorial parks, memorial plazas, memorial monuments belong to non-architectural memorial space. The core of monumental space is the expression of emotion and the emotional awakening of visitors. Any work must be approached from the perspective of the person experiencing it, with the goal of being received by the person experiencing it. Light is an important factor in the composition of space[8] (Sun & Zhang, 2023),

light in memorial space has the role of atmosphere creation and emotional expression, in other words, in memorial space, different kinds of light have different effects on the emotional arousal of visitors, the purpose of this study is to take the Nanjing Massacre Memorial Museum as an example, to explore the impact of artificial light on the emotional arousal of visitors in memorial space, based on emotional arousal, which can help to construct a design framework for the creation of emotions by artificial light in memorial places.

2. Literature Review

2.1. Memorial Space

In the history of human civilization, memorial space is one of the earliest types of architectural space to appear and develop today[7] (Puchkov, 2022). A memorial space can be understood as a space that has a memorial significance and can accommodate users to perform memorial acts and activities. Memorial spaces can be divided into memorial architectural spaces and non-architectural memorial spaces, as well as into interior and exterior spaces of buildings[6] (Mamurkhanovna, 2022). Memorial landscapes, memorial squares and monuments belong to the external space; memorial buildings and so on belong to the internal space. Memorial architecture carries human emotions and memories of major events or important people, and reflects the common values of human development, as the earliest type of public buildings, memorial buildings are the material carriers of memory emotions, with material and spiritual dual attributes[4] (Frescura & Lee, 2022). As one of the memorial buildings, the memorial hall has the significance of inheriting historical events and education.

2.2. Artificial Light Design of the Nanjing Massacre Memorial Hall

The memorial hall for the victims of the invasion of Japanese army Nanjing massacre is the site of the massacre of the invasion of Japanese army Nanjing massacre Jiangdongmen collective massacre and the victims of the mass graves. On 13 December 1983, the memorial hall for the victims of the invasion of Japanese army Nanjing massacre formally started the construction. On 15 August 1985, the Memorial Hall for the Victims of the Nanjing Massacre of the Japanese Invasion Forces was officially completed and opened[10] (Zhu, 2022). From December 1994 to December 1995, the Memorial Hall was expanded with the construction of a new Memorial Wall for Compatriots in Distress and the "Ancient City Disaster" group sculpture, as well as the excavation of the "Site of Mass Graves", and from June 2005 onwards, the Memorial Hall was expanded with the construction of a new Sculpture Square, Gathering Square, Commemoration Square, Meditation Hall, Historical Exhibition Hall and Peace Park. Since June 2005, the Memorial Hall has built a new Sculpture Square, Assembly Square, Memorial Square, Meditation Hall, Historical Materials Exhibition Hall and Peace Park. From December 2013 to December 2015, the Memorial Hall was expanded again, with the construction of the new "Victory Square", "Road to Victory", "Victory Flame "Victory Park" and "Victory Exhibition Hall"[3] (Chang, 2022). The overall atmosphere of the Memorial Hall is sorrowful and sad, with various forms of lighting to render different emotions. Among them, the artificial light design of the main hall (Historical Materials Exhibition Hall) is strongly representative. Various kinds of artificial light express the emotions of pain, pity, anger, seriousness, heaviness, solemnity, resistance, victory, struggle, fear, sanctity, and death. The main exhibition hall of the Nanjing Massacre Memorial Hall uses a lot of artificial light for the design. Different areas display different emotions, which need to be rendered with special light to correspond to the emotions, in order to better help visitors to quickly feel the emotions and recall the emotions.

2.3. Emotional Arousal

Light mainly affects human vision, the eyes are the most important perceptual senses, according to statistics, more than 80 percent of the information received by human beings originates from vision. Light can create good spatial visual effects and improve people's mood in a subtle way[5] (Kong et al., 2022), and it can also improve people's mood in a subtle way. Memorial halls with different themes need to accurately convey different emotions to visitors, and light plays an important role in the emotional stimulation of memorial halls. Furthermore, Arousal is a fundamental aspect of everyday emotion perception and emotion regulation[9] (Wang et al., 2022). Through the change of memorial halls in different forms of artificial light, thus directly affecting the visual perception of visitors, and stimulating the visual nerve, so that the thought of subconsciously affected by the influence of change, the visitor's emotional stimulation has a certain role in promoting.

3. Methodology/Materials

The method used in this research is exploratory. The purpose of the study is to understand the impact of different kinds of artificial light in memorial halls on visitors' emotions, as well as to summarise a theoretical framework of artificial light design for memorial halls to satisfy all kinds of emotions through exploratory research, which will have a facilitating effect on visitors' emotional awakening and better rapid engagement of their minds and thoughts into the memorial halls. The Nanjing Massacre Memorial Hall was chosen as the research area, firstly, this location is in accordance with the application cases of artificial light in memorial halls, and secondly, in order to focus on the transfer of different subtle emotions, this venue focuses on the emotional awakening of visitors, and there are a variety of artificial light designs to be analysed. This study was mainly conducted using a structured questionnaire method. In terms of data collection, the first step is to enter the main arena of the Nanjing Massacre Memorial Hall for field observation and taking photographs to understand the emotions expressed in the various spatial parts of this memorial hall; the second step is to categorise the forms of artificial light in the main arena and simulate some of the light effects by using the software; and finally, a structured questionnaire is made for data collection. Structured questionnaire survey of 300 visitors. The structured questionnaire utilized a five-point Likert scale, with 1 representing the none and 5 indicating the highest level of highest/or very high. The survey was conducted between November 1, 2022, and November 25, 2022. 300 valid questionnaires were returned. In order to better study the impact of different types of artificial light in the memorial hall on the emotional stimulation of visitors, a comparative study of the types of artificial light inside the hall and the emotions expressed was carried out to analyse the types of light that can more accurately stimulate the emotions of visitors in different emotions.

4. Results and Findings

The field research found that the main site of the Nanjing Massacre Memorial Hall primarily expresses the emotions of pain, compassion, anger, seriousness, heaviness, solemnity, defiance, victory, struggle, fear, and sanctity. Based on the pictures taken in the field research and the software simulation pictures will be summarised and the corresponding emotions will be derived (see Figure1-Figure8). The questionnaire will be designed through the following perspectives: direction of light exposure, light environment, shape of light, colour of light, intensity of light exposure, light environment atmosphere.

Figure 1: A sense of solemnity, A sense of seriousness

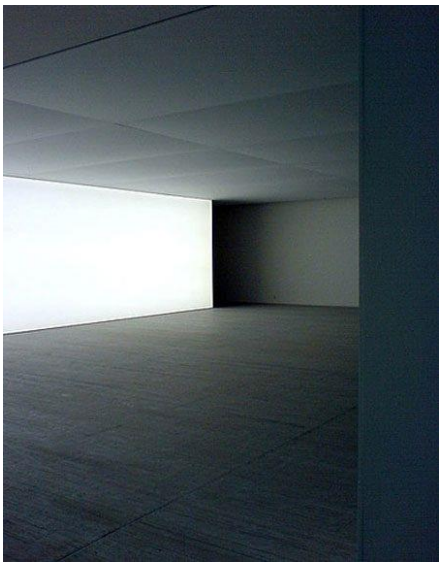

Figure 2: Fear, Helplessness, Loneliness

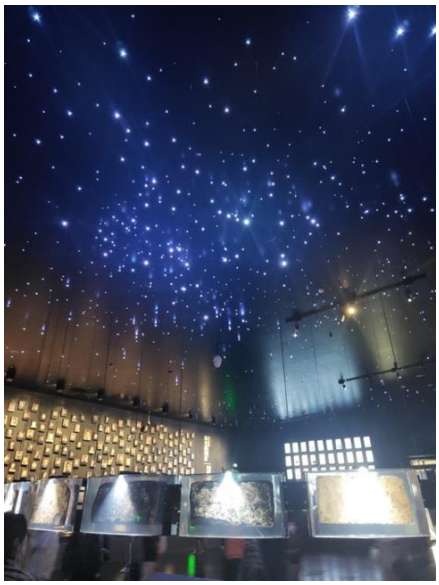

Figure 3: Messiness

Figure 4: Mystery, Sacredness

Figure 5: A sense of fear, Happiness

Figure 6: Struggle, Resist

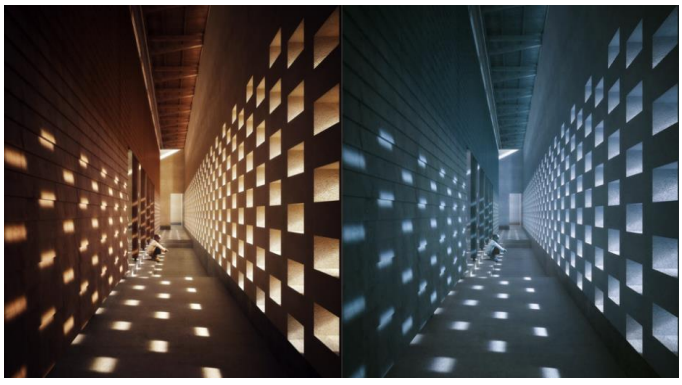

Figure 7: Memories, Hope

Figure 8: Sense of Immersion

Descriptive statistical analysis: A structured questionnaire was used to conduct the study and data was analysed using SPSS 26.0. And the statistical results are as follows:

In questions 7 to 22, Above 3.5 represents the majority of questionnaire respondents' approval, below 3.5 represents partial approval (see Table1). The study employed the Kaiser-Meyer-Olkin (KMO) test, along with Bartlett's test of sphericity, to determine the appropriateness of conducting a Principal Component Analysis (PCA). The criterion for proceeding with PCA is a KMO value greater than 0.6, and this study yielded a KMO value of 0.889 (KMO > 0.7), indicating highly suitable data for factor analysis (see Table2).

Table 1: Descriptive Statistics

Question Number	Mean	S.D.
1	1.20	0.404
2	1.15	0.356
3	1.27	0.443
4	1.04	0.204
5	1.05	0.217
6	2.75	0.634
7	4.41	0.824
8	4.09	0.968
9	3.56	1.256
10	3.41	1.363
11	4.16	1.039
12	4.48	0.782
13	4.42	0.809
14	4.21	1.048
15	3.93	1.167
16	3.61	1.329
17	4.36	0.831
18	4.47	0.797
19	4.08	0.972
20	4.27	0.972
21	4.32	0.831
22	3.96	1.197

Table 2: KMO Bartlett's Test of Sphericity

KMO		**0.889**
Bartlett's Test of Sphericity	Approx. Chi-Square df	1108.173 120
	P value	0.000

Following the analysis, three common factors with characteristic roots greater than 1 were identified. These factors explained variances of 21.517%, 20.074% and 16.114%, respectively after rotation. The cumulative variance explained by these three factors after rotation amounted to 21.517%, 41.590% and 57.705% (see Table3).

Table 3: Total Variance Explained

Component	**Eigen value (Unrotated)**			**Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Total	% Of Variance	Cumulative % of Variance	Total	% Of Variance	Cumulative % of Variance	Total	% Of Variance	Cumulative % of Variance
1	6.483	40.520	40.520	6.483	40.520	40.520	3.443	21.517	21.517
2	1.607	10.042	50.561	1.607	10.042	50.561	3.212	20.074	41.590
3	1.143	7.143	57.705	1.143	7.143	57.705	2.578	16.114	57.705
4	0.924	5.776	63.481						
5	0.909	5.681	69.161						
6	0.735	4.597	73.758						
7	0.662	4.139	77.897						
8	0.620	3.876	81.773						
9	0.477	2.984	84.757						
10	0.446	2.790	87.546						
11	0.425	2.656	90.202						
12	0.369	2.305	92.508						
13	0.360	2.251	94.758						
14	0.323	2.017	96.776						
15	0.267	1.669	98.445						
16	0.249	1.555	100.000						

In addition, upon confirming the alignment between the three factors and the 22 evaluation factors with the question items, the factors were assigned appropriate names based on their correspondence (see Table3).

Based on Table 4, seven groups of Factor 1 exhibit factor loading coefficients above 0.46, namely the emotions are affected by light, artificial light expresses heaviness, artificial light expresses seriousness, artificial light expresses concentration, artificial light expresses solemnity, artificial light expresses mystery and sanctity, and artificial light renders a sense of immersion. These evaluation items mainly reflect the evocation of particular emotions by various types of artificial light (sense of solemnity, seriousness, immersion, mystery, sanctity and concentration). As a result, Principal Component 1 is designated as the "Solemn, Heavy, Sanctity and Mysterious Factor."

Similarly, Table 4 indicates five groups of Factor 2 with factor loading coefficients above 0.60, namely the emotional change, warm and cold light, and intensity of light exposure. These evaluation items mainly reflect the fact that emotional expression and emotional arousal in memorial halls are affected by warm and cold light and the intensity of light exposure. Therefore, Principal Component 2 is named the "Emotional Expression Factor."

Finally, four groups of Factor 3 in Table 4 demonstrate factor loading coefficients above 0.61. These evaluation items mainly reflect the fact that Dark environments and special lighting are designed to create psychological discomfort. Consequently, Principal Component 3 is referred to as the "Psychological Discomfort Factor."

Table 4: Factor loading (Rotated)

Factor	Question Number	Factor1	Factor2	Factor3
Solemn, heavy, sanctity and mysterious	8	0.461	0.430	0.301
	11	0.758	0.044	0.269
	12	0.553	0.268	0.176
	13	0.689	0.339	0.028
	14	0.769	0.177	0.055
Emotional expression	17	0.612	0.455	0.238
	22	0.479	0.348	0.213
	7	0.316	0.609	-0.045
	18	0.052	0.795	0.176
	19	0.195	0.693	0.404
	20	0.368	0.612	0.179
	21	0.473	0.696	0.115
Psychological discomfort	9	0.360	0.016	0.612
	10	0.039	0.097	0.857
	15	0.214	0.136	0.670
	16	0.057	0.328	0.693

5. Conclusion

As a conclusion, most respondents felt that the special artificial light design in the memorial would affect the emotional change of the visitors. Secondly, in terms of the direction of artificial light exposure, the majority of respondents felt that shadows and visual effects created by top-down light exposure in slightly darker environments produce a sense of heaviness, seriousness, solemnity and concentration; In terms of the general light environment, the majority of respondents felt that bright light improves concentration, and that a beam of light in a dark environment can bring a sense of mystery and sanctity; In terms of light colour, the majority of respondents felt that cold light was more fearful compared to ambiguous light, red and orange light brought about a sense of struggle and messiness, and lighter orange light was more hopeful and reminiscent; In terms of the intensity of light exposure, the majority of respondents felt that high contrast light and high intensity of light had an impact on the emotional arousal of visitors, and that high intensity of light increased the attention of visitors and brought about a certain sense of immersion. Finally, it is found through research that different kinds of artificial light design in the memorial hall can affect the visitors' emotional arousal to a certain extent, most of the light in the dark environment can bring a sense of concentration, most of the cold light or cold light environment can awaken the sense of fear, on the contrary, the warm light environment can awaken the sense of warmth, hope and reminiscence, the point light and the surface of the light compared to the more chaotic sense of the line of the top light brought by the shadow effect can awaken the visitors' sense of solemnity and sense of solemnity. Therefore, the results of this study can provide a theoretical basis for the design of artificial light in memorial halls.

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