

# Interactive Experience Design in History Museums Based on Distributed Cognition :Focusing on the Case of History Museums in China

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**Abstract:** In the rapid development of experience economy, the cultural experience environment of history museums is gradually enriched, and the interactive experience of museum visitors becomes more and more important. Distributed cognition theory is one of the cognitive theories that emphasize the interaction between the cognitive subject and the environment as a complete system, which precisely solves the problem of a single cognitive approach in traditional history museums due to the limited function and participation. This study aimed to redefine the interactive experiential elements of museums in conjunction with distributed cognition theory in order to enhance visitor interaction and experience. The scope of the study was limited to the experiential elements of history museums and the interactive experience processes based on distributed cognition (content interaction, instrumental interaction and contextual interaction), and the main methodology used was a case study. The types of guiding devices, the five senses of experience, and the ways of interactive experience based on them were analyzed in three museums: the Forbidden City Museum in Beijing, the Terracotta Warriors and Horses Museum in Qin Shi Huang, and the Dunhuang Museum. Various design approaches that help enhance visitors' sensory experience and engagement are demonstrated. Results of the study showed that the elements of interactive experience design for history museums under the distributed cognition theory and explains how these elements affect the feelings and experiences of museum visitors. Each of the three museums in the case study underperformed in their respective cognitive, interactive and experiential elements. Based on these findings, it is necessary to add and enrich the interactive experience elements for the five senses of museum visitors' experience. To make the cognitive process of museum visitors more fluid. The study concludes that interactive experience design based on distributed cognition theory improves visitor engagement but also opens up new possibilities for interactive and educational experiences in history museums. This study highlights the need for museums to adapt to modern technological trends and cognitive theories in order to remain relevant and engaged in the digital age. Ultimately, this thesis contributes to the wider field of design by demonstrating the practical applications and benefits of distributed cognitive theory in creating more dynamic, interactive, and personalised museum experiences.

**Keywords:** Distributed Cognition, User Experience, Interactive Design, Museum Engagement

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## 1. Introduction

In recent years, various types of history museums have sprung up, becoming an important platform for publicizing and displaying culture and enhancing cultural confidence. According to China's Ministry of Culture and Tourism, 395 new museums were registered in China in 2021, bringing the total number of registered museums to 6183, ranking first in the world[1]. In this social context, it becomes an important task to enrich the experience process of museums and optimize the cognitive effect of visitors. Distributed Cognition Theory is precisely an attempt to enhance visitors' interactive experience in history museums. It emphasizes the interaction between the cognitive subject and the environment, and treats cognition as a system, including all participants, artifacts, and the specific context[2]. For example, the Palace Museum combines traditional culture with modern technology through digital cultural and creative experiences. Visitors can view artifacts through mobile apps and participate in virtual historical scenes using augmented reality[3]. The Museum of the Terracotta Warriors and Horses of Qin Shihuang employs advanced gesture interaction technology that allows visitors to interact with exhibits through gestures. This real-time interactive experience not only increases the fun of the visit, but also allows visitors to more intuitively understand the production process and historical story of the Terracotta Warriors[4].

This study attempts to view history museum visitors as more active cognitive subjects in exhibitions and interactive experiences through distributed cognition theory, emphasizing the interactive role of the audience and the environment, stimulating the interest and creativity of the audience, and expanding the social influence of the museum. The main research method is to summarize the use and trend situation of history museums in all interactive experience elements through the method of case study, and to propose an interactive experience model to provide a reference for the future interactive experience design of history museums.

## 2. Literature Review

This study is based on a theoretical framework of distributed cognitive experience and user sensory experience, with a particular focus on relationships with user engagement.

### 2.1 Distributed Cognitive Experience

Regarding the application of distributed cognitive experience in museums, one research in this area uses the framework of interpretive archaeology and phenomenology by Pallud[5]. The field study indicates that technologies available in museums namely audio guides, interactive kiosks, and computers contribute positively to an experience of the past. A more reflective design practice that embraces critical discourses can transform interactive exhibition design and therefore the museum visiting experience. In terms of enriching the interactive experience form of historical museums, the particular context of wine tourism Kirova investigates how interactive technology affects the wine tourists' experience during a wine museum visit. The research is grounded on the theory of value co-creation and value co-destruction and explores tourists' perceptions of technology integration during their visit to the innovative wine museum, 'La Cité du Vin', in Bordeaux, France[6]. Meanwhile, Orr discussed the capabilities of extended reality technology in informal learning environments, such as museums and cultural heritage sites. These affordances vary across settings, ranging from personalizing learning experiences, increasing engagement through interactive activities, and augmenting exhibits with rich multimedia content[7]. This part of the literature fully embodies the positive role of distributed cognition on the history museum, which lays the foundation for the research of this paper.

## 2.2 Interactive experience and user sensory experience

As for enhancing the museum experience and improving user enthusiasm, Kocaturk presented the design, development, and evaluation of GDOM (Geelong Digital Outdoor Museum) application that integrates intangible heritage stories into places of public significance through a 3D virtual immersive environment. Interest in interactive virtual reality (IVR) is increasing due to its potential for embodied learning and group-led teaching[8]. It discusses the design and application of narrative thinking and emotional experience in virtual museums and extends the research on interactive narrative structures in games and film art by Jianqiang [9]. The shortcomings of the interactive narrative content, such as selectivity, unity, and participation create a new formal language and provide strong practical support for the interactive narrative method of the virtual museum. Komarac explored two dimensions of visitors' immersion into museum experience: aesthetics and escapism. While both dimensions of immersion into experience contribute to the overall satisfaction, the aesthetic experience of museum visits was found to contribute to it more[10]. These literature embody the interactive elements of increasing the museum, which can enhance user enthusiasm and enhance the museum experience, so this path can be fully considered.

## 3. Research Methodology

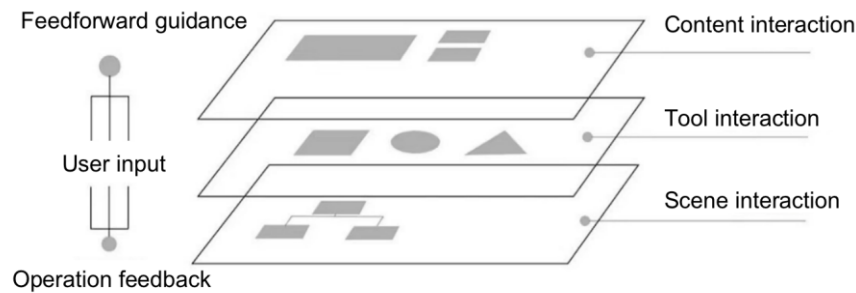
This study begins with interactive experience and aims to enrich the scope of research on Chinese history museums. The research method is mainly based on case study analysis, and the Forbidden City Museum, Dunhuang Museum, and the Terracotta Warriors and Horses Museum of Qin Shihuang were selected. The common criterion of the three cases is that all of them have a complete set of elements of the interactive experience, and all of them upgraded their own guided tours in recent years. At the same time, they are in three different locations, more representative. The data is mainly derived from online statistics to produce relatively significant results. By analyzing the case of Chinese history museums, the importance of introducing the theory of distributed cognition in interactive experience is illustrated.

### 3.1 Distributed Cognition Theory Inspect

#### 3.1.1 Essential Tenets of Distributed Cognition Theory

The use of distributed cognitive experience in history museums, on the other hand, is an innovative experience design concept that emphasizes the interaction between the cognitive subject and the environment, and considers cognition to be a system that includes all participants, artifacts, and the specific context in which they find themselves. It was initially proposed by American psychologist Edwin Hutchins in the late 1980s[11]. Some scholars see museums as places where visitors build consensus, and the consensus-building process can be linked to the participatory sense-making of Ezequiel Di Paolo, Elena Clare Cuffari, and Hanne De Jaegher[12]. The path of "participatory meaning construction" shows that museums should not be reduced to a one-way space of communication and reception. This kind of thinking includes the idea of distributed cognition, that is, the situation, the subject's thoughts, and language are actually unified.

The cognitive process, as per Distributed Cognition Theory, is divided into three main layers (content interaction, content interaction, and content interaction), as depicted in [Fig. 1]. The profounder processes of user cognition are also a confluence of these multiple factors.



[Fig. 1] Elemental Map of Distributed Cognition

### 3.1.2 Characteristics of Distributed Cognition

The distinguishing features of Distributed Cognition Theory are (1) Emphasis on the synthesis of individuals with external representations, (2) Highlighting the role of artificial products, (3) Stressing the dispersion of cognition, (4) Focusing on interaction and the propagation of information, and (5) Giving attention to specific situations and contexts. Distributed cognition deciphers cognitive phenomena by examining the environment produced by tasks, characterized mediums (such as tools, displays, manuals, navigation maps), the interplay between individuals, and all activities entailing interactions with artifacts. These activities comprise the behaviors of individuals, the interactive conduct between individuals and an array of devices, the interactive activities among individuals and other members, or the collaborative interactions with tools among members of a collective task force.

## 3.2 History Museums and Experiences Based on Distributed Cognition

### 3.2.1 History Museum Based Distributed Cognition

The display content of history museums mainly includes exhibition distribution materials, interactive devices and so on, while under the perspective of distributed cognition, the scope of cognition is extended to the subject and the surrounding environment, that is to say, the overall interactive online and offline activities of the museum, and the experience space of the museum itself all belong to a part of distributed cognition of history museums, which can be broadly classified into three categories of interaction: content interaction, instrumental interaction, and scene interaction [Table 1].

Content interaction mainly refers to the interactive hierarchical relationship between the exhibition content and the visitors, which mainly includes the museum's display materials, special interesting courses, interface design, and so on.

Tool interaction mainly refers to the museum guide equipment itself, which must meet the user's perceptual and aesthetic needs, with the basic function of understanding the history and culture of the exhibits. Museum guide products are mainly divided into the central control system, guide voice machine, museum robot, portable AR equipment, QR code APP, as well as the main realization of a variety of interactive devices, such as gesture interaction, virtual projection and other technologies. The experiential elements of these devices are divided into four directions according to human senses: touch, sound, screen, and operation.

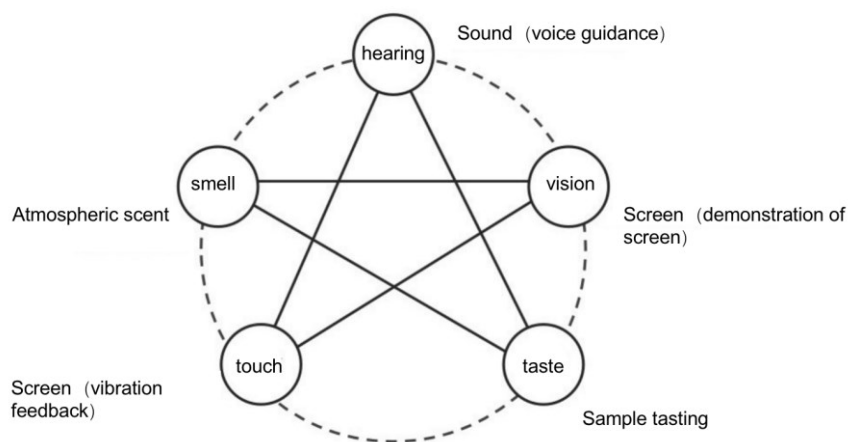
Scene interaction mainly includes the online environment and the environment for visitors to learn and collaborate as well as the objective environment, which is an important part of providing a sense of immersion.

[Table 1] Elements of the History Museum based on Distributed Cognition

Distributed cognitive hierarchy	Type	Characteristic	Function
Content interaction	Display materials, special interesting courses, interface design, etc.	Informative	Variety of learning activities through experience, fun and education
Tool interaction	Central control systems, guide voice machines, museum robots, portable AR devices, QR code APPs, etc.	Experiential	Building different interactive experience processes to meet individual requirements
Scene interaction	Online environment; collaborative environments ; objective environments	Immersion	Interaction with the scene, messaging and interaction with the community

### 3.2.2 Tourism Experience Elements Based Distributed Cognition

The design of the tourism experience can be explained from the perspective of the five senses. Visually, attention should be paid to creating attraction through the layout of exhibits, lighting effects, and use of colors. Aurally, information can be conveyed through voice guidance and sound design. Tactilely, providing touchable exhibits or interactive devices can enhance visitor interactivity. Taste and smell experiences, although less commonly used, can stimulate the senses through scent in certain contexts. By leveraging these five sensory elements, history museums can create a rich visitor experience that deepens understanding of exhibits and enhances the overall visitor experience[13].








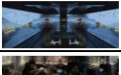


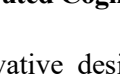


[Fig. 2] Museum Experience Element Incorporating the User's Five Senses Model

### 3.2.3 Tourism Experience Elements Based Distributed Cognition

In applying distributed cognition theory to interactive museum experiences, it is important to focus not only on the navigational devices themselves and the content displayed, but also on the collaborative and communicative activities of visitors during the viewing process. This involves three main aspects: content interaction, tool interaction, and scene interaction. Content interaction is mainly to present as much information as possible, tool interaction aims to make the user experience and knowledge more convenient and efficient, and scene interaction is mainly to fully immerse the user as much as possible and guide the user to think and make decisions about the information [Table 2].

[Table 2] Experience Elements of History Museums with Distributed Cognition

Type	Multifunctional	Photo	Sight	Touch	Hear	Smell	Taste
Tool interaction	Screen display 3D display Voice description		●	●			
	Voice prompt				●		
	Museum central control, 3D display Voice explanation		●	●	●		
	Voice description AR display		●		●		
	Voice description AR display		●	●			
Content interaction	Research Courses		●		●		
	Exhibition sample		●	●		●	●
	Display Materials			●	●		
Scene interaction	Interactive space		●		●		
	Collaborative interaction		●	●	●		●
	Online interaction		●		●		

### 3.3 Interaction Design Elements for Distributed Cognitions

Museum interactive design is an innovative design approach introduced to enhance the visitor experience. It allows visitors to participate more actively in museum exhibitions and interact with the exhibits through the use of advanced technological tools and multimedia elements. The elements of interactive design are as follows:

1. Participatory. Interactive design should be able to capture the interest of the audience and trigger their participation. This can be achieved in a variety of ways, such as the use of touch screens, sound, visual effects, and other technologies, so that the audience can actively participate in the exhibition and interact with the exhibits.

2. Narrative. The interactive design should have a clear story line or theme that is able to incorporate the exhibits and the historical context so that the audience can better understand and feel the historical events.

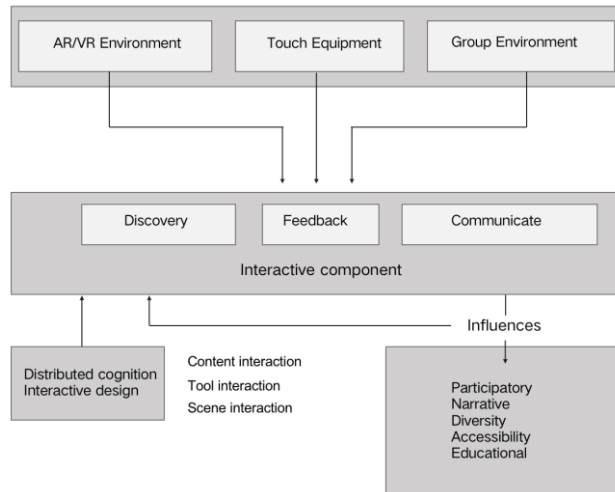
3. Diversity. Interactive design should provide a variety of experiential methods and display formats to meet the needs and interests of different audiences. This can include audio narration, video display, virtual reality (VR) experience, gamification, and other forms of interaction, so that the audience can interact with the historical exhibits in different ways.

4. Accessibility. Interactive design should take into account the needs of different audiences, including physical disabilities, language abilities, cultural backgrounds, and so on. The design should be as easy to understand as possible, with multilingual options and assistive features to ensure that all audiences are able to participate.

5. Educational. The interactive design should have an educational value that conveys historical knowledge and understanding to the audience. Through interactive design, visitors can learn about history through hands-on participation and experience, stimulating their curiosity and interest in

learning.

In conclusion, museum interactive design is unique in increasing visitor engagement and interest, providing personalised experiences, integrating education and entertainment, and creating deep learning and immersive experiences.



[Fig. 3] Interactive Experience Design Elements for Distributed Cognition

### 3.4 Interactive Experience Model of History Museum Based on Distributed Cognition

The criterion for selecting the case study is that it is a registered history museum in China. The case study was analysed by first presenting an overview of each museum. Second, the interactive experience performance of the history museums based on the model was analysed. The writing method follows the sequence of steps (distributed cognition components, experience elements, and interactive components). The element was applied by marking "●". The marking method was used in the interaction design section.

[Table 3] Interactive Experience Model Based on Distributed Cognition

Name	History Museum				
Location					
Topic					
Photo					
Distributed cognition components	Tool interaction		Content interaction		Scene interaction
	Handheld device		Research Courses		Interactive space
	APP, Applet		Exhibition sample		Collaborative interaction
	Museum central control		Display Materials		Online interaction
Experience Elements	Five senses	Characteristic	Methods of expression		
	Sight				
	Touch				
	Hear				
	Smell				
	Taste				
Interactive components	Components	Rating	Distribution chart		
	Participatory				
	Narrative				
	Diversity				
	Accessibility				
Educational					

## 4. Results

### 4.1 History Museums Case Studies

The case studies are presented in [Table 4] to [Table 6] below.

Distributed cognitive elements encompass tools, content, and screen interactions. In this case, the tool interaction is largely present, while the other two are lacking. The lack of content interaction sessions for experiential programmes inevitably affects the efficiency of museum knowledge absorption.

[Table 4] Analysis of the Beijing Palace Museum

Name	Beijing Palace Museum					
Location	No.4 Jingshanqian Street, Dongcheng District, Beijing					
Topic	Tea - The World - Special Exhibition on Tea Culture at the Palace Museum					
Photo						
Distributed cognition components	Tool interaction		Content interaction		Scene interaction	
	Handheld device	●	Research Courses	○	Interactive space	●
	APP, Applet	●	Exhibition sample	○	Collaborative interaction	○
	Museum central control	●	Display Materials	●	Online interaction	○
Experience Elements	Five senses	Characteristic	Methods of expression			
	Sight	●	Hundreds of groups of tea culture-related artefacts, including tea, tea utensils, paintings, calligraphy and inscriptions, as well as some restoration scenes and interactive experiences, such as the Song Dynasty tea ceremony, the Tang Dynasty tea ceremony, and tea art performances.			
	Touch	●	Can touch some tea-related utensils, such as teapots, teacups, tea trays, etc., and feel the material and form of the utensils			
	Hear	●	Music and sound elements, some traditional tea songs, tea poems, tea tunes			
	Smell	●	Can smell the aroma of tea and some tea-related spices such as sandalwood, incense, jasmine, etc.			
	Taste	●	Tea tasting opportunities to taste different tea broths and get a feel for the flavour and texture of the tea			
Interactive components	Components	Rating	Distribution chart			
	Participatory	3				
	Narrative	4				
	Diversity	2				
	Accessibility	3				
	Educational	5				

In this case, again for the element of content interaction is lacking. However, in terms of the tool interaction perspective, the virtual interaction format excels.

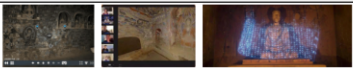
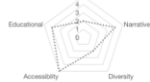
[Table 5] Analysis of the Qin Shihuang Imperial Mausoleum Museum

Name	Qin Shihuang Imperial Mausoleum Museum					
Location	North Qinling Road, Lintong District, Xi'an City, Shaanxi Province, China					
Topic	Digital Smart Tourism "Bringing Heritage to Life"					
Photo						
Distributed cognition components	Tool interaction		Content interaction		Scene interaction	
	Handheld device	●	Research Courses	●	Interactive space	●
	APP, Applet	●	Exhibition sample	○	Collaborative interaction	●
	Museum central control	●	Display Materials	○	Online interaction	●
Experience Elements	Five senses	Characteristic	Methods of expression			
	Sight	●	Using matrix panorama technology, the Terracotta Warriors and Horses are presented to the audience in "ultra-high definition" with 20 billion pixels.			
	Touch	●	Various interactive devices can be touched			
	Hear	●	Can hear some introductions, explanations and lectures about the Terracotta Warriors.			
	Smell	○	-			
	Taste	○	-			
Interactive components	Components	Rating	Distribution chart			
	Participatory	3				
	Narrative	4				
	Diversity	5				
	Accessibility	3				
	Educational	3				



In this case, there is a serious lack of elements for content interaction. It can be seen that it emphasises distributed cognitive human-product interaction and ignores the element of environment.

[Table 6] Analysis of the Dunhuang Museum

Name	Dunhuang Museum					
Location	No.1390, Mingshan North Road, Dunhuang City, Jiuquan City, Gansu Province, China					
Topic	Dunhuang Museum "Digital Dunhuang" Theme Exhibition					
Photo						
Distributed cognition components	Tool interaction		Content interaction		Scene interaction	
	Handheld device	●	Research Courses	○	Interactive space	○
	APP, Applet	●	Exhibition sample	○	Collaborative interaction	●
	Museum central control	○	Display Materials	○	Online interaction	●
Experience Elements	Five senses	Characteristic	Methods of expression			
	Sight	●	The exhibition showcases the digital achievements of the Dunhuang Academy's Institute of Cultural Relics Digitisation, including replica coloured sculptures, high-fidelity digitised mural replicas, replica musical instruments, etc., as well as the digitised scenes of the six major grottoes and replica caves.			
	Touch	○	-			
	Hear	●	The exhibition also digitally recreates Dunhuang's music and dance, and is accompanied by professional interpretation and guided tours.			
	Smell	○	-			
	Taste	○	-			
Interactive components	Components	Rating	Distribution chart			
	Participatory	2				
	Narrative	4				
	Diversity	2				
	Accessibility	5				
	Educational	4				

## 5. Results and Discussion

To analyse this study, data was collected through literature, previous research, and internet information. Although history museums are now technologically advanced and the three exhibitions have different themes and contents, there are still deficiencies in the interactive experience part. The results of analysing the interactive experience cases of history museums with distributed cognition are as follows: ○: lacking, ◎: moderate, ●: good. As shown in [Table 7], the Qin Shihuang Imperial Mausoleum Museum did a more balanced job of interactive cognitive experiences, while the tea exhibition at the Palace Museum was slightly lacking in diversity, and the digital Dunhuang at the Dunhuang Museum was poor in terms of engagement and diversity.

[Table 7] Analysis of the Results

Name	Participatory	Narrative	Diversity	Accessibility	Educational
Beijing Palace Museum	◎	●	○	◎	●
Qin Shihuang Imperial Mausoleum Museum	◎	●	●	◎	◎
Dunhuang Museum	○	◎	○	●	◎

This study emphasizes the important role of interactive experience elements in museums based on distributed theory. Therefore, this study can be used to configure museum guiding devices, as well as environmental designs that can enhance the five senses experience, in order to better adapt to the

changing needs of visitors in the coming era. For example, the participants of information dissemination on social media platforms are characterized by wide participation, diversity and communication identity at the same time[14]. And the development of APP and small programs can obviously increase the interactivity of museum visitors. In the future, museums will shift their focus from "things" to "human", with visitors as the cognitive subject[15]. Diversified learning forms and participation channels can undoubtedly enhance the visitors' sense of identity and promote the cognitive efficiency.

## 6. Conclusion

In recent years, with the improvement of living standards, people's requirements for tourism experience have become higher and higher, developing from a single visual sensory experience to a multidimensional experience. At the same time, technologies such as virtual reality and big data have been developing rapidly and are being applied more and more widely in the field of tourism, resulting in a smarter and richer experience for tourists. Using virtual reality technology, travellers can experience unvisited places and recreate historical activities.

This study aimed to incorporate distributed cognition theory into the interactive experience process of history museums. The study analyses the properties of Distributed Cognition Theory, the elements of the museum experience and the interactive elements, and constructed a model to analyse this approach. First, the cognitive process of distributed cognition theory was explored in depth. Second the classification of the experiential elements of the museum product was introduced. Third, the model of the interactive experience was constructed based on the corresponding theory and experiential elements. Finally, the results of the analysis were obtained.

The model as well as the analysis results derived from this study not only meets the cognitive process and experiential needs of museum visitors, but also serves as a channel for a more personalised and enriched contact with exhibits and culture. It plays an important role in improving the experience of guided museum tours. The portion of the study that addresses the interactive experiential elements of the museum responds to the previous theory of "participatory meaning construction." This is because in the related theory, every touchpoint that the visitor, as a subject, comes into contact with, constructs the cognitive process of the visitor's tour. This study plays a positive role in guiding the practice of interactive experiences in museums in the future, but it should be noted that interactive design generally also includes accessibility for visitors with disabilities, and at present, Chinese museums basically only have accessibility designs for visitors with walking disabilities, which is also a limitation of this paper. Future research will pay more attention to the interactive experience of hearing-impaired, visually-impaired and other disabled visitors in the study.

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