

Influence of Interactive Perception of Digital Memorial on Immersion and Visiting Memory of Young Audiences under the SOR Model

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Abstract. The digital memorial has gradually become an important space for young audiences to understand the historical narrative, accept red cultural education and form the visiting memory. Based on the SOR model, this paper examines how interactive perception influences the immersion and visiting memory of young audiences in the digital Memorial. With 202 young audiences aged 18 to 35, this paper verifies the relationship between interactive perception, immersion and visiting memory through regression analysis and bootstrap mediation effect test. The results show that interactive perception had a significant positive impact on immersion, immersion had a significant positive impact on visit memory, and immersion played a partial mediating role between interactive perception and visit memory. The communication effect of the digital memorial hall does not only depend on the technical display itself, but also on whether the interactive design can promote the young audience to actively enter the historical situation, concentrate their attention and form a deeper level of memory coding. This paper provides a reference for the memorial to optimize the digital interactive exhibition items and improve the visiting experience and educational effect of young visitors.

Keywords: SOR model, Interactive perception, Immersion, Visit memory

1. Introduction

Digital technology is changing the way the memorial is displayed. The traditional memorial hall mainly relies on physical objects, pictures, words and explanations to complete the historical narrative, while the digital Memorial Hall converts historical events, character stories and memorial space into digital content that can be viewed, operated and experienced through VR, AR, interactive projection, touch screen, 3D modeling and digital images. Digital intelligence network technology can promote the Party History Memorial from static display to dynamic interaction, and make historical materials enter the public cultural space in a more vivid way [1]. Sensory stimulation, scene construction, human-computer interaction and social interaction all affect the audience's psychological perception and behavioral response, and sensory stimulation has a particularly significant effect on attention and immersion experience [2].

For young audiences, the digital interactive exhibition is not only an information display tool, but also an important medium for entering the historical situation. The youth group has been in the digital media environment for a long time, and is more accustomed to obtaining information through clicking, selecting, feedback and immersive viewing. The research of Robina-Calderín et al. shows that in the Z generation and millennial group, the higher the degree of immersion, the stronger the individual's emotional response, willingness to participate and actual visit intention [3]. It can be seen that the key to whether the digital Memorial can truly play the function of education and memory construction is not whether advanced technology is used, but whether the technology is transformed into an effective interactive experience and immersion experience.

The existing digital museum research focuses on the willingness to continue using, the willingness to recommend and satisfaction. Previous studies have proposed that the visual attraction, scene authenticity, ease of operation and interactivity of digital museums can affect the recommendation intention through perceived value and user attitude [4]. In addition, the interactivity, vividness and authenticity of digital museums will affect users' willingness to continue using them through the sense of presence and pleasure [5]. These studies show that the design features of digital exhibitions will affect user response through psychological mechanisms. However, in the context of the memorial hall, particularly regarding the formation mechanism of historical memory among young audiences, there is still room for further discussion.

Therefore, taking the SOR model as the analytical framework, this paper regards the interactive perception in the digital Memorial as external stimulation, the sense of immersion as an individual psychological state, and the visit memory as a cognitive response, focusing on whether the interactive perception affects the visit memory of young audiences through the sense of immersion.

2. Literature review

2.1. Digital memorial and interactive experience

A digital memorial is the product of the combination of digital technology and the narrative of memorial space. It not only retains the historical education, emotional arousal and memory inheritance functions of the memorial, but also enhances the audience's sense of participation and context through digital technology. Zhou believes that digital intelligence technology enables the memorial hall of party history to strengthen the dissemination of red culture through virtual simulation, intelligent navigation and interactive display, and make historical relics move from static display to dynamic narrative [1]. The research on digital museums provides an important reference for the research on digital museums. Chen et al. pointed out that the design features of digital museums can be divided into aesthetic features and functional features, in which interactivity and operability belong to functional features, and visual attraction and scene authenticity belong to aesthetic features [4]. Wu and An explained from the perspective of immersion experience that sensory stimulation, scene construction and human-computer interaction in the virtual museum can enhance the audience's attention and understanding of cultural content [2].

These studies jointly show that the technical design in digital cultural space is not a neutral tool, but an important stimulus that affects the audience's psychological experience and behavioral response. For the digital Memorial, the value of interactive design is not only to improve the visiting interest, but also to help young audiences enter the historical situation, understand the memorial narrative and form memories.

2.2. Interactive perception

Interactive perception emphasizes users' subjective judgment of the degree of interaction in the process of media use. McMillan and Hwang pointed out that perceived interactivity is mainly composed of communication direction, user control and time factors [6]. The important contribution of this study is to shift interactivity from a purely media function to user perception, emphasizing that the effect of interaction depends on whether users actually feel control, feedback and participation.

In the research of digital museums, interactivity is also regarded as an important factor affecting the quality of experience. Shi et al. believe that interactivity, vividness and authenticity in digital museums together constitute the quality of interaction, and can affect users' willingness to continue using them through the sense of presence and pleasure [5]. Chen et al. also found that although interactivity may not directly affect recommendation intention, it will significantly affect users' perceived value and attitude [4]. It can be seen that interactive perception is not only the embodiment of technical functions, but also an important psychological entrance for the audience to actively participate in the narrative of the exhibition.

2.3. Immersion

Immersion is the core psychological variable in digital presentation research. Witmer and Singer defined the sense of existence as a state in which an individual subjectively experiences himself in another environment although his body is in a real environment [7]. They believe that immersive experience is closely related to attention engagement, the sense of environmental encirclement, natural interaction and the weakening of real environment perception. This study provides a classic basis for immersion measurement in a virtual environment.

Museum research also continues to emphasize the importance of immersive experiences. Komarac and Ozretićdošen divided the museum immersion experience into aesthetic experience and escape experience, and found that interactive technology can help the audience enter the immersion state [8]. Kim pointed out in the research of immersive digital exhibition that immersive digital experience can affect the audience's psychological image, attitude and behavioral intention through the dimensions of entertainment, education, aesthetics and escape [9]. Robina-Calderín et al. also proved that a higher level of immersion experience can improve the emotional performance and behavioral intention of youth groups [3].

2.4. Visit memory

Visit memory refers to the recognition, recollection and re-experience of exhibits, scenes, information and experience by the audience after the visit. Sweetman, Hadfield and O'Connor found that different exhibition methods will affect the visiting memory. Physical touch and multi-sensory experience can improve the recognition and recall quality of the exhibits and their related stories [10]. At the same time, the audience's memory of descriptive information is usually better than that of name and age information. This shows that situational narration and multisensory participation contribute to memory formation. Daviddi et al. found in the virtual museum visiting experiment that the longer the audience watched the exhibits, the higher the probability of correctly identifying the exhibits in the future [11]. This study shows that virtual visits can also form a memory effect similar to real visits and attention input, viewing time and re-experience intensity are important factors affecting memory.

In the context of digital Memorial, visiting memory not only refers to whether the audience can remember a digital exhibit, but also includes whether they can recall the historical background, character stories, age clues and interactive experience. Therefore, it is an important embodiment of the communication effect of the digital Memorial.

3. Theoretical model and research hypothesis

The SOR model emphasizes that external stimuli affect subsequent reactions through the individual's internal psychological state. This model has been widely used in digital museum research [4, 5].

This paper regards interactive perception as an external stimulus, because it can improve the young audience's sense of control, participation and feedback on the exhibition content. As an internal psychological state, immersion reflects the degree to which the audience enters the historical situation, focuses attention and produces an immersive experience. As a cognitive response, visiting memory reflects the audience's recognition and recall of historical information and interactive experience. Based on this, this paper puts forward the following Hypotheses:

H1: Young audiences' interactive perception of the digital Memorial positively affects their immersion.

H2: Immersion has a positive impact on young audiences' visiting memory of the digital Memorial

H3: Immersion mediates the relationship between interactive perception and visit memory

4. Research methods

4.1. Research approach

This study adopts a questionnaire survey method, which directly reflects the psychological experiences and memory judgments of young audiences during real visits and retains their subjective evaluations based on actual memorial experiences.

4.2. Research object

The subjects of this study are young audience respondents aged 18 to 35 who have visited the physical memorial with digital interactive exhibitions. They should have real experience with the digital interactive Memorial and have actually contacted or used VR, interactive projection and other equipment. The questionnaire was completed anonymously, and all respondents were informed of the purpose of the study and complied with the provisions of ethical review. Finally, 202 valid questionnaires were obtained.

4.3. Measuring tools

Based on the research of McMillan and Hwang and Shi et al., this paper proposes variable 1: Interactive perception [5, 6]. This variable refers to the subjective feelings of young visitors on whether they can easily access the exhibition content, actively control the interactive process, obtain rich information and receive timely feedback during their visit to the digital Memorial. Combined with the situation of the digital memorial hall, this paper measures the interactive perception as the convenience of content acquisition, the richness of interactive content, the sense of operational control and the speed of system response.

Based on the research of Witmer and Singer and Komarac & Ozretić, this paper proposes variable 2: Immersion [7, 8]. This variable refers to the degree to which young audiences' attention is attracted by the displayed content when using digital interactive exhibition items, and produces immersive, historical context, weakening of real environment perception and natural interactive experience. Given the context of the digital memorial hall, this paper measures immersion as input experience, historical context, neglect of the real environment, and natural interaction.

Based on the research of Sweetman et al. and Daviddi et al., this paper proposes variable 3: Visiting memory [10, 11]. This variable refers to the recognition, recollection and re-experience of young visitors of digital exhibits, historical scenes, descriptive information, age information and interactive experience after the visit. In light of the digital Memorial's situation, this paper measures visit memory as recognition of digital exhibits, recall of descriptive information, recall of age information and recall of interactive experience.

Gender, age and identity were included in the analysis as demographic variables. All variables were measured with the 5-point Likert scale, except the basic information items. To assess the questionnaire's stability, the scale's reliability and validity were examined. The results showed that the coefficient of each dimension was higher than 0.80, and the reliability of the questionnaire was good. The significance value of the validity test is less than 0.001; there is a significant correlation between variables, and the data are suitable for factor analysis.

5. Results and discussion

5.1. Descriptive demographic results

A total of 202 valid samples were collected in this study. From a gender distribution perspective, there are 103 women (51.0%) and 99 men (49%). The proportion of men and women is relatively balanced. In terms of age, the number of people aged 25-35 was the largest, a total of 104, accounting for 51.5%; 98 people aged 18-24, accounting for 48.5%.

From the perspective of identity distribution, 113 workers, accounting for 55.9%, and 89 students, accounting for 44.1%. The sample is mainly composed of 25-35-year-olds and participating workers, and the overall distribution is relatively balanced. Demographic descriptive results are shown in Table 1.

Table 1. Demographic descriptive results (n=202)

Variable	Category	n	%
Gender	Male	99	49
	Female	103	51
Age	18-24 years old	98	48.5
	25-35 years old	104	51.5
Current status	Students in school	89	44.1
	Already working	113	55.9

5.2. Regression analysis and mediating effect

This study used regression analysis to test the relationship between interactive perception, immersion and visiting memory, and took gender, age and current identity as control variables (as

shown in Table 2).

Model 1 takes immersion as the dependent variable. Interactive perception had a significant positive effect on immersion ($b=0.373$, $P<0.001$), indicating that the higher the level of interactive perception, the stronger the immersion of respondents. Therefore, H1 holds; that is, interactive perception has a significant positive impact on immersion. Age had a significant negative effect on immersion ($b=-0.610$, $P<0.01$). The model interpretation rate was 20.4%.

When the interactive exhibition items in the digital Memorial can make it easier for young audiences to obtain content, a rich interactive experience, feel the control of the operation process and receive timely feedback from the system, it is easier for the audience to focus on the exhibition situation and enter a higher level of immersion. Witmer and Singer emphasized in their sense of existence theory that attention engagement, the sense of environmental encirclement and natural interaction are the core conditions for the formation of immersion experience, and interactivity is the key external stimulus to trigger these conditions [7]. In the context of museums, Komarac and Ozretić also found that interactive technology can effectively promote the audience to enter the two immersion dimensions of aesthetic experience and escape experience [8]. Shi et al. further pointed out that the quality of interaction in the digital museum will significantly improve the user's sense of presence, which is an important component dimension of immersion [5]. Wu and An's research on the Dunhuang digital museum also shows that human-computer interaction, as an important external stimulus, can significantly enhance the audience's concentration and psychological involvement in the virtual scene [2]. From the perspective of the SOR model, interactive perception, as an external environmental stimulus, effectively activates young audiences' internal psychological state and the generation of immersion by strengthening their sense of control, participation and feedback on the exhibition content.

The results of model 2 showed that immersion had a significant positive effect on visit memory ($b=0.290$, $P<0.001$), indicating that the stronger the immersion of respondents, the higher the level of visit memory. The effect of interaction perception on visit memory was still significant ($b=0.203$, $P<0.01$). The interpretation rate of the model increased to 23.8%. Therefore, H2 is established, and immersion has a significant positive impact on visit memory.

When young audiences enter a deep immersion state in the digital interactive exhibition, their attention is highly focused on the current situation and temporarily ignores the external information unrelated to the experience [7], which provides superior cognitive conditions for the encoding stage of memory. Daviddi et al. found in their research on virtual museums that the longer the audience watched the exhibits and the more vivid the re-experience, the higher the probability of correctly identifying the exhibits in the future, indicating that the immersive attention input directly promoted the formation of memory [11]. Sweetman et al. further confirmed through experiments that the exhibition method with stronger multi-sensory participation and immersion can significantly improve the recognition and recall quality of the exhibits and related stories, which shows that immersion experience deepens the memory trace through the multi-sensory processing path [10]. Kim also pointed out that the entertainment, educational and aesthetic dimensions of immersive digital experiences can significantly affect the audience's psychological image, which is an important form of memory coding [9]. The research of Chen et al. shows that the design features that can trigger users' sense of immersion in digital museums will indirectly affect their subsequent behavioral intention through users' attitude, indicating that immersion has a lasting cognitive effect in the process of psychological processing [4]. From the logic of the SOR model, immersion, as an internal psychological state, is the key intermediate link between external interactive stimuli and subsequent cognitive responses.

The regression results show that the reason why the interactive design in the digital Memorial can improve the visiting memory of the young audience is that the interactive process enhances the audience's sense of control and situational substitution, making it more focused on processing historical information, which is consistent with Witmer & Singer's view on attention engagement and immersion experience [7].

Table 2. Regression analysis results

Variable	Immersion			Visit memory		
	B	SE	t	B	SE	t
Interactive perception	0.373	0.075	4.957***			
Immersion				0.29	0.061	4.718***
R ²		0.204			0.238	
R ² -sq		0.187			0.219	
F		12.584***			12.24***	

The study used the bootstrap method to test the mediating effect between interactive perception, immersion and visit memory (as shown in Table 3). The indirect effect of interactive perception on visiting memory through immersion is significant (effect=0.108, SE=0.032, 95% CI [0.049, 0.177]), and the indirect effect accounts for 34.73% of the total effect, indicating that interactive perception plays a mediating role in improving visiting memory through immersion. The direct effect of interactive perception on visiting memory was also significant (effect = 0.203, SE = 0.069, 95% CI [0.067, 0.339]), accounting for 65.27% of the total effect. The total effect was 0.311, and the 95% confidence interval was [0.176, 0.446]. Interactive perception had a significant positive effect on visiting memory.

Table 3. The mediating effect of immersion between interactive perception and visiting memory

	Effect	se	LLCI	ULCI	Effect proportion
Total effect	0.311	0.068	0.176	0.446	
Indirect effect	0.108	0.032	0.049	0.177	34.73%
Direct effect	0.203	0.069	0.067	0.339	65.27%

Interactive perception can not only directly enhance visiting memory, but also indirectly enhance visiting memory through immersion, which verifies the mediating role of immersion in this path. Therefore, H3 was initially supported in the regression analysis, because after adding the sense of immersion, the influence of interactive perception on visiting memory was still significant, but the coefficient decreased, indicating that the sense of immersion may play a partial mediating role.

The mediating effect shows that young visitors' visiting memory is not simply from the novelty of digital technology, but from the continuous psychological process of interactive stimulation, immersion processing and memory formation. Sweetman et al. found that multi-sensory and more participatory presentation methods help to improve the quality of memory [10]. Daviddi et al. pointed out that the viewing time and re-experience intensity in the virtual museum will affect the subsequent recognition effect [11]. This also explains why H1, H2 and H3 are supported.

6. Conclusion

Based on the SOR model, this study examines the relationship between interactive perception, immersion and the personal visit memory of young visitors to the digital Memorial. The results show that interactive perception can significantly and positively affect immersion, immersion can significantly and positively affect personal visit memory, and immersion plays a partial mediating role between interactive perception and visit memory. It can be seen that digital interactive exhibitions do not only play a role through technological novelty. More importantly, by enhancing the perception of young audiences on content control, interactive feedback and system response, it prompts them to enter the historical context more deeply and further improves their memory effect on the exhibition content.

The theoretical significance of this study is that interactive perception, immersion and personal visit memory are included in the same SOR model, which supplements the explanation of the psychological mechanism in the study of the communication effect of digital memorials. In practice, the results suggest that when designing digital interactive exhibitions for young audiences, the memorial hall should pay attention to the operability of interactive content, feedback speed and situational substitution. Digital equipment should not only be visible, but also be participatory, provide feedback and store memory. The memorial hall should combine interactive design with historical narration, emotional experience and memory to avoid the simple pursuit of technology.

This study still has some limitations. First of all, the sample is concentrated on young audiences, lacking the applicability test of other age groups. Secondly, the questionnaire survey method mainly relies on the respondents' self-reports, which can be supplemented by the experimental method or an objective memory test in the future. Subsequent research can further compare differences among types of memorial halls, digital interactive exhibitions, and instant and delayed memory, to more comprehensively explain the communicative effect of interactive experience in digital memorial halls.

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