Original Research

Horse Riders, Treasure Hunters, Picky Eaters, and Deep Divers: Exploring How Visitors Interact with an Exhibition at the Natural History Museum

Dingyi Wei, University College London, UK
Ava Fatah gen. Schieck, University College London, UK

Abstract: As museums usually target large numbers of visitors with great diversities, it is important for museum professionals to have a well-rounded understanding of the visitors as well as an approach to categorize them so that curation strategies can be applied accordingly and effectiveness achieved. This article presents a study of the exhibition "Dippy Returns" at the Natural History Museum in London. By performing on-site observation, we categorized visitors—by their movements and interactions with the exhibits—into four types: Horse Riders, Treasure Hunters, Picky Eaters, and Deep Divers. We also interviewed a curator of the exhibition to understand intended visitor experiences from the museum's perspective. We believe that the categorization can help museum professionals better understand on-site visitor behaviors from the perspectives of both interactions and movement, which responds to the trend for museum exhibitions nowadays to deploy a diversity of activities and more flexible visiting routes. The categorization could serve as a common language that curators and designers can use to communicate their expectations and improve visitor experiences with exhibitions.

Keywords: Museums, Exhibitions, Interaction, Movement, Visitor Categorization

Introduction

In August 2022, the International Council of Museums (ICOM) approved the updated museum definition, which continued to recognize museums as institutions open to the public and identified that they offer a diversity of experiences for the purposes of "education, enjoyment, reflection, and knowledge sharing" (ICOM, n.d.). The fact that the target audience of museums is the public and the purposes of museums have multiple dimensions indicates that, in general, museums usually welcome a large number of visitors. The official data from the Department of Culture, Media and Sport (DCMS) in the UK disclosed that the DCMS-sponsored museums and galleries, excluding the Museum of the Home and the National Portrait Gallery, welcomed a total of 9.5 million visits in the third-quarter of 2022 (GOV.UK 2013). The figure was nearly twice that of the previous year and more than six times of the data from 2020 (GOV.UK 2013), indicating a promising recovery from the COVID-19 pandemic, when many museums were closed in response to government restrictions (Adams 2020).

COMMON GROUND

Considering the large number of museum visitors, the stakeholders on the museums' side, including organizers and curators, need to have a thorough understanding of the categories of the visitors in order to create exhibitions that are useful and effective (Najbrt and Kapounová 2014). As a result, museum visitors have been categorized from various perspectives, which are indicative of their different characteristics.

John Falk (2009) identified five types of museum visitors: Experience Seekers, Explorers, Facilitators, Hobbyists and Professionals, and Rechargers. Such categorization was based on the motivation of the visits. Similarly, De Vecchi (2021) listed eight types of visitors: Avid Cultural Users, Experience Sharers, Safe Apprentices, the Cultural Nostalgic, the Cutting-Edge, the Busy Ambitious, Enthusiastic Experts, and Leisure Seekers. These models focus on the predetermined motivations of the visitors before the start of their tours, but the actual visits are influenced by both the motivations and random on-site events (Falk 2009). Therefore, direct observation and description of on-site behaviors could be more helpful for exhibition designers and curators to better understand what is really happening between the exhibitions and the visitors.

In 1983, Levasseur and Veron (1983) proposed four categories of visitor behaviors based on an on-site observation at an exhibition, and they metaphorically used names of animals to identify the four types of visitors: the ant visitors, butterfly visitors, fish visitors, and grasshopper visitors. An ant visitor was considered to have a "proximal visit." They would stand closely to the signs, follow the chronological order proposed by the exhibition, and avoid crossing spaces. The visit included a maximum of stops and lasted for the longest period of time (approximately twenty minutes) compared with the other three types of visits. A butterfly visitor had a pattern of a "pendular visit," and they walked in a zig-zag way and stayed in the exhibition for a shorter while (approximately fifteen minutes). A fish visitor took a "slip tour," and they walked fast through the exhibition without too many stoppages (spent approximately five to ten minutes), while a grasshopper visitor would walk directly to the exhibit they were interested in, and this "punctum"-only visit lasted for the shortest period of time (approximately five minutes).

The model provided a straightforward manifestation of visitor categories, but it was essentially looking at the routes of visits without involving a detailed description of how visitors engaged with the exhibits. The work has been reviewed and cited by numerous researchers until this day, and they all recognized the typology as more of a spatial implication (Mancas et al. 2009; Celentano et al. 2009; Rosso 2022). The four categories were essentially considering the exhibition territory as "a network of redirections in space," and it was "temporalized by the signifying body of the subject" (Rosso 2022). However, there was little elaboration on how the visitor interacted with the specific content of the exhibition.

The strong focus on visitors' spatial movement (and less on their interactions) by Levasseur and Veron is understandable, because, in the 1980s, looking, reading, and observing were almost the only forms of interaction in museums. After over forty years,

museums are now using a diversity of media and technologies, creating more activities to enrich visitors' experiences, and making their visits more active in embodying various behaviors (Clini et al. 2017; Grammatikopoulou 2016; Galani et al. 2020; Clarke et al. 2021). Instead of simply walking around, observing the exhibits, and reading the labels, museum visitors nowadays have opportunities to watch a video, to touch a model, to take photos of models from different angles, or to press a button and play some music. As museums are influenced by and are embracing all the possibilities brought by new types of exhibits other than artifacts held in a box or hung on the wall, there is a necessity to understand how visitors engage with both the space and the exhibits since the spatial configuration and exhibit components are important both for the exhibitions and for influencing visitors' on-site behaviors (Bitgood 1992, 2006; Tzortzi 2014; Tzortzi and Fatah gen. Schieck 2023).

In addition, Levasseur and Veron's model assumed that an exhibition follows a chronological order, while this may not be the case all the time. Linear or directed sequences do not represent spatial features for all exhibitions, and there are many types of exhibitions that encourage visitors to explore freely by wandering around (Naredi-Rainer 2004; Neufert 2012; Tzortzi and Hillier 2016). Therefore, there is not always a "chronological order" to compare against while studying visitors' routes.

Considering the diversity of exhibition spaces as well as the current trend in which museums offer versatile exhibits and interactions, we suggest that a new categorization for visitors' on-site behaviors should be developed to fit into the museums of the twenty-first century. In this article, we extend the model by Levasseur and Veron (1983) to include not only how visitors move around the space but also how they interact with the exhibits.

We chose to study and observe the exhibition "Dippy Returns" at the Natural History Museum during the summer of 2022 because it involved exhibits with different features and represented a similar approach to current exhibitions with both digital and non-digital elements. This exhibition was located in an enclosed gallery, which made it ideal for us to carry out the observation-based study. The exhibition did not have a prescribed route (except for an entrance and an exit), which gave visitors more freedom to explore the site and made the different visitor types more distinguishable from each other.

We carried out on-site observation and notetaking using Levasseur and Veron's study as a methodological guide. In their work, they used curvy lines and dots to mark the routes and the standing points of the visitors and then categorized them based on the geometrical patterns of their movements. Adopting a similar method, we further added a detailed description of interactions with the exhibits for each visitor as an important part of the notes. Based on the observation and the analyses of the graphs and notes, we propose four types of visitors: Horse Riders, Treasure Hunters, Picky Eaters, and Deep Divers. We also hope to indicate that animal references, such as ants and fish, are not adequate for representing human behaviors since people have richer personalities and more complex decision-making abilities. The resulting categorization can be applied in a wider range of exhibitions that

include interactive and/or digital installations and that do not necessarily have prescribed visiting sequences. In addition to the site observations, we interviewed the curator of the exhibition to identify and verify the possible contribution of the proposed model. We believe that this model will provide a more practical approach and a common language for designers and curators by only focusing on what actually happens at the exhibition without the need for more knowledge about the background of the visitors, which is uncontrollable by the museums. Museum professionals will be able to capture the extent to which the exhibits are noticed, utilized, and interacted with by the visitors, and this will enable them to evaluate their curatorial decisions based on a systematic study of real-life interactions. In the next section, we introduce interactions in museums, followed by the study and the methodology, and then we present the results followed by the discussion.

Interactions in Museums

Interactions in museums usually refer to either one of two situations: human-information interaction and human–human interaction. While the former has been taking place since the very first museum in history, that is, the Museum of Alexandria, in which objects were displayed for prominent scholars to watch (Alexander 2017), the latter is increasingly discussed by recent research.

To address human-object interaction, there are models on interactive installations that could be referred to, such as Michelis and Müller's (2011) study on interacting with public displays. They recognized the six stages of engaging with the installation as passing by, viewing and reacting, subtle interaction, direct interaction, multiple interaction, and follow-up actions. The six stages were named as the Audience Funnel, indicating that each stage only retained part of the audience from the last. Similarly, Brignull and Rogers (2003) used three types of activities, peripheral awareness activities, focal awareness activities, and direct interaction activities, to describe interactive processes with increasing attention and commitment of users. Recognizing that human beings could play different roles when they are in different stages of interaction, Wouters et al. (2016) named the users of public interactive installations as passers-by, bystanders, participants, audience members, and actors. These models regarding interactive installations can be referred to when looking at levels of interactions at museum exhibitions, and we are borrowing some of the aforementioned terms to describe visitors' interaction with the exhibits in this article.

In the context of museums, a previous research article presented a model that broke down the process of interacting with a museum exhibit into five stages: lingering, exploring, direct interaction, primary outcome, and secondary outcome (Wei et al. 2020). It was a process in which a visitor approaches, understands, plays with, and reflects on a museum installation, and the five stages were then applied to visualizing visitors' engagement processes that deviated from the label instructions (Figure 1). The five stages could also be used to describe

different levels of engagement by identifying the stage until which a certain visitor proceeds. Different levels of engagement result in different types of visitors, and Dean (1996) categorized them as casual visitors (move through a gallery quickly, do not become heavily involved), cursory visitors (show a genuine interest in the experience and collections), and study visitors (thoroughly examine exhibitions). Contrary to Levasseur and Veron's (1983) model, this categorization focused only on the interactions without addressing the significance of visitors' movement.
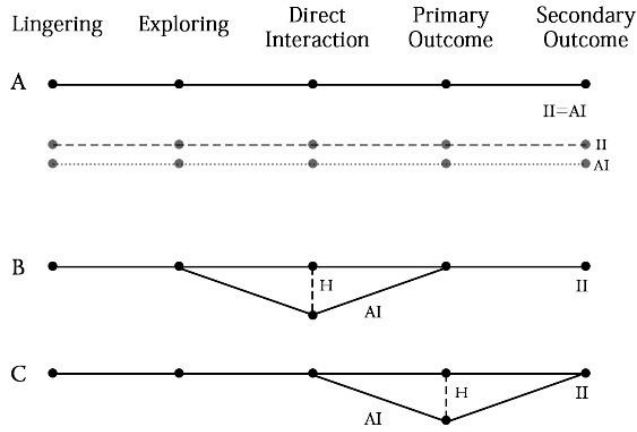

Figure 1: Line Graphs Indicating the Deviation of Engagement[1]
Source: Wei et al. 2020

With the development of digital technologies, the forms of human-object interaction in museums are increasingly involving embedded and embodied installations, extended engagement, and multisensory experiences (Hornecker and Ciolfi 2019). The new forms of interaction could take advantage of devices such as multi-touch surfaces, projections, and mobile applications (Vaz et al. 2018), and the diversity of installations brings diversity to visitor behaviors. Since 2017, there has been a drastic growth and development in the study of technology and museum visitor experiences, mostly discussing the core concepts of interaction and experience (Lu et al. 2023).

The human–human interaction in museums is usually discussed with respect to employee–visitor communication (Shaby et al. 2019; Ferreiro-Rosende et al. 2022) and visitor–visitor communication (Vom Lehn et al. 2001; Bamberger 2009; Shaby et al. 2019). Specifically, visitor–visitor communication usually includes the communication of technical operations (i.e., how to engage with an interface) and the expression of emotions (Bamberger 2009; Shaby et al. 2019), and the interactions can be observed regardless of whether the physical setting

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[1] II: Intended Interactions, AI: Actual Interactions, H: Deviation Between II and AI. A: Complete Overlap Between II and AI, B (Middle): Deviation Between II and AI at the Direct Interaction Stage, C (Lower): Deviation Between II and AI at the Primary Outcome Stage

encourages them (Shaby et al. 2019). In this article, we will only cover some interactions among visitors as supplementary observation results. However, we acknowledge that human–human interaction is a substantial part of museum visitor studies (Dim and Kuflik 2014).

The Study

The Natural History Museum and "Dippy Returns"

The Natural History Museum is located in South Kensington in London, surrounded by a few other renowned museums, including the Science Museum and V&A Museum. It has a huge collection of life and earth science specimens and covers five main fields of study: botany, entomology, mineralogy, paleontology, and zoology. The building of the museum is divided into four color-coded zones, which are the red zone (the theme of geology), the green zone (the theme of evolution), the blue zone (the theme of diversity), and the orange zone (the places to see science at work and for relaxation).

The exhibition "Dippy Returns: The Nation's Favorite Dinosaur" (referred to as Dippy Returns in this article) was located at the Waterhouse Gallery in the green zone of the museum on the ground floor (Figure 2). It comprised (1) a cast skeleton made from a fossilized Diplodocus (a dinosaur), (2) a model of the skull of Diplodocus, and (3) four projections playing films with atmospheric music and prerecorded narrations. The cast was donated to the museum in 1905 and became a great attraction. In 2017, it left the museum and took a tour around the UK. After coming back to the Natural History Museum, it was displayed at Waterhouse Gallery from May 27, 2022, to January 2, 2023. The gallery was an enclosed space with a designated entrance and exit, but visitors could wander around freely within the gallery during their visit.

Figure 2: Location of the Waterhouse Gallery in the Natural History Museum
Source: Natural History Museum, n.d.

The Environment

In order to reconstruct the environment, we used a 3D scanning application with LiDAR and acquired the scanned 3D models (Figure 3) of different parts of the gallery and then stitched them in the computer to derive a complete plan of the exhibition. We then marked the exhibits on the plan with corresponding photos, as in Figure 4.

"Dippy Returns" was chosen as a case study for visitor categorization because it could partly represent the recent exhibitions that involve a diversity of exhibits. It had both the physical and the digital elements, both visual and audio outputs, and both passive and hands-on interactions. It provided a platform for visitors to engage with the items through different and diverse approaches and would potentially make different visiting types more distinguishable from each other.

In order to explore visitor types considering both their visiting routes and interactions with the exhibits, we built on Levasseur and Veron's model (1983) and referred to Michelis and Müller's (2011) six stages of interaction. In the following sections, we will present a new model that represents four types of museum visitors.
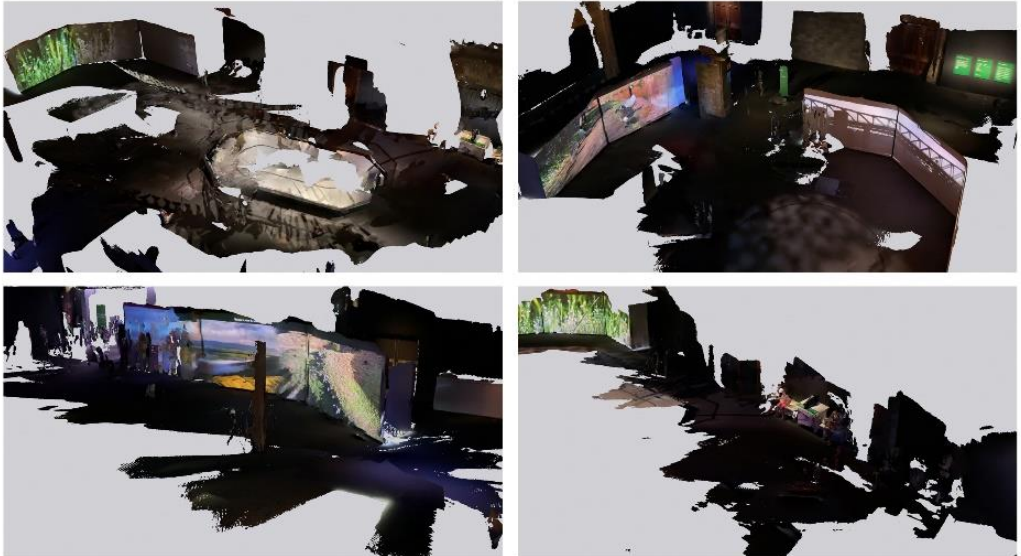

Figure 3: Examples of Screenshots of 3D Scans That Were Used to Compose the Exhibition Plan
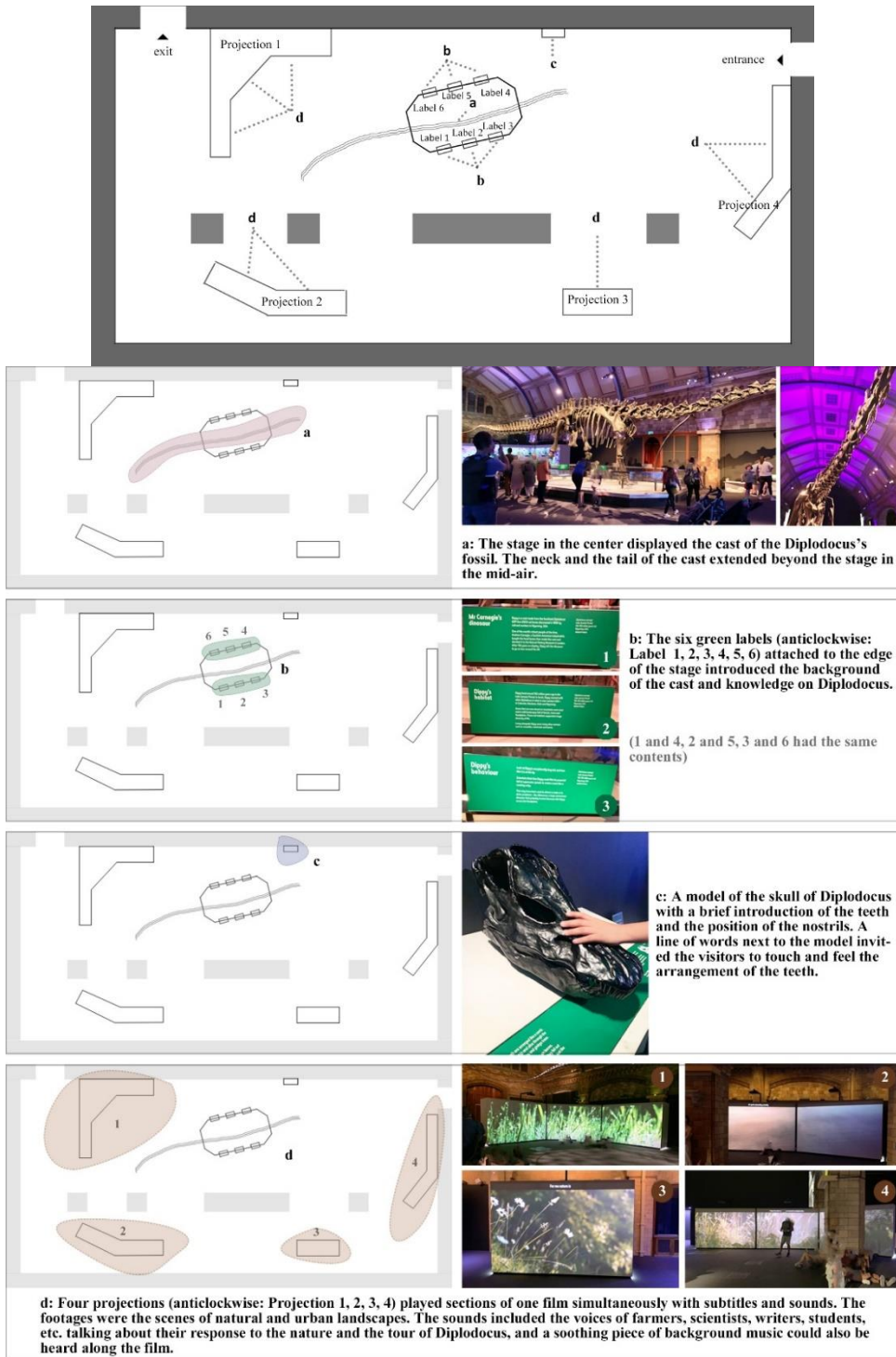
a: The stage in the center displayed the cast of the Diplodocus's fossil. The neck and the tail of the cast extended beyond the stage in the mid-air.

b: The six green labels (anticlockwise: Label 1, 2, 3, 4, 5, 6) attached to the edge of the stage introduced the background of the cast and knowledge on Diplodocus.

(1 and 4, 2 and 5, 3 and 6 had the same contents)

c: A model of the skull of Diplodocus with a brief introduction of the teeth and the position of the nostrils. A line of words next to the model invited the visitors to touch and feel the arrangement of the teeth.

d: Four projections (anticlockwise: Projection 1, 2, 3, 4) played sections of one film simultaneously with subtitles and sounds. The footages were the scenes of natural and urban landscapes. The sounds included the voices of farmers, scientists, writers, students, etc. talking about their response to the nature and the tour of Diplodocus, and a soothing piece of background music could also be heard along the film.

Figure 4: The Plan of "Dippy Returns"

Methods

Observations and Ethics

The main method adopted in this study was on-site observation. The observation took place on two Wednesday afternoons, July 20, 2022, and July 27, 2022. The time arrangement was subject to the museum's requirements and restrictions. A total of thirty individual visitors (i.e., those who visited the exhibition on their own) were observed for the purpose of categorizing visits, and a further forty groups (mostly consisting of two people, but there were also three- and four-people groups) of visitors were observed to identify any forms of interaction exclusively for groups. Although the number of visitors observed was very small compared with the total of around one million who have engaged with the exhibition (Davis 2023), we targeted to identify the types of visitors rather than derive their accurate proportions, and hence, we consider the observation adequate for drawing conclusions.

The study was communicated to and approved by the Audience Research Team of the Natural History Museum prior to its commencement. Throughout the observation, no pictures or videos of the visitors were taken, and no visitors were identifiable in the notes. No children or visitors suspected to be under the age of 18 were observed. As required by the museum, the researchers performing the observation wore badges to identify themselves. Each identified visitor (or group of visitors) was observed from entering to leaving the exhibition.

Notes and Analysis

The behaviors and movements of the visitors were drawn and recorded on printed A4 plans of the exhibition. The method of notetaking referred to and resembled the representation in Levasseur and Veron's work, where they used curvy lines to represent the movement of visitors, the letter A to represent where visitors stopped, and the letter R with an arrow to represent where visitors were looking.

In this study, aside from drawing the movement of each identified visitor with lines, more behaviors were included in the notes to record the detailed interaction with the exhibits. For example, W(d): watch the dinosaur, W(t): watch the tail, W5s: watch film scenes change five times, P: take photo(s), P(d): take a photo of the dinosaur, P(p1): take photo(s) of the first projection, R: read (with an arrow identifying the item being read), and T: touch.

We intentionally did not record the exact time duration of each visitor interacting with the exhibits. Our initial observation suggested that due to the diversity of visitors at the museum, they interacted at very different paces. For example, some visitors walked much slower than others and, hence, stayed for a longer while in the gallery. Some visitors were likely to be tourists from other countries, so it took them longer to read the labels. We decided that the absolute measure of time in minutes and seconds was not fully indicative of visitors' experiences or commitment to the exhibition. Instead, we regarded the detailed notes of

interactions as an alternative approach to understanding the "time" that visitors spent. For instance, a visitor who read the labels multiple times and kept referring back to the dinosaur cast was considered to spend more time than a visitor who read the label only once, and a visitor who watched the film scenes change five times obviously spent more time at the projections than a visitor who only watched one scene.

The categorization of visitors was based on a comprehensive analysis of their on-site movement and interactions. The features of how they moved around the space, as well as how they interacted with each exhibit, were considered and indicative of the category they fell into. A detailed description of each type of visitor is provided in the Results section.

Interview

Aside from the on-site observation, we also interviewed a member of the Design and Interpretation Team of the Natural History Museum, who led the curation of "Dippy Returns." The thirty-minute face-to-face interview addressed questions regarding the background and the purposes of the exhibition. With signed consent, the recorded audio was converted into text transcripts to extract key information. The results of the interview were compared with the observation to evaluate to what extent the museum's intentions were achieved as well as how the categorization could be applied to obtain a better understanding of the visitors. The preliminary findings are shared in the following Results section.

Results

Four Basic Types of Visitors

After recording and carefully reviewing the movement and behaviors of thirty individual visitors, a total of four visitor types were identified. The naming, features, examples, and notes of the four types are elaborated on in the following paragraphs.

Horse Riders

Number of visitors: 9/30 (No. 2, 5, 6, 7, 16, 18, 19, 20, 26)

Description: Horse Riders go through the exhibition in an almost nonstop and nonrepetitive manner. They enter from the entrance, quickly go through the shortest possible route while looking around at the items, and leave from the exit. Their movements are usually simple curves without any implication of lingering. In terms of interactions, they only interact with the exhibits to the minimum extent, and they seldom do anything else aside from walking and glancing. Referring to Michelis and Müller's Audience Funnel, these visitors are mostly just passing by and occasionally proceed to the viewing and reacting stage, but they do not go any further. The engagement process is similar to a parade on horseback, which means the visitors pass the items only once, and they rarely look back.

Example: Visitor No. 16 (Figure 5) was a typical Horse Rider. He entered from the entrance and walked directly to the exit. Although he looked around and looked at the dinosaur along the way, he did not stop or take any photos. The Horse Riders, including Visitor 16, are presented in Figure 6.
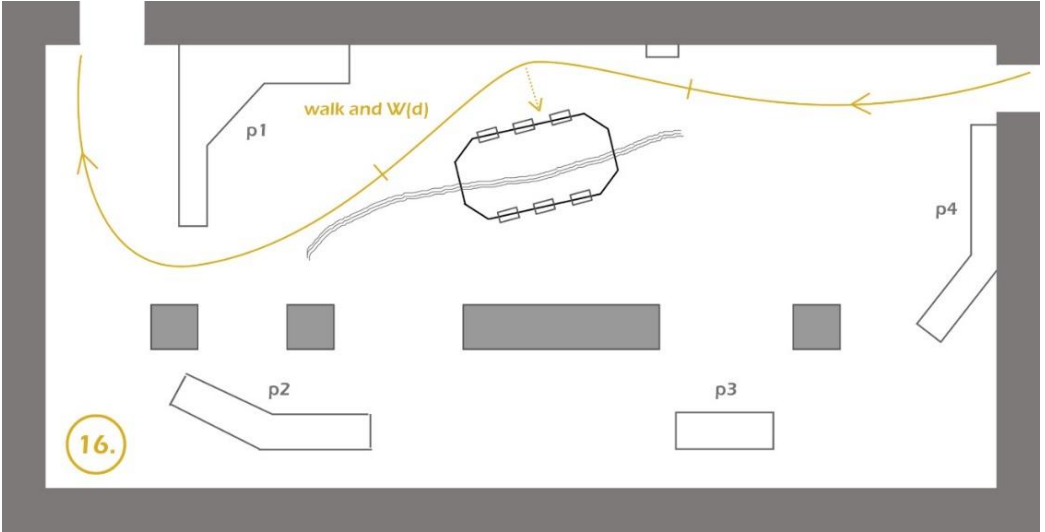

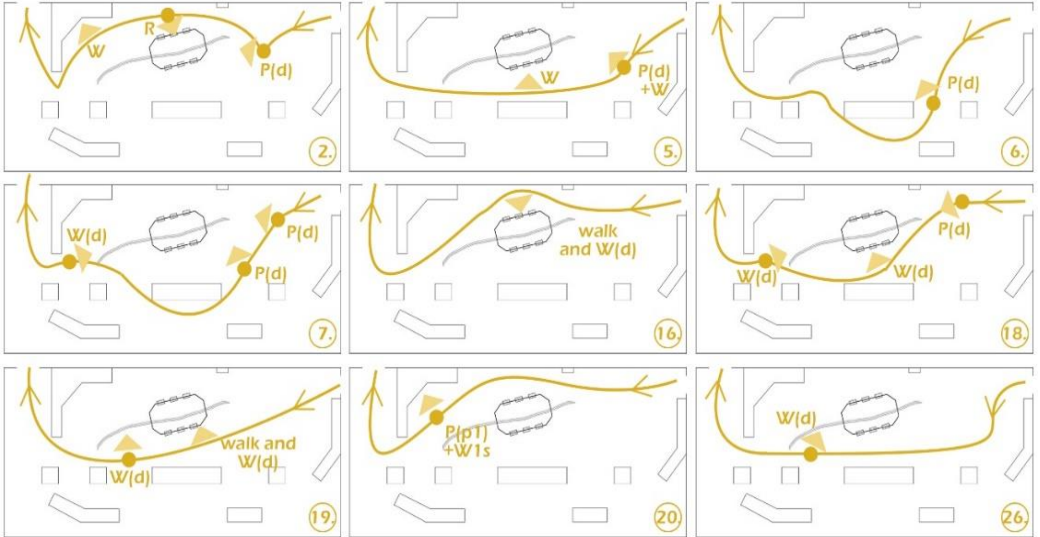Figure 5: Horse Rider: Visitor 16 (>: Direction of Walking, -->: Eye Gaze)

Figure 6: Horse Riders: Visitors 2, 5, 6, 7, 16, 18, 19, 20, 26 (>: Direction of Walking, ▶: Eye Gaze, ●: Standing Point)

Treasure Hunters

Number of visitors: 12/30 (No. 1, 4, 9, 11, 14, 15, 17, 21, 24, 25, 27, 30)

Description: Treasure Hunters engage with the exhibition in an efficient manner. They pick up key information but not necessarily all the information available. They engage with a variety of items, but not necessarily in-depth. Their movements show some repetitiveness but not much. It is difficult to tell what they like and dislike about the exhibition because they seem to engage evenly with several items that they judge to be important. They have direct interactions with most items, including the cast, the labels, and the projections. However, it is difficult to see them entering the multiple interaction stage (explained as reengagement by Michelis and Müller). The engagement process is similar to a treasure-hunting game. They identify the location of the "treasures," collect the information, and leave. There is not too much attachment to the items, and they seem to be after efficient experiences and processes.

Example: Visitor No.9 (Figure 7) was a typical Treasure Hunter. He entered the exhibition from the entrance and took photos of the dinosaur from the front. Then, he walked directly to Label 5 and read it. He then read and took a photo of Label 4 and then read Label 6. After that, he went toward Projection 1, stood in front of it, and watched the film for a short while. Without waiting until the next scene in the film, he left the exhibition from the exit. The Treasure Hunters, including Visitor 9, are presented in Figure 8.
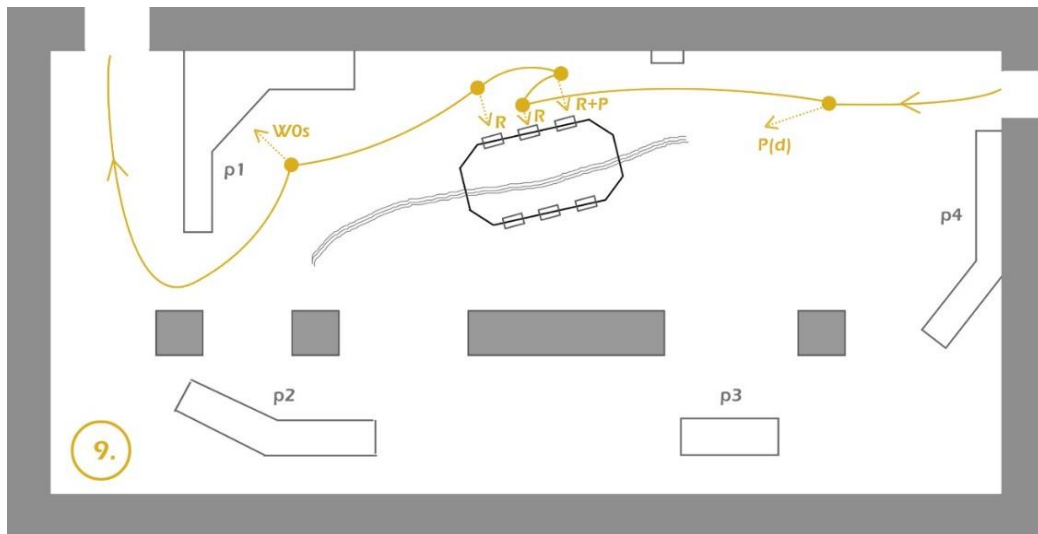

Figure 7: Treasure Hunter: Visitor 9 (>: Direction of Walking, -->: Eye Gaze, ●: Standing Point)
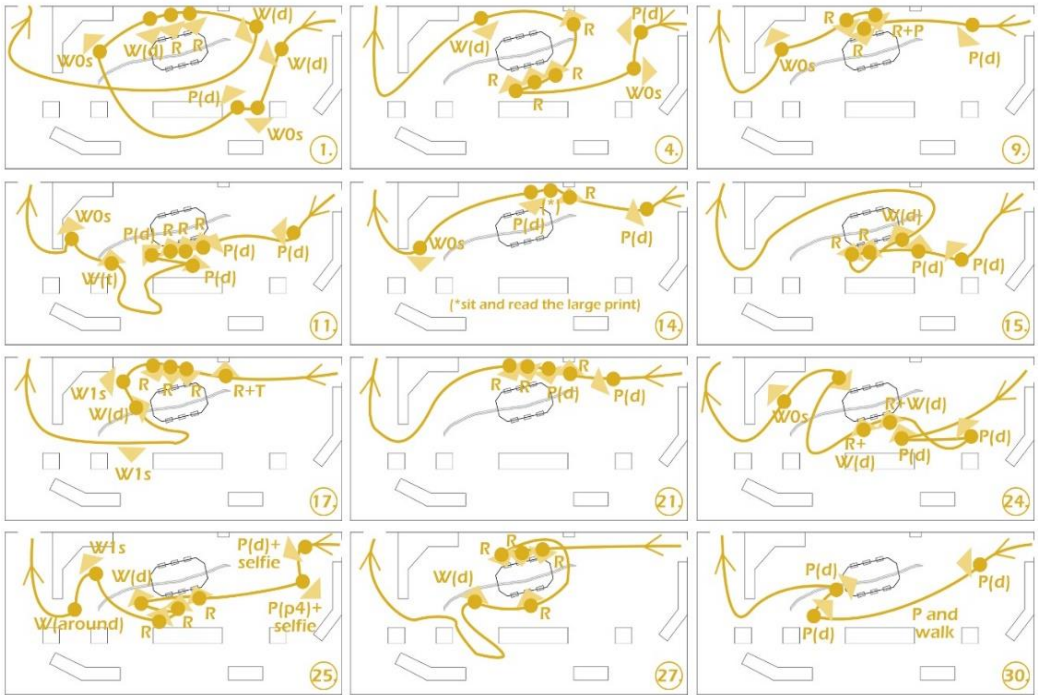
Figure 8: Treasure Hunters: Visitors 1, 4, 9, 11, 14, 15, 17, 21, 24, 25, 27, 30
(>: Direction of Walking, ▶: Eye Gaze, ●: Standing Point)

Picky Eaters

Number of visitors: 6/30 (No. 8, 10, 12, 23, 28, 29)

Description: Picky Eaters are very specific about what they want to do with the exhibition. They may not go through all the items, and some may not even pay attention to the largest item (in this case, the fossil cast). Instead of picking up most information in an efficient way as the Treasure Hunters do, or enthusiastically engaging with all items like the Deep Divers (introduced in the next category), they like to focus their attention by interacting with one exhibit to the maximum extent possible while not necessarily minding ignoring most other items. Among all the visitors, they are the most likely to be observed having multiple interactions (i.e., interacting repetitively), but they only interact in such ways with one exhibit. With other items, they may show very little interest and behave like Treasure Hunters or even Horse Riders. They appear to be very "picky" at the exhibition, having big "appetites" for their personal favorites while not taking most of the others. In terms of their movements, although it is possible that the routes look as simple as that of Horse Riders, they usually spend a large proportion of their tours with one item and possibly at one spot.

Example: Visitor No.12 (Figure 9) was a typical Picky Eater. She entered from the entrance, took a picture of the dinosaur as most other visitors did, and noticed Projection 4.

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She put her bag on the floor in front of the projection and sat on it. She seemed fully concentrated on the film and watched more than twenty scenes, which was very rare among all the visitors. After a while, she stood up and went to label 2. She read the label, looked at the dinosaur, and then walked to the back of the dinosaur to take a photo of the tail. After that, she left the exhibition from the exit. The Picky Eaters, including Visitor 12, are presented in Figure 10.
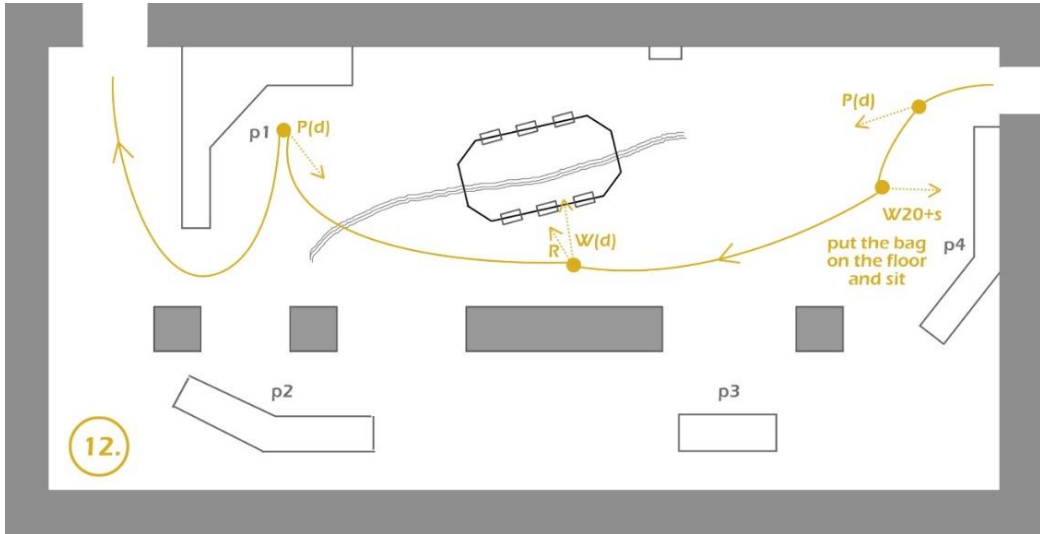

Figure 9: Picky Eater: Visitor 12 (>: Direction of Walking, -->: Eye Gaze, ●: Standing Point)
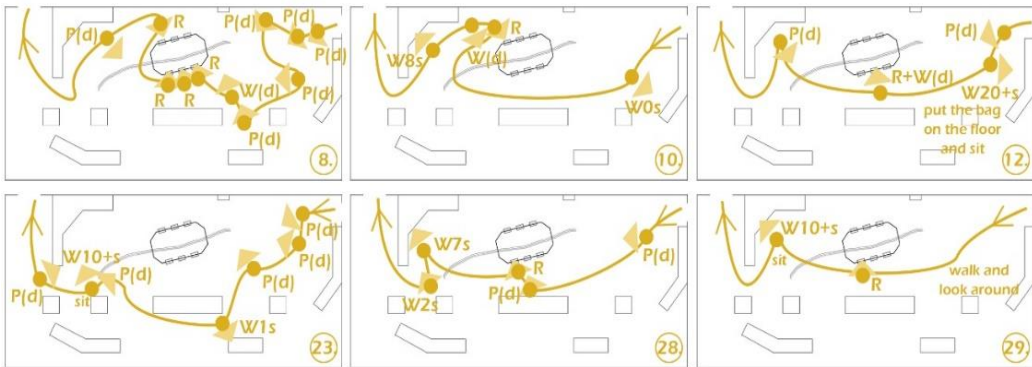

Figure 10: Picky Eaters: Visitors 8, 10, 12, 23, 28, 29 (>: Direction of Walking, ▶: Eye Gaze, ●: Standing Point)

Deep Divers

Number of visitors: 3/30 (No. 3, 13, 22)

Description: Deep Divers are very enthusiastic about the exhibition. Unlike Picky Eaters, who are only interested in one specific item or activity, Deep Divers are passionate about almost all the information and forms of interactions available on-site. They directly engage

with every item, and they have multiple interactions with some, if not all, of the exhibits. They indulge in the theme of the exhibition as if they are diving and exploring the ocean. Deep Divers always demonstrate devotion to the exhibition by carefully interacting with exhibits in almost all possible ways. Their movements are usually very complex and repetitive.

Example: Visitor No.3 (Figure 11) was a typical Deep Diver. She entered the exhibition like everyone else and started reading Labels 4, 5, and 6. However, unlike most other visitors, she looked up and carefully examined the cast every time she finished reading one label. She then walked to Projection 1 and watched it for a few seconds. Then, she took a photo of the tail of the dinosaur and started to observe the cast from various angles while walking around the stage. She also took a detour to have a look at Projection 3. As for the other two Deep Divers, Visitors 13 and 22 were two of the few individual visitors who showed interest in the model of the skull (although neither touched the skull). It was noted that Visitor 22 even briefly checked out the large print booklets for visually impaired visitors. It was apparent that all three visitors showed a strong interest in the details of the exhibition. The Deep Divers, including Visitor 3, are presented in Figure 12.
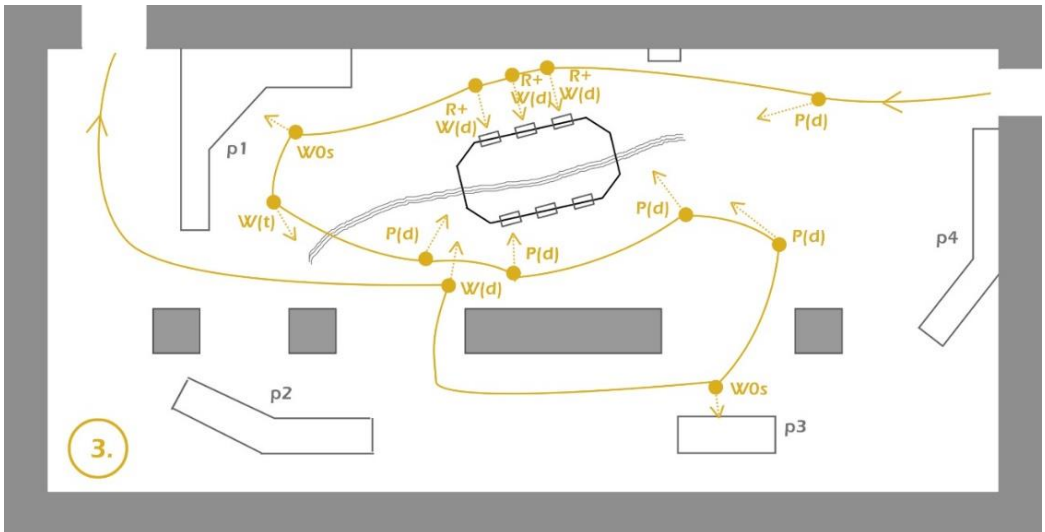

Figure 11: Deep Diver: Visitor 3 (>: Direction of Walking, -->: Eye Gaze, ●: Standing Point)
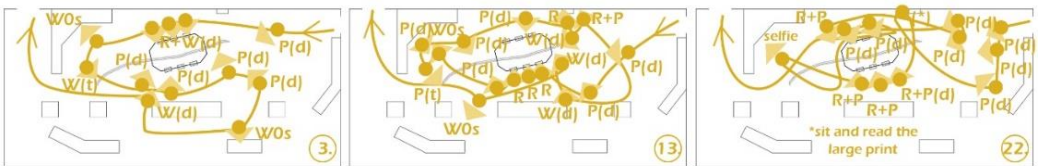

Figure 12: Deep Divers: Visitors 3, 13, 22 (>: Direction of Walking, ▶: Eye Gaze, ●: Standing Point)

Group Visitors

Although the categorization is built on the observation of individual visitors, those who visited in groups were also observed for a more comprehensive conclusion. Thus, forty groups of visitors were observed, and their on-site movement and behavior were recorded in the same way as for the individual visitors.

According to the observation, 75 percent of the forty groups visited the exhibition in a pattern that was similar to that of Treasure Hunters, and the ratio was significantly higher than the proportion of Treasure Hunters in individual visitors, which was 40 percent. Most groups interacted with the exhibits efficiently, which means that they quickly watched the film (for a very short while), took photos with/of the dinosaur, and probably browsed the labels. It was rare to see Deep Divers in groups. As a matter of fact, only one group of visitors was observed to be Deep Divers. However, it was not common to see Horse Riders as well.

One significant feature exclusive for group visitors was that they enjoyed interactions among themselves. The two most observed interactions were conversations (including discussion and scaffolding) and taking photos of each other (named as "follow-up actions" by Michelis and Müller).

Interview Results

The interview with the curator revealed that despite the presence of the dinosaur cast, the team put more thought and effort into the four projections, which were identified as the "main component of the interpretation." As the exhibition was launched after a nationwide tour of the cast, it was regarded as the homecoming of the dinosaur, and the curator said that the team wanted to showcase "the tour and the huge success that had been in reaching over two million visitors across the UK" as well as "the diversity of UK landscapes and biodiversity," which were intended to be demonstrated by the videos and soundtracks of the projections. In terms of the specific actions they expected from the visitors, the curator said that they would love to see visitors not only observing the cast in different lights but also watching the films, which would trigger emotional connections with the dinosaur. They thought it was lovely to see people "sitting on the floor, doing their things," and the curator said clearly that they intentionally kept the scientific background information of the dinosaur at a "relatively low level" and wanted it to be more of a "reflecting back on the tour" and "what that's meant to people." The exhibition was eventually aimed to "hook them (visitors) in to think about the natural environment on their doorstep and how important it is," which was a big difference from the exhibition before the tour, at which only the cast was displayed.

The observation, however, revealed that the majority of visitors were spending most of their time with the dinosaur cast instead of the projections. The curator was slightly surprised when she learned that the projection did not receive the attention they were hoping for, but she immediately showed understanding of the situation since the team knew how popular the dinosaur cast was.

Discussion

Spatial configuration and exhibition objects are equally important, for they respectively serve as the skeletons and flesh of museum exhibitions (Tzortzi and Hillier 2016). While traditionally the categorization of museum visits/visitors was built on either the movement (e.g., the ant visitors, the butterfly visitors, the fish visitors, and the grasshopper visitors by Levasseur and Veron) or the extent of engagement (e.g., casual visitors, cursory visitors, and study visitors by Dean), we believe and our study shows that the two are inseparable and should both be discussed.

It should be pointed out that the four visitor types in our categorization do have some connection with the four types presented by Levasseur and Veron. For example, an "Ant" would stop in front of almost every exhibit, which is similar to the movement of a Deep Diver, while a "Grasshopper," just like a Picky Eater, would go straight to an item that seems interesting while ignoring most other exhibits. The observation notes showed that different types of visitors have different numbers of stoppages at the exhibition, which echoes Levasseur and Veron's model.

However, the four types in our study are not simple renewed versions of the four animals. First, and most importantly, we have endowed the visitor types with patterns of interactions with the exhibits, and we reveal that one visitor is different from another not only because they move differently but also due to the different approaches they adopt to engage and interact with the exhibits and, consequently, the overall time of their visit. A Horse Rider interacts by mainly glancing, avoiding any other possibilities provided by the exhibition, such as taking photos and touching the model; a Treasure Hunter interacts with the exhibits to the minimum extent possible, just sufficient to give them the key information, and they do not wish to engage any further; a Picky Eater interacts with one or two items in depth, exploring the items to the maximum extent; a Deep Diver fully explores all approaches of interaction within the site, including closely observing, taking photos, watching films, and touching the skull model. Our study suggested that looking at visitors' movements alone is not adequate to distinguish one type of visitor from another. For example, a Picky Eater would have the same pattern of walking as a Horse Rider or a Treasure Hunter, but the three types are actually treating the visits with different levels of commitment and focus.

We believe that not only the visiting routes but also the levels of interactions can be visualized, and the patterns of interaction for each visitor category are presented in Figure 13. If taking each exhibit as the horizontal axis and the levels of interacting with each of them as the vertical axis, the graphs for interactions among Horse Riders, Treasure Hunters, and Deep Divers are all horizontal or nearly horizontal lines with different average levels of interactions (Horse Riders: the lowest, Treasure Hunters: higher, Deep Divers: the highest). Visitors of these three types do not show particular preferences for the exhibits, unlike Picky Eaters, whose graph for interaction has a spike, indicating the focus of interaction.
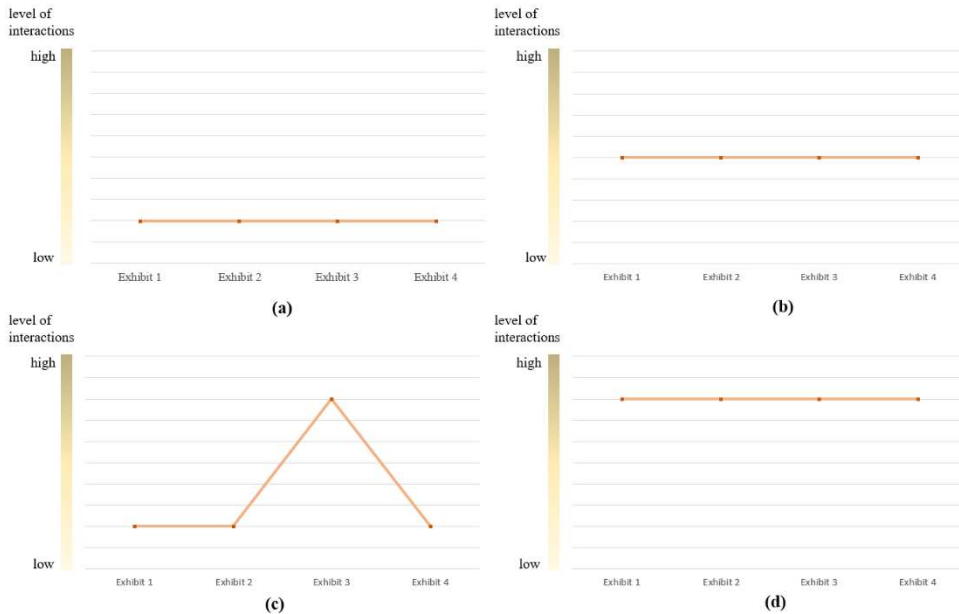
Figure 13: Visualization of Interactions of (a) Horse Riders, (b) Treasure Hunters, (c) Picky Eaters, and (d) Deep Divers

We believe that in the age of digital technologies and when museums are incorporating a diversity of exhibits, this typology will help interpret visitor movement and behaviors, which in turn can help curators inform their approach.

In addition, while Levasseur and Veron identified the shape of their routes by naming them proximal visits (the Ant), pendular visits (the Butterfly), slip tours (the Fish), and punctum (the Grasshopper), we focused on identifying the complexity and lengths of the routes. For example, a Deep Diver would possibly walk the longest distance on the site, and the routes have the most curves.

An advantage of this categorization is that it leaves out the factors relating to the background of visitors, which are unlikely to be precisely controlled and anticipated by the museums. Instead of categorizing visitors by their motivations or professions, we acknowledge that on-site visiting experience, as John Falk (2009) pointed out, can be affected by random events. As a result, we believe that looking at both on-site movement and behaviors would provide a practical approach to capturing the reality of museum visits. Meanwhile, this categorization is not exclusive to exhibitions with a prescribed visiting sequence and is applicable to a wider range of exhibitions.

The Proportion of Four Visitor Types

The results show that Treasure Hunters were possibly the most common type among both individual and group visitors at this exhibition. There were fewer Horse Riders and Picky Eaters, and there were fewest Deep Divers. This could be an indication that most observed

visitors had some, but not much, interest in the exhibition. The limited number of visitors observed might not be representative of all visitors who have engaged with the exhibition, and we acknowledge that a larger sample could reverse the results. In addition, we believe that the proportion of four visitor types should be measured on a case-by-case basis, which means studies on other exhibitions may demonstrate completely different results.

Figure 14: Visitor Types and Numbers

Meanwhile, the observed differences between individual and group visitors indicated that visiting with or without company does have an influence on how museum visitors interact with the exhibits as well as move on the site. There were fewer Horse Riders in group visitors, and there were also fewer Deep Divers. On the one hand, the interactions among group members enhanced their interest in the exhibits, while on the other hand, the group agenda could reduce their chances to further engage with the exhibits for longer times. Although frequent interactions with others from outside the groups were not observed, we acknowledge that other visitors presenting (including strangers) could also influence visitors' on-site behaviors.

During the observation and the follow-up analysis, we noticed that although there were a few visitors who could arguably be allocated to another category (such as Visitor No. 28, who could be a Treasure Hunter instead of a Picky Eater), in most cases, the visitors' behaviors were easily recognizable. Meanwhile, if a visitor seemed to be a Horse Rider in the first half of the visit, they would continue to be one for the rest of the tour. We believe this is because of the spatial design of "Dippy Returns," as visitors were able to understand the composition of the exhibition right after they entered the gallery. However, we acknowledge that at exhibitions with different rooms, one type of visitor may switch to another when they see things that they did not expect.

Research and Design Implications

The categorization of visitors' on-site behaviors can be adopted as an approach by exhibition curators and designers to describe their expectations more specifically and straightforwardly.

For example, at the interview, the curator was essentially conveying that they wanted to see a lot of Picky Eaters with a special interest in the projections. It was also implied that they hoped to see Deep Divers more than Treasure Hunters, because they were expecting in-depth reflections rather than efficient collection of information. If the museum professionals collected and categorized adequate samples at this exhibition, they could derive the proportions of each type of visitor and discuss their implications. The categorization could be adopted as a language to better communicate the expectations of the museum and compare the actual on-site experiences of the visitors.

While preparing for or trying to improve an exhibition, the exhibition curators, designers, and technicians can start to think: what kind of visitors/visits are we creating? For example, if they hope to create a Treasure-Hunter-like experience for a majority of visitors, are the design of the interfaces, instructions, and affordances adequate and clear enough to enable efficient interaction? If they expect Picky Eaters to have an intensive interest in a certain installation, is there adequate physical space for crowd gathering or capacity for a group of visitors to interact simultaneously?

The intentions of the organizers and curators should then be reflected in the design of the installations. Although visitors may not know about an installation in advance, they can perceive its affordance (physical, geometric, and symbolic features) and interact with it accordingly (Norman 1988, 1999; Achiam et al. 2014). Meanwhile, the space around the installation has a crucial influence on the actual behaviors performed by the visitors (Tröndle 2014; Tzortzi and Hillier 2016; Tzortzi and Fatah gen. Schieck 2023). With a clear intention of the percentages of the four types of visitors in mind, the relevant professionals could make corresponding decisions regarding the interfaces and the physical space more conveniently.

Another application of the categorization is that museum curators, managers, and researchers can adopt it on a sample of visitors to efficiently understand the popularity of a certain exhibition as well as each item within the exhibition. For example, if the exhibition is experiencing an unexpectedly high proportion of Horse Riders than other exhibitions in the same museum, or if there are Picky Eaters gathering in front of a certain exhibit, the museum professionals may treat these as signs to start investigating whether controllable factors that influence the performance of the exhibition could be identified and lessons learned for future projects. They can adopt further methods, such as interviews and surveys, to identify the specific reasons for the unexpectedly high or low percentages of a certain type of visitors.

Having in mind the presumed type of visitors allows museum professionals to design and arrange the exhibits, the form of interaction, and the spatial configuration with more confidence and control. We believe that the categorization of Horse Riders, Treasure Hunters, Picky Eaters, and Deep Divers can provide curators and designers with a fresh perspective to process, improve, and review their works.

Limitations and Future Research

As previously mentioned, the limited number of visitors observed in this study might not be adequate for deriving the proportions of each type. However, the main purpose of this article is to present the categorization as a tool for museum professionals and scholars to communicate their intentions for visitor experiences and to evaluate exhibitions, which has been achieved. A much larger sample is needed to apply the categorization for evaluating future exhibitions (as indicated in Research and Design Implications). In addition, more exhibitions could be studied to generalize, validate, or extend the visitor types presented.

In this article, we have looked at different types of visitor behaviors. Future research can explore how different factors, such as crowds and visitors' fatigue, may influence these behaviors and relate to the categorization of visitors.

Ethics

This research acquired ethics approval from the UCL Research Ethics Committee. The issued project ID is 17073/001.

Conclusion

Taking into consideration both their movements in the exhibition space and their interactions with the exhibits, exhibition visitors can be categorized into Horse Riders, Treasure Hunters, Picky Eaters, and Deep Divers. This categorization can be applied by museum professionals, including curators and designers, to better communicate their expectations for the exhibitions and the target visitors, and it can also serve as a tool to shape and improve these exhibitions.

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The authors declare that generative AI or AI-assisted technologies were not used in any way to prepare, write, or complete this manuscript.

Informed Consent

The authors obtained informed consent from all participants.

Conflict of Interest

The authors declare that there is no conflict of interest.

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ABOUT THE AUTHORS

Dingyi Wei: PhD Candidate, The Bartlett School of Architecture, University College London, London, UK
Corresponding Author's Email: dingyi.wei.16@ucl.ac.uk

Ava Fatah gen. Schieck: Professor of Media Architecture, The Bartlett School of Architecture, University College London, London, UK
Email: ava.fatah@ucl.ac.uk