Accessibility, Assistive Technology and Digital Environments, Vol. 162, 2025, 62–70
https://doi.org/10.54941/ahfe1006013

Exploring Museum Experiences for People With Cognitive Disabilities: Characteristics, Challenges and Digital Design Opportunities

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ABSTRACT

Cognitive impairments affect thinking, memory, and attention, posing challenges to traditional museum exhibitions that rely on static text and images. From a human factors perspective, this study examines how individuals with mild cognitive impairment (MCI) perceive museum exhibits differently from cognitively normal visitors and explores their museum visit experiences. Through in-depth interviews with 15 participants—including individuals with MCI, their relatives, and care agency staff—this study identifies psychological, cognitive, and ergonomic barriers they face. Thematic analysis reveals key difficulties and design opportunities, leading to digital design recommendations that enhance accessibility. By incorporating the perspectives of individuals with cognitive impairments, this study advances human factors research in museum design and contributes to more inclusive exhibition experiences.

Keywords: Accessibility, Experience, Cognitive impairment, Human factors, Ergonomics

INTRODUCTION

Enhancing museum visitor experiences has been a long-standing concern in the fields of ergonomics (Bridgeman & Tseng, 2011), human-computer interaction, museology and design research (Falk & Dierking, 2013). With the emergence of new technologies and new media (Kaplan & Haenlein, 2010), art, science and technology, digital design has emerged to provide creative exhibition content, enrich the exhibition format and improve the visitor experience.

Cognitive impairment is an intellectual disorder that affects an individual's ability to plan, understand, and reason. Existing research has revealed the barriers and design opportunities of cognitive impairment in learning, educational, and recreational scenarios, but its difficulties and design opportunities in museum scenarios have not been adequately addressed (Bennett, 1995). For instance, individuals with cognitive impairments may process and interpret exhibits differently from the general population, raising critical human factors issues that require further investigation (Tout-Smith, 2018).

To better understand how cognitive impairment experience museum exhibits, this paper aims to address two research questions:

RQ1: What are the differences between mildly cognitively impaired and cognitively normal people in perceiving museum exhibits?

RQ2: What are the experiences in the museum visit experience for people with cognitive impairment?

LITERATURE REVIEW

Technologies for Museum Exhibition

With advancements in digital and information technologies (Brynjolfsson & McAfee, 2014), museums are evolving from traditional static displays into dynamic, interactive spaces that engage visitors in more immersive and personalized ways. Emerging technologies not only enrich exhibition formats but also enhance accessibility, allowing diverse audiences to experience cultural heritage in novel ways.

Among these innovations, VR and AR technologies create immersive environments that deepen visitors' understanding of exhibits. For instance, the Louvre in Paris integrates AR into its tours, enabling visitors to explore fine details that are otherwise imperceptible, thereby fostering a greater appreciation of the artwork (Mosquera, 2024). Similarly, multimedia and interactive displays leverage videos, animations, and digital interfaces to bring historical and cultural narratives to life (Liu, 2005). At the National Museum in Tokyo, digital screens dynamically reconstruct ancient artifacts, illustrating their original usage and historical significance (Stylianou-Lambert, Bounia, & Heraclidou, 2022).

Artificial intelligence and big data analytics further refine the museum experience by enabling personalized exhibit recommendations and intelligent interpretation. The British Museum employs an AI-powered guiding system that adapts exhibit information in real-time based on visitors' walking patterns, ensuring a more tailored and engaging exploration (Davenport, 2018). In parallel, motion-sensing interactive technologies provide an intuitive way for visitors to engage with exhibits. At the Smithsonian Museums, somatosensory devices allow users to manipulate virtual models, making complex scientific concepts more tangible and comprehensible (Byers, 2018).

Beyond enhancing engagement, technology also plays a crucial role in fostering inclusivity. Haptic feedback and assistive technologies have been introduced to accommodate visitors with cognitive or sensory impairments. The National Museum of the Netherlands, for example, provides haptic models that allow individuals to perceive the structural details of architectural works through touch, expanding accessibility to those with visual or cognitive disabilities (Sharples, 2024).

By integrating these technologies, museums are not only redefining the exhibition experience but also making cultural and educational resources more inclusive and interactive. As digital advancements continue to shape visitor engagement, museums will increasingly serve as immersive learning

environments that bridge the past and the present through innovative technological applications (Steinfeld & Maisel, 2012).

Cognitively Impaired Individuals

Mild Cognitive Impairment (MCI) refers to a condition characterized by mild declines in memory, judgment, and planning abilities, though not severe enough to meet the criteria for dementia. Despite these challenges, individuals with MCI often retain a strong interest in cultural and educational activities. However, they may encounter specific difficulties when visiting museums, necessitating thoughtful design adaptations to improve their experience.

One of the primary challenges for MCI visitors is difficulty in processing complex information. While they maintain cognitive function to some extent, they may struggle with lengthy textual explanations and intricate exhibit details. To address this, the Natural History Museum in the UK enhances accessibility through illustrated exhibits and concise verbal descriptions, making it easier for visitors with cognitive impairments to grasp key information (Hein, 1998).

Navigational support is another crucial aspect, as memory decline and spatial disorientation can make wayfinding within large exhibition spaces challenging. The Shanghai Museum, for instance, provides prominent maps and clear signage throughout its galleries, helping visitors navigate the space more efficiently. Additionally, MCI visitors tend to favor interactive and multisensory experiences over passive textual engagement. Museums that incorporate dynamic demonstrations, videos, and interactive installations can significantly improve accessibility. The California Museum of Science and Technology, for example, employs interactive touchscreens to present scientific concepts in an intuitive manner, allowing visitors with cognitive impairments to explore content through simple, guided interactions.

Beyond exhibit design, environmental comfort plays a vital role in accommodating MCI visitors. Sensitivity to noise and complex stimuli can make overwhelming environments stressful, reducing engagement. To mitigate this, the Helsinki Art Museum in Finland provides designated quiet zones where visitors can take breaks in a calm setting before resuming their exploration (Csikszentmihalyi, 1990).

In summary, optimizing museum experiences for individuals with MCI requires a holistic approach that includes simplified information delivery, enhanced wayfinding systems, interactive learning opportunities, and carefully managed environmental conditions. By implementing these strategies, museums can create a more inclusive and engaging space, ensuring that individuals with cognitive impairments can continue to participate in cultural and educational experiences.

RESEARCH DESIGN

This study employs in-depth interviews with 15 selected participants, including individuals with cognitive impairments, their relatives, and care agency staff. The goal is to explore psychological and cognitive barriers as

well as design opportunities for this population. Thematic analysis is used to identify key patterns in the data (Willig & Rogers, 2017, pp. 17–37).

Respondents and Recruitment

Participants were recruited through a combination of simple random sampling, online searches, social media posts, and snowball sampling. To ensure diverse perspectives, we sought individuals from varied work environments, cultural backgrounds, and regions. After screening 16 candidates, we conducted interviews with eight participants, all of whom had prior museum experiences and could provide insights into their browsing challenges.

Data Collection

Semi-structured interviews were conducted in 2024, both online and in-person. Each session lasted approximately 40 minutes, with participants providing informed consent. The interviews covered topics such as demographics, browsing experiences, interaction challenges, and environmental adaptation. Participants also shared their perspectives on existing barriers and suggested improvements for museum accessibility.

Data Analysis

Thematic analysis was used to extract key themes from the data. The process began with transcription and open coding, identifying issues such as "information complexity" and "unfriendly navigation tools." These codes were iteratively refined and categorized into broader themes. This systematic approach provided insights into how individuals with cognitive impairments interact with museum environments, offering guidance for designing more inclusive spaces.

By structuring insights from the ground up, this study highlights critical accessibility challenges and contributes practical recommendations for enhancing museum experiences through human-centered design and ergonomics.

FINDINGS

For RQ1, this study reveals the different characteristics of people with cognitive disabilities and cognitively normal people in perceiving museum exhibits. Based on this finding, we further identified the difficulties faced by people with cognitive disabilities in the museum visit experience, including the specific obstacles faced in psychological, cognitive, and human factors, in response to RQ2. Finally, we propose a series of opportunities to enhance the museum visit experience of people with cognitive disabilities through digital design, providing support for human factors engineering researchers and practitioners.

Comparison of the Characteristics of the Two Populations

There are significant differences between cognitively normal and cognitively impaired people in several aspects of the museum visiting experience. These differences were not only in terms of frequency and mode of visit, but also in terms of adaptability of the exhibition space, use of digital equipment, adaptability to the environment, and perceptions of suggestions for future improvements, particularly in terms of human factors and ergonomics.

Firstly, people with cognitive disabilities visit relatively infrequently, usually once a month or less, and often need to be accompanied by others during their visits. P5 noted that the living conditions of people with cognitive disabilities are affected, and that some of them require the use of specific assistive devices to support daily activities. This need makes their autonomy in the museum limited and affects their overall experience. On the other hand, people with cognitive disabilities face significant challenges in information comprehension. Museum exhibits often contain a great deal of complex information and terminology, and P2 mentions that "the lengthy text and complex terminology of exhibition information makes it difficult for people with cognitive disabilities to understand the content and easily become frustrated." This complexity of information makes people with cognitive disabilities feel confused and helpless during the visit.

In contrast, cognitively normal people are diverse in age, gender, occupation, and life situation and are usually able to conduct museum visits independently. They visit more frequently, usually 1–2 times per month, and are able to use a variety of technologies provided by museums without difficulty and without the need for special assistive devices. This independence and frequent visits allow them to better adapt to the museum environment and exhibition content.

In terms of visiting experience and interaction, cognitively normal people are able to easily understand the content of exhibits and interact with them. They were generally comfortable navigating the exhibits and utilized digital narrative technology to enhance their understanding of and interest in the exhibits. P1 observed that foot traffic was significantly higher in areas that adopted digital narrative than those that did not, suggesting that this technology was effective in engaging visitors and facilitating communication.

Comparatively, people with cognitive disabilities faced challenges in understanding the content of the exhibits during their visit. Due to differences in their personal knowledge base and level of cognitive impairment, they may feel confused and have difficulty connecting with the exhibits. P6 noted that digital narratives can help them overcome their distress over unfamiliarity with the exhibits and the historical context, thus enhancing engagement and experience. This difference is particularly important when designing human-computer interaction, which needs to take into account the special needs of people with cognitive disabilities.

In terms of environmental adaptation and comfort, cognitively normal people are usually able to adapt to the spatial layout and crowd density of a museum and enjoy the visit without additional support or guidance. However, people with cognitive disabilities tend to feel uneasy in noisy or

crowded environments. P8 mentioned that many museums failed to take these special needs into account adequately, resulting in people with cognitive disabilities facing additional challenges during their visits, and often needing to work through these difficulties on their own. This suggests that the application of ergonomics is crucial when designing museum environments. P3 noted that factors such as heavy foot traffic, harsh lighting and high noise levels can trigger anxiety and mood swings. Therefore, considering the special needs of people with cognitive disabilities in museum design, such as creating a quiet and comfortable environment and optimizing the spatial layout, can effectively enhance their visiting experience.

Digital narratives have different values for cognitively normal and cognitively impaired people. For the cognitively impaired, digital narratives are seen as an effective means to enhance the museum experience, helping them to better understand the exhibits and stimulate their interest. P4 emphasizes the importance of digital narratives as a "bridge" between people and museums.

For people with cognitive disabilities, the value of digital narratives is even more significant. It can not only help them overcome the barrier of understanding but also enhance their independence and sense of participation. P2 and P5 both argue that museums should adopt digital narratives as soon as possible to meet the needs of people with cognitive disabilities and enhance their visiting experience.

In summary, there are significant differences in museum visits between cognitively normal and cognitively impaired people. These differences are reflected in the understanding of exhibits, the ability to adapt to the environment, and the need for digital narratives. In order to enhance the inclusiveness and accessibility of museums, designers should pay more attention to the special needs of people with cognitive disabilities and help them better integrate into the cultural experience of museums by optimizing exhibit design and applying ergonomic principles.

Visiting Experience

People with cognitive disabilities face multiple challenges when visiting museums, not only due to the design of museum environments and services, but also due to their own cognitive characteristics. By focusing on human factors and ergonomics, we can better understand the problems they encounter in their browsing experience and suggest improvements accordingly to meet their specific demands.

The complexity of exhibits and related information in museums, as an important place for cultural dissemination, significantly increases the comprehension difficulty of people with cognitive disabilities, as mentioned in P7. P7 mentioned that the complexity of such information in exhibitions subconsciously increases the difficulty of browsing during their visit, and affects their overall experience. Therefore, from an ergonomic point of view, simplifying the information on display and using more understandable language and illustrations can effectively reduce the cognitive load and enhance comprehension.

Secondly, the environmental factors of museums, such as confined space and excessive light sources, may lead to a lack of spatial awareness, which was agreed by P3, who suggested that these factors may affect the mood and concentration of people with cognitive disabilities. P6 mentioned that the lack of clear and concise introductions in museums' displays makes it difficult for people with cognitive disabilities to effectively understand the exhibits, and they may miss out on the deep impression. To address this issue, designers should consider optimizing the environmental layout to create a quieter and more comfortable visiting space to reduce external interference and help people with cognitive disabilities better adapt to the environment.

People with cognitive disabilities face unique challenges when it comes to information guidance and social interaction. P1 mentions that "guided tours and information comprehension difficulties are problematic," which makes it difficult for them to keep up with traditional guided tours. Therefore, providing multi-sensory guided tours (e.g., virtual reality and tactile maps) is particularly important. In addition, P3 noted that people with cognitive disabilities often have communication barriers with staff or other visitors, and a lack of self-confidence makes it difficult for them to interact. They want conversational, interactive guided tours to enhance engagement and a sense of belonging. Their engagement and satisfaction can be effectively enhanced by designing more inclusive interactive experiences.

It is often mentioned that the knowledge a person possesses comes from a particular education or experience or socio-cultural environment rather than from him/herself. Digital narratives, as an important means of bridging the gap between visitors and museums, encompass a wide range of disciplines: computers, design, psychology, sociology, museology, ergonomics, etc. P2 believes that museums should adopt digital narratives as soon as possible, and after experiencing them first-hand, she believes that their potential value has been underestimated for a long time. On the other hand, P1 and P5 share this view.

P8 expanded around this idea to make a more in-depth point: people experience barriers when visiting museums due to their personal knowledge base and level of cognitive impairment, and digital storytelling could better alleviate people's distress over unfamiliar exhibits and boring historical contexts.

Digital Design Opportunities

Our analysis also suggested several digital design opportunities. To enhance the museum experience for individuals with cognitive disabilities, optimizing environmental design and digital support systems is essential. Visitors with mild cognitive impairment often struggle with information complexity, excessive textual content, and certain exhibition formats. When information is presented in a more structured and simplified manner—such as through dynamic visual demonstrations and concise verbal explanations—their comprehension and engagement significantly improve. Reducing cognitive overload in exhibitions allows these visitors to better process and retain the knowledge conveyed.

Another major challenge lies in navigation and spatial orientation. Memory difficulties and a weakened sense of direction make it difficult for visitors with cognitive impairments to follow traditional wayfinding methods. They require clear, prominent, and intuitive path guidance to move through exhibitions comfortably. Enhancing intelligent guiding systems and incorporating simplified directional cues can greatly improve their sense of security and autonomy, allowing them to explore museum spaces with greater ease.

The usability of digital interactive devices also plays a crucial role. Many visitors experience frustration when faced with complex interfaces or unintuitive operations, particularly with VR installations, touchscreens, and other digital tools. A more user-friendly design, with straightforward interactions and clear instructions, can ensure that these technologies enhance rather than hinder the museum experience. The success of digital engagement depends on minimizing interaction barriers and aligning design with the cognitive capabilities of users.

Beyond information accessibility and digital interaction, environmental comfort is another key factor influencing the experience of visitors with cognitive disabilities. A quiet atmosphere, appropriate rest areas, and well-adapted facilities not only provide physical comfort but also help reduce cognitive stress, allowing visitors to engage with exhibitions more effectively. Thoughtful adjustments in lighting, acoustics, and seating arrangements can significantly contribute to a more inclusive museum environment.

CONCLUSION

This study contributes to two key areas. First, it enhances understanding of museum exhibition diversity by incorporating the perspectives of individuals with cognitive disabilities. This inclusion broadens the discussion on accessibility and enriches the design of museum experiences. Second, it advances human factors research in museum design by identifying specific needs and providing new insights into optimizing exhibition experiences for this audience.

However, this study contends with several limitations. The sample is not fully representative of individuals with diverse cognitive disabilities, limiting generalizability. Future research should expand demographic and cultural diversity while employing comprehensive observational, survey, and experimental methods to refine insights. Additionally, while this study primarily focuses on narrative strategies, deeper exploration of interaction design is needed. Future work should develop and test diverse interaction prototypes to enhance accessibility, integrating perspectives from human-computer interaction and ergonomics to create more inclusive museum experiences.

ACKNOWLEDGMENT

The authors would like to acknowledge all participants of this study.

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