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Understanding Visitor Experiences at the Pauline Gandel Children's Gallery

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Abstract

The Pauline Gandel Children's Gallery is a new exhibition at Melbourne Museum designed for the uniquely young age range of 0-5 year olds. The goal of this project was to help the museum understand the gallery's current use and educational value. The team conducted a tracking and timing study, interviews, and observational studies to evaluate the popularity, holding power, and educational value of exhibits. Results showed that designers were successful in providing the unique age range with engaging learning experiences.

Executive Summary

Project Overview

The Pauline Gandel Children's Gallery is a newly renovated children's exhibition opened in December 2016 at the Melbourne Museum in Melbourne, Australia. In response to an abundance of new research that emphasizes the importance of stimulating the minds of children at a young age, the Melbourne Museum designed the gallery for a uniquely young age range of children from 0 to 5 years old. After the gallery had been open for several months, the museum sought to confirm that the exhibits were successful in providing this young age range with a meaningful and engaging learning experience. To help the Melbourne Museum gain a better understanding of the use and educational value of the Pauline Gandel Children's Gallery, the team completed the following four objectives:

1. Achieved a full understanding of the goals of the exhibits in order to test and finalize the procedures and tools required to gather the desired data
2. Conducted a tracking and timing study to evaluate exhibit use, popularity, and holding power
3. Conducted interviews to evaluate learning outcomes and visitor engagement
4. Conducted observational studies in selected areas by observing and recording behaviors for specific age groups to identify commonly observed behaviors and evaluate educational value

Pathway, Visitation, and Timing Findings

In preparation for the studies, the team took guided tours of the gallery led by gallery designers in order to gain a deeper understanding of major exhibits, allowing the team to test and develop effective methods for each study. The main study conducted was the tracking and timing study, during which team members used a map of the gallery and a timing sheet to track a total of 52 children, equally distributed across the following four age groups: babies, toddlers, children ages 3 to 4, and children ages 4 to 5. The data obtained from the study was used to evaluate the usage, popularity, holding power, and caregiver interaction of areas and exhibits within the gallery.

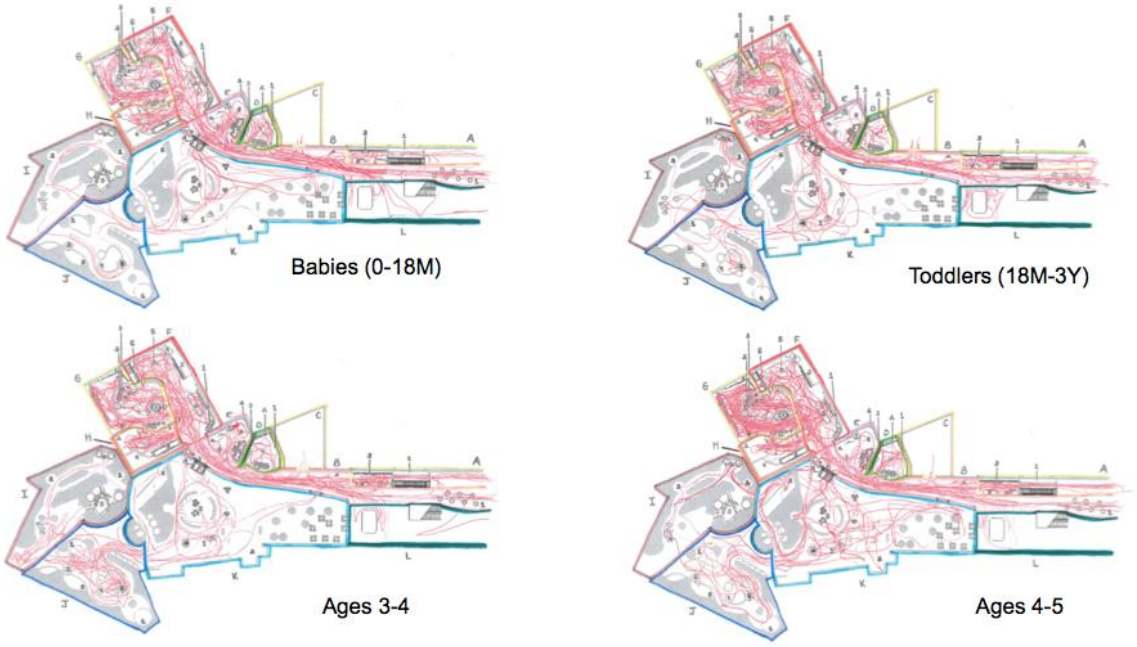

Figure 1: Visitor Tracks from 52 Observed Children

To evaluate the usage of exhibits and areas, the team analyzed compilations of recorded pathways. The most notable findings were found from the age-specific compilations, shown below in Figure 1, where the density of pathways in specific areas shows the areas that were favored by each age group. The older age groups favored the Net and Burrow Area (G) and the Dinosaur Dig Area (J), while the younger age groups favored the Shapes Wall Area (D) and the Mirror Room (E). The compilations also indicate that all age groups equally favored the Camouflage Disco Area (H).

The timing and visitation data was also used to evaluate popularity, holding power, and caregiver interaction. Popularity was defined as an exhibit's ability to attract children, and was evaluated by the number of visits each exhibit received. Holding power was defined as an exhibit's ability to engage a child and maintain their attention, and was evaluated by average time per stop. To evaluate caregiver interaction, the average caregiver interaction score was calculated for each exhibit by averaging the exhibit's highest interaction score from each of the 52 tracks.

Results of the popularity analysis can be seen in the graphs shown in Figure 2. Seven out of the ten most popular exhibits are located in the Big Box area within the gallery. In addition, seven out of the ten least popular exhibits are located in the outdoor areas, indicating that the outdoor areas are much less popular with visitors.

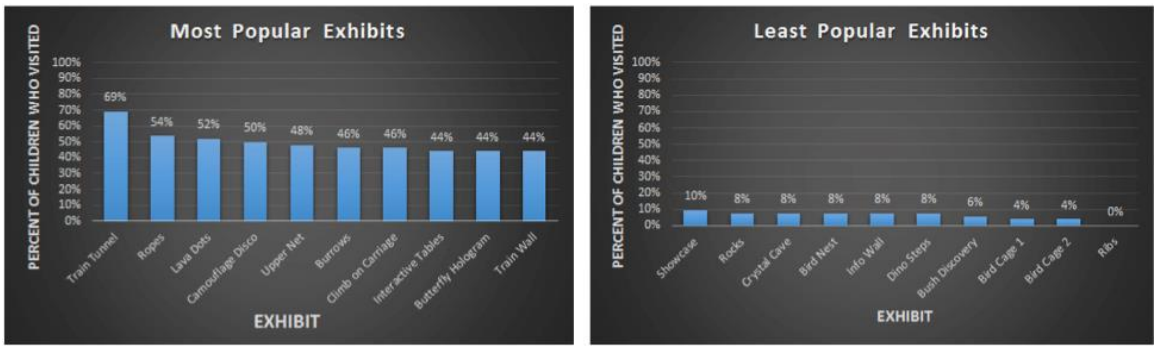

Figure 2: Exhibit Popularity

Results of the holding power analysis can be seen in Figure 3, in which the blue bars represent the difference between an exhibit's holding power and the gallery average holding power. Exhibits with the highest holding powers were story-based exhibits such as the Books and the Tiddalick Story. These exhibits held children's attention for the longest amount of time because children became invested in the stories. The exhibits with lower holding powers were often simple features located in major pathways that children would quickly move through but not spend a significant amount of time interacting with, including the Dino Footsteps, Train Tunnel, and Lava Dots. For such exhibits, a low holding power does not necessarily indicate poor performance; in contrast, it shows that they are being used as intended, as they were designed to be used for short durations.

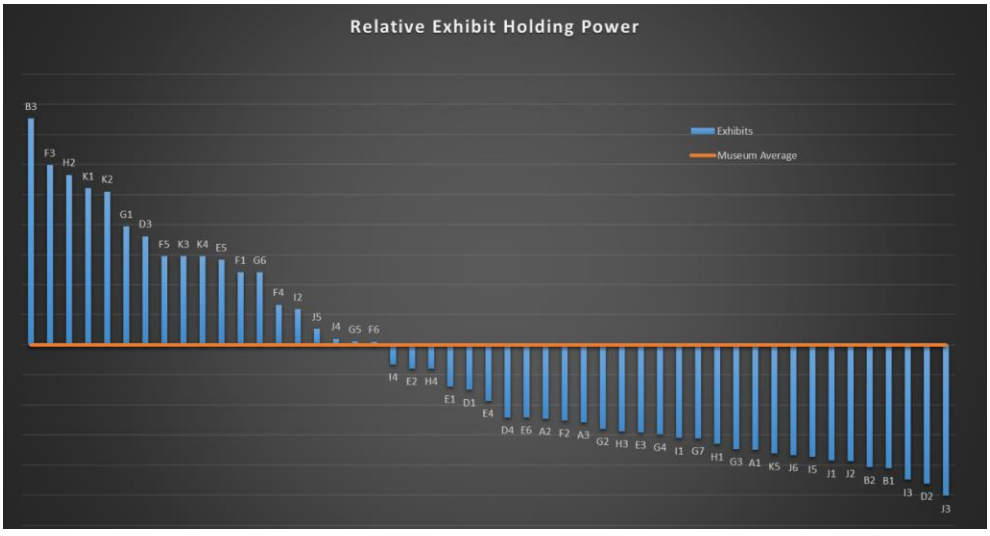

Figure 3: Exhibit Holding Power

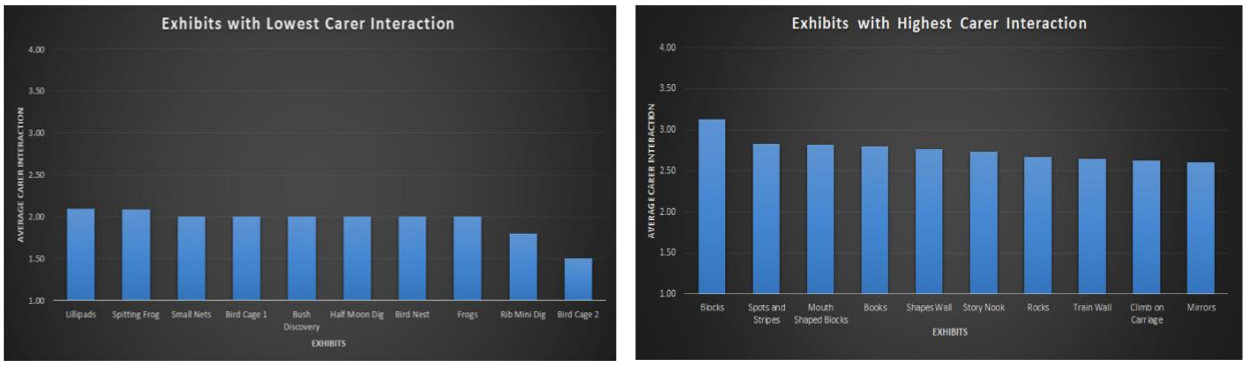

Figure 4: Caregiver Interaction

Results of the caregiver interaction analysis can be seen in Figure 4 below. It was noted that caregiver interaction decreases with age, as babies require more help from their caregivers while older children enjoy playing independently. The exhibits with the highest caregiver interactions contain activities that appeal to both caregivers and children, including exhibits where caregivers can teach or play with their children. The exhibits with the lowest caregiver interactions are either non-interactive exhibits or exhibits containing features that caregivers were less likely to interact with, including water and sand pits.

In-Depth Exhibit Analyses

Figure 5: Upper Climbing Net

To fully analyze all major exhibits within the gallery, the team used the results from the tracking and timing study, interviews, and observational studies to draw comprehensive conclusions. An example of comprehensive conclusions regarding popularity can be seen with the Upper Climbing Net, pictured in Figure 5. The Upper Climbing Net was the fifth most popular exhibit within the gallery, also ranking first in number of repeat visitors and first in number of stops at an exhibit. These rankings show the exhibit's high popularity as well as its ability to draw children back to the exhibit. Visitation data showed that the Upper Net was most popular with children ages 4 and 5, which is confirmed by the age group pathway compilation maps. The exhibit's popularity is further confirmed by interview data, as the most

caregivers mentioned the Upper Net as their child's favorite exhibit, with the majority being caregivers of children ages 4 to 5.

An example of comprehensive conclusions regarding educational value can be seen with the Butterfly Holograms, pictured in Figure 6. The exhibit contains touchscreen drawing pads and virtual holograms that promote sensory learning and encourage social interactions that teach children how to play and share with others. During the observational study, children were observed engaging in educational conversations with their caregivers about how to use the exhibit as well as drawing patterns on the butterflies with focused facial expressions, which are both behaviors that indicate learning. One caregiver mentioned the exhibit during a post-visit interview as an exhibit that stands out as an educational exhibit, further demonstrating its educational value.

Figure 6: Butterfly Holograms

Conclusions

The results of the studies show that the renovation of the Pauline Gandel Children's Gallery has been overwhelmingly successful in engaging the youngest visitors. The pathway and visitation data indicate that the exhibits are meeting their design intentions by attracting the intended ages and creating the intended energy levels within specific areas. In addition, the results of the interviews and observational studies indicate that the gallery possesses educational value. During the interviews, 82% of caregivers stated that the gallery is educational, and also stated that the exhibits promote several different types of learning, including sensory learning, tactile learning, and the learning of motor skills through physical movement. Although the gallery is meeting design expectations, the team noted that the exhibits are also being used in unexpected ways. Children love to find new and inventive ways to use all aspects of the gallery, turning simple design features into climbing structures and play toys. Overall, designers of the gallery were successful in creating an area that stimulates the minds of a uniquely young age range while allowing them to safely play, explore, and learn.

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Authorship

Brenna Blakslee: Responsible for writing the Abstract, Executive Summary, Introduction, Background Sections 1, 2.1, 2.2, 2.3, 4.1, and 4.3, Methods Sections 1, 3, and 4, Findings and Results Sections 1.1, 3.1, 3.2, 4.1, 4.2, 4.3, 4.4, 5.3, 5.5, 5.6, and Conclusions and Recommendations Sections 1.4, 1.5, 1.6, 1.8, and 3. She was also responsible for editing all sections of the paper.

Justin Coppolino: Responsible for writing Background Sections 3.1, 3.2, and 3.3, Methods Sections 2, Findings and Results Sections 2.1, 2.2, 2.3, 2.4, 3.3, 5.1, and 5.8, and Conclusions and Recommendations Sections 1.1, 1.2, 1.3, 1.7, and 3.

Gabrielle France: Responsible for writing Background Sections 2.1 and 4.2, Findings and Results Sections 1.2 and 5.2, and Conclusions and Results Sections 2.1, 2.2, and 3.

Jack Nigro: Responsible for writing Findings and Results Sections 3.4, 5.4, and 5.7, and Conclusions and Recommendations Sections 3.

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1. Introduction

Advancements in the fields of developmental neurobiology and social science have uncovered valuable information regarding early childhood development that has greatly influenced the evolution of children's museums. Research has shown that children benefit from being exposed to interactions that stimulate their brains starting as infants, and that the most impactful experiences for children involve 'learning by doing' through activities that they can relate to aspects of their everyday lives. Such experiences are crucial for young children, as they greatly influence children's social, emotional, cognitive, and physical development (Mustard, 2010). Children's museums have used this research to design exhibits that create valuable learning experiences for children of all ages. The exhibits of children's museums consist of hands-on activities that encourage family interaction, promote learning, and foster creativity by allowing children to play, discover, and explore (Mayfield, 2005).

The Pauline Gandel Children's Gallery is a newly designed children's exhibition located within the Melbourne Museum in Melbourne, Australia. The gallery is a renovated version of the original children's gallery that was built by the Melbourne Museum in 2000. In response to the abundance of new research that emphasizes the importance of stimulating the minds of children at a young age, the museum designed the new children's gallery for a younger age range of infants to five-year-olds. As the museum explains in an advertisement for the gallery, "The exhibition experiences combine hands-on exploration and discovery, open-ended play-based learning, extraordinary immersive environments and unique museum collection objects" (Children's Gallery, n.d.). Within the exhibition, children can dig for fossils in the dinosaur dig exhibit, express themselves through dance in the camouflage disco exhibit, or play and discover in the outdoor botanical garden.

The children's gallery was officially opened to the public in December of 2016. In the limited time since its opening, museum staff conducted a preliminary survey to gain visitor's perspectives of the new gallery, from which they received positive responses. The Melbourne Museum has seen a 20% increase in admissions since the opening of the gallery, indicating that it has been initially successful in attracting visitors. After the gallery had been open for several months, the museum sought to conduct more in-depth studies to gain a deeper understanding of how exhibits within the gallery were being used by visitors and to ensure that the exhibition was

providing visitors with a meaningful and engaging experience. Since the exhibition is intended for a very young age range for which there is little published research concerning learning and engagement in the museum context, the museum was also concerned with confirming that the exhibits were successful in promoting learning in such young children.

To help the Melbourne Museum gain a better understanding of the use and educational value of the Pauline Gandel Children's Gallery, a tracking and timing study, interviews, and observational studies were performed within the exhibition. The data gathered through the studies allowed for the evaluation of the current usage, popularity, holding power, and level of caregiver interaction at each exhibit within the gallery. Results of comprehensive evaluations show that the renovation of the Pauline Gandel Children's Gallery has been overwhelmingly successful in engaging the youngest visitors.

2. Background

Children's museums originated in the early 1900s and have been evolving for the past century, experiencing particular growth within the last thirty years. They offer a unique museum experience by providing a hands-on approach to learning through exhibits that encourage children to play, interact, and explore. Exhibit design is crucial for children's museums to meet their main goals of engaging children of all ages and providing impactful and memorable learning experiences. To ensure that the exhibits are meeting their design expectations and working effectively to promote learning, they are consistently evaluated using a variety of tracking and observational techniques. These techniques provide information regarding the pathways visitors take between exhibits, the length of time they spend at each exhibit, the physical and verbal behaviors they demonstrate while interacting with the exhibits, and their personal opinions and perspectives, allowing for a comprehensive understanding of exhibit effectiveness.

2.1. The Evolution of Children's Museums

At the turn of the 19th century, educators such as John Dewey and Maria Montessori revolutionized childhood education. John Dewey promoted progressive education, which emphasizes learning by doing. He believed that students should be invested in what they are learning, and that the topics should relate to their everyday lives (Cleaver, 1992, p. 6). Maria Montessori believed that adults should provide their students with more independence. She encouraged adults to act more as guides than as teachers, giving students the freedom to explore and learn on their own (Cleaver, 1992, p. 6). In the mid 1900s, Swiss psychologist Jean Piaget further influenced the ideas of childhood development by stating that children best learn by directly experiencing the world and its objects. He emphasized that for children to learn most effectively, they need to question, examine, and analyze these experiences, comparing new situations to familiar situations (Cleaver, 1992, p. 7-8). These theories introduced a new approach to education, which greatly influenced the development of children's museums.

The first children's museum was opened in Brooklyn, New York in 1899. It was described as "a radical departure from traditional models" (as cited in Mayfield, 2005, p. 180), as it contained hands-on, interactive exhibits rather than the view-only displays that were typically

present in adult museums. The basic function and goals of children's museums differ from that of traditional museums, and some even hesitate to classify them as museums at all (Mayfield, 2005). While traditional museums preserve and display collections of objects and specimens with the goal of adding to general knowledge, children's museums provide interactive physical environments where childhood is nurtured and children and families can play and learn together. Children's museums are designed to foster creativity, broaden cultural experiences, and encourage learning about how things function through interaction and play (Mayfield, 2005).

The Pauline Gandel Children's Gallery, opened in December of 2016 at the Melbourne Museum in Australia, is a modern example of a children's museum that demonstrates these general goals and functions. The museum staff at the Melbourne Museum went to great lengths to design exhibits that promote learning through creativity and play, spending two years working with more than 500 children to understand what they would like to see in the museum (Pountney, 2016). The Pauline Gandel Children's Gallery is a renovation of the original Melbourne Museum children's gallery, which was built in 2000 and intended for children between the ages of three and eight years old. As stated by Melbourne Museum education and community programs manager Georgie Meyer, "... so much more is now understood about how learning occurs from birth and how a child's brain develops from birth and the importance of coming to cultural institutions and making them welcoming for babies and toddlers" (Pountney, 2016). In response to this new information, the museum redesigned the children's gallery for a younger age range of infants to five-year-olds. It includes a variety of interactive exhibits with lights, sounds, and climbing objects, which are intended to stimulate creativity and promote learning by play (Pountney, 2016).

2.2. The Design of Children's Museum Exhibits

To meet the overall goal of engaging visitors in educational experiences, children's museums work to develop exhibits that attract and hold the attention of visitors while effectively communicating learning objectives. In an article on child development, Audrey van der Meer, a professor of neurophysiology at Norwegian University of Science and Technology, discusses the importance of stimulating the brains of children from birth onward. She explains that "neurons in the brains of young children quickly increase in number and specialization" and "[can] form up to a thousand new connections per second" when children are stimulated by new learning

experiences (The Norwegian University of Science and Technology, 2017). However, simply pushing a child in a stroller cannot produce such experiences. To be effective, the experience must be self-produced by the child through interaction. When properly designed, museum exhibits are excellent ways to produce stimulating experiences and promote learning in young children.

2.2.1. Importance of Developmental Stages

To design an effective exhibit, it is crucial for developers to realize that children process information differently than adults and have unique ways of making sense of new information. Children progress through developmental stages as they grow, and are constantly changing in the ways they solve problems and view the world. According to Table 1 shown below, published by the Child Development Institute in 2011, children experience ten stages of development from birth to age five in which their physical, emotional, and social capabilities evolve (Child Development Institute, 2011).

As shown in Table 1, the motor functions, communication, and social skills of children drastically change in their first five years of life. The variation in capabilities and learning processes within this age range makes museum design a complex, yet critical, process, as a design that stimulates and engages a five year old might contain concepts or activities that are too advanced to stimulate and engage a one year old. Although children may demonstrate behaviors and characteristics from more than one developmental stage at a given time, they develop at fairly predictable intervals, which allows for their social and mental capabilities to be generalized for specific age ranges (Ringel, 2005). By researching the developmental ranges of the target audience, museum developers are able to portray the main messages of an exhibit in ways that specifically meet the needs of each age group.

Age	Physical and Language Abilities	Social Behaviors
Birth to 1 Month	• Sensory Capacities: makes basic distinctions in vision, hearing, smelling, tasting, touch, temperature, and perception of pain	• Helpless • Asocial • Fed by mother
2 to 3 Months	• Sensory Capacities: color perception, visual exploration, oral exploration • Sounds: cries, coos, grunts • Motor Ability: control of eye muscles, lifts head	• Visually fixates at a face • Smiles at a face • May be soothed by rocking
4 to 6 Months	• Sensory Capacities: localizes sounds • Sounds: babbling, makes most vowels and about half of the consonants • Motor Ability: control of head and arm movements, purposive grasping, rolls over	• Recognizes his mother. • Distinguishes between familiar people and strangers, no longer smiles without purpose • Expects feeding, dressing, and bathing
7 to 9 Months	• Motor Ability: control of trunk and hands, sits without support, crawls about	• Protests separation from mother. • Enjoys "peek-a-boo" • Specific emotional attachment to mother
10 to 12 Months	• Motor Ability: control of legs and feet, stands, creeps, apposition of thumb and forefinger • Language: says one or two words, imitates sounds, responds to simple commands	• Waves goodbye • Plays pat-a-cake • Gives and takes objects • Curiosity, exploration
1 to 1 ½ Years	• Motor Ability: creeps up stairs, walks (10-20 min), makes lines on paper with crayon • Dependent behavior	• Obeys limited commands • Repeats a few words • Interested in his mirror image • Feeds himself • Very upset when separated from mother
1 ½ to 2 Years	• Motor Ability: runs, kicks a ball, builds cube towers • Capable of bowel and bladder control • Language: vocabulary of more than 200 words	• Resentment of new baby • Does opposite of what he is told • Temper tantrums
2 to 3 Years	• Motor Ability: jumps off a step, rides a tricycle, uses crayons, builds a 9-10 cube tower • Language: starts to use short sentences, controls and explores world with language, stuttering may appear briefly	• Copies caregivers' actions • Clinging, possessive about toys • Enjoys playing alongside another child • Resists parental demands and gives orders • Inability to make decisions • Differentiates facial expressions of anger, sorrow, and joy
3 to 4 Years	• Motor Ability: Stands on one leg, jumps up and down, draws a circle and a cross (4 yrs) • Self-sufficient in many routines of home life	• Cooperative play with other children • Imitates caregivers • Intense curiosity • Imaginary friends
4 to 5 Years	• Motor ability: mature motor control, skips, broad jumps, dresses himself • Language: speaks clearly, has mastered basic grammar, relates a story, knows over 2,000 words	• Prefers to play with other children • Becomes competitive • Prefers sex-appropriate activities • Feels pride in accomplishment

Table 1: Developmental Stages of Children Ages 0-5 (Child Development Institute, 2011)

Gail Ringel, vice president of exhibits and production at Boston Children's Museum, provided an example of utilizing developmental stages in museum design in her presentation at the J. Paul Getty Museum Symposium, where she discussed the design of the *Five Friends from Japan* exhibit. The intended goal of the exhibit was to expand the understanding of Japan and the Japanese culture. To meet this goal, developers researched children's ability to understand cultural differences and identities at different ages, keeping in mind that 10% of museum visitors were under the age of 1, 28% were between the ages of 2 and 5, 15% were between the ages of 6 and 15, and the remaining 47% were adults (Ringel, 2005). Museum staff convened an internal study group and gathered information from a variety of sources about children's understanding of cultural differences and identity, ultimately finding that children between the ages 4 and 6 are just beginning to develop their own cultural identity and gain an interest in how and why people act in specific ways. Ringel also explained that children can be categorized into three periods according to their ability to comprehend abstract ideas: the pre-operational period, which includes children ages 2 to 7 who are unable to grasp abstract ideas, the concrete operational period, which includes children ages 7 to 11 who are more rational and objective but only with concepts that they can physically see, and the formal operational period, which includes children ages 11 to 15 who are able to conceptualize more abstract ideas (Ringel, 2005). The developers used both their research on children's ability to understand cultural differences and the conceptual capabilities of the operational periods to guide their design and help them present specific messages of the exhibit in ways that their target audience would be able to process and comprehend. This process led them to the successful design of a variety of interactive, hands-on opportunities within the exhibit that allowed for children of all ages to learn about the Japanese culture (Ringel, 2005).

2.2.2. Cultural and Societal Impacts

In addition to developmental models, the cultural and societal context in which children are currently living is another important consideration in exhibit design. To understand the interests of children at different ages and to see the world from their point of view, museum developers conduct observational studies and interviews. The information provided by observational studies and interviews allows developers to see how children view their social relationships with their family, friends, and teachers and determine what motivates children to

learn, helping them design exhibits that explain concepts in forms that are easily relatable to the children's everyday lives (Ringel, 2005). A recent study showed that exhibits which present information in a socio-cultural context familiar to children, such as through storytelling or physical play, are more impactful and memorable for children, as the children are able to connect the exhibits to familiar activities (Anderson, Piscitelli, Weier, Everett, & Tayler, 2002). An example provided in the study involved a group of children between the ages of 4 and 6 who were brought to an art gallery to observe various works of art. While viewing the art, a guide conducted an open-ended discussion during which the children were encouraged to look closely at the work, contribute their opinions, and develop a story about the contents of the artwork. When the children were later interviewed about the artwork, they were able to readily recall and discuss the different aspects of the work. Providing the information in the form of a story helps children process and remember the information, as hearing stories read from books or told by caregivers is a familiar and enjoyable part of a child's life (Anderson, Piscitelli, Weier, Everett, & Tayler, 2002).

2.2.3. The Role of Adults and Caregivers

Museum developers also need to take into account the role of parents and caregivers when designing children's museum exhibits. At the Boston Children's Museum, it was found that 47% of their 420,000 yearly visitors are adults, making it important to consider family learning and adult engagement (Ringel, 2005). Adults have a significant impact on the child's museum experience, as they play a large role in determining the course of the day, and it has been found that parental involvement is essential to successful early childhood education (as cited in Hobbs, 2015). Studies have shown that conversations between caregivers and children at interactive exhibits, specifically involving open-ended questions, improve the quality of the child's engagement and learning by encouraging them to question and analyze the learning topics (Haden, Jant, Hoffman, Marcus, Geddes, & Gaskins, 2014). However, in accordance with the educational theories of Maria Montessori, it is also important for adults to allow children to explore and learn on their own (Ringel, 2005). Therefore, exhibit developers must design exhibits in a way that creates a balance between adult interaction and child independence.

The Pauline Gandel Children's Gallery demonstrates the importance of caregiver-child interaction, as it was specifically designed to promote the concept that caregivers are a child's

first teacher. As previously discussed, the growth of children from birth to age five is crucial to their development. Current research in the area of attachment theory has revealed that the attachment bond between a caregiver and infant is a key factor in the development of the infant's social, emotional, physical, and mental well-being, as it promotes growth in the parts of the brain responsible for interaction, communication, and relationships. It has been found that a strong and secure attachment bond between a caregiver and infant can lead to positive self-esteem, lasting relationships, compassion, and resiliency later in the infant's life (The Urban Child Institute, 2011). Young children best learn through everyday experiences with the people they love and trust, which is why the Melbourne Museum has worked to incorporate caregiver interaction throughout the children's gallery. The gallery is designed to encourage caregivers to play, discover, and learn with their child through interactive exhibits in which the caregivers can participate and teach their children. By encouraging caregiver interaction, the gallery is promoting the development of a secure attachment bond and, in turn, the learning and early development of the child.

2.3. Strategies for Assessing Exhibitions

Museums play an important role in the public's advancement of knowledge and growth, making it critical to consistently assess the value of museum exhibits and galleries. Museum developers design each exhibit with an intended goal for visitors to achieve. Extensive research is performed before the exhibit is constructed to help ensure that the exhibit performs as intended. However, it is not until after the exhibit is completed and being used by the public that an assessment can be performed to evaluate the exhibit. To determine the effectiveness of exhibits, researchers combine different methods of data collection to gather information that evaluates all aspects of an exhibit. Traditionally, researchers use methods that gather information regarding the pathways visitors take through the museum and the interactions visitors have with each exhibit, allowing for an overall analysis of exhibit and gallery performance. The leading method of gathering data, which involves following visitors through the exhibition and closely observing their behavior, introduces many ethical concerns. Researchers often choose to ask for consent before beginning a tracking study in order to eliminate legal and ethical issues, using a variety of different methods to gain visitor consent while keeping the reliability of the data intact.

2.3.1. Tracking and Timing

A tracking study is defined as "following and recording visitor behavior in an area larger than a single exhibit component, usually an exhibition" (Yalowitz & Bronnenkant, 2009). Tracking studies allow museum staff to acquire rough data to determine the effectiveness of their exhibits. There is no direct method to measure "effectiveness," as many factors contribute to an exhibit's effect and it cannot be gauged by a single metric. By collecting different types of data, the museum staff is able to make inferences about how well their museum is performing. Qualitative data can be combined with quantitative data in order to form conclusions based on visitor interactions (Moussouri & Roussos, 2013). Qualitative data refers to observations of visitor behavior and interaction with the exhibits and data collected from interviews and surveys. Quantitative data is numeric and measurable data including visitor pathways, time spent at each exhibit, and number of exhibits visited that is commonly analyzed with computer software programs. Analysis and comparison of both quantitative and qualitative data allows museums to determine factors such as the most and least popular exhibits and make conclusions about the effectiveness of their exhibits.

The information recorded during a tracking study depends on the goals of the study and the intended use of the data collected. In general, tracking studies are used to determine the effectiveness of an exhibit. For this purpose, a tracking and timing study combined with interviewing or surveying will collect the most useful data. Yalowitz and Bronnenkant (2009) break down the data collected from a successful tracking and timing study into four main groups:

1. Stopping Behaviors—This group of variables is used to describe where people went, where they stopped, and how they spent their time:

- Total time in area
- Total number of stops
- Proportion of visitors who stop at a specific element
- A level of engagement scale for specific elements (i.e., high, medium, low)
- Time (min:sec) of a stop at a specific element
- "Down time" or non-exhibit related behaviors, such as talking on a cell phone or discussing something not related to the exhibition

2. Other Behaviors—These often describe what people did above and beyond the stops, and include the following:

- Visitor path (the route a visitor takes through the space)
- Social interactions with others in the group
- Social interactions with visitors of other groups
- Social interactions with docents or volunteers
- Using hands-on/interactive elements
- Watching videos

3. Observable Demographic Variables— (It is assumed that there will be a margin of error)

- Estimated age
- Number of adults and children in party
- Gender

4. Situational Variables—These include any situational variables that may affect visitor behavior:

- Levels of crowding
- Month or season
- Day of week
- Time of day
- Special events or programs going on at the museum
- Special events or programs occurring in the exhibition
- Presence of staff, carts, or other related experiences

A detailed tracking and timing study that follows this format for data collection will provide clear results regarding the effectiveness of museum exhibits. Combining the data collected while recording "stopping behaviors" with observations of "other behaviors" from the list above allows for the analysis of physical trends in the flow of visitors. Observable demographic variables and situational variables allow museum staff to make inferences about certain patterns in the behaviors of visitors. For example, the museum can determine which exhibits are most popular to a certain gender, or if certain age groups prefer a certain exhibition (Yalowitz & Bronnenkant, 2009).

2.3.2. Interviews with Children

A key element to a successful tracking study is a follow-up interview or questionnaire, which provides museums with information that they are unable to obtain purely through the timing, tracking, and observation of visitors. Although observations of children's behaviors provide insight into how much they are learning at exhibits, many researchers find that "there is a great deal of difficulty in making any detailed analysis of how deeply children learned" through observations alone (Piscitelli & Anderson 2001). Interviews provide an alternative method of data collection that focuses on first-hand accounts of experiences and lessons learned. Asking visitors specific questions after they experience an exhibit for the first time allows the researcher to understand what knowledge the visitors have gained. For example, after visitors left the Places of Invention Gallery within the National Museum of American History at the Smithsonian Institution in Washington DC, researchers asked, "What are key skills of an inventor?" The responses to this simple question demonstrated what visitors were taking away from the exhibition and how much attention was being paid to each exhibit, as there was a sign posted at each exhibit that described important skills of inventors and entrepreneurs. Researchers calculated the percentage of visitors that remembered the specific "skills" presented at each exhibit to help them determine which exhibits were the most memorable and effective in spreading knowledge, displaying the value of interviewing visitors to acquire data (Krantz, 2015). The data collected from interviews and surveys enables museum staff to directly measure the overall effectiveness of an exhibition using first-hand opinions and perceptions from visitors.

Children's museums present a unique challenge when attempting to conduct post-visit surveys and interviews, as the intended audience of the exhibits are primarily young children in early developmental stages. Children of this age often have a difficult time verbalizing their thoughts and ideas, with some even being too young to speak, making conducting formal interviews as would be done with adults nearly impossible (Clark 2004). To overcome this obstacle, methods of non-verbal communication can be applied to extract information from children. Although non-verbal interview methods are not as direct or specific as asking questions in a formal interview, they are effective in providing information regarding exhibit popularity and value.

Two common methods of conducting non-verbal interviews include asking children to draw their favorite experience from the museum and having children physically point out their

favorite exhibit from a set of pictures. In the first method, the children's drawings are compiled to determine which exhibits are most preferred by children by how many children chose each exhibit as their favorite. The drawings also provide insight into the child's thought processes, as "accompanying stories about their pictures revealed their feelings, interests and knowledge about their prior encounters with museums" (Piscitelli & Anderson 2001). The second method provides similar information regarding the popularity of each exhibit, but in a more time- and resource-friendly manner. A survey that involves a child pointing at a poster only takes a few seconds, whereas it may take several minutes for a child to draw a picture. If the children are old enough to speak and develop their own ideas, follow-up questions can be used to determine the specific aspects of each exhibit that the children enjoyed most. This information provides insight into what the children learned at the exhibit based on the reasons they enjoyed it.

An additional solution that addresses the issue of interviewing young children is to interview the parents or caregivers accompanying the children. In 2004, Mallary Swartz and Kevin Crowley conducted a study on the role of parents in the learning of children at museums, where the primary methods of gathering data were through visitor observations and interviews. After the parents and child had experienced all exhibits, the researchers asked the parents a set of specific questions involving "which (exhibits) were their favorites, what they did at each exhibit, what they talked about at the exhibit, whether they were trying to teach anything at the exhibit, whether they thought their child learned anything at the exhibit, and what a teacher or a scientist might think a child could learn from this exhibit" (Swartz & Crowley, 2004). The responses to these questions were recorded and analyzed for trends. An important piece of analysis in this study was the comparison of the information parents believed their children had learned at an exhibit to the intended learning goals of the exhibit, which allowed for an easy determination of exhibit performance and learning potential.

2.3.3. Consent and Ethical Issues

A major concern while planning or conducting a tracking study is the issue of consent and the ethics and legality of a non-consensual survey. In order to limit these issues, many researchers only choose to track visitors that look to be 18 years of age or older. However, this solution is not applicable when young children are the intended targets of a study. For a tracking study of a children's museum, it is important to only study children who are accompanied by a

parent or guardian. To prevent any ethical or legal issues, it is recommended that the researcher gain consent from the accompanying adult before conducting a study on a child (Yalowitz & Bronnenkant, 2009). According to Regan Forrest (2014), an Australian expert on museum visitor tracking, studies in which visitors have given consent to be involved are completely legal and harmless. Non-consensual visitor tracking studies fall under a legal grey area, and are typically avoided (Forrest, 2014). However, many researchers feel morally obligated to inform visitors that they are potential candidates for a tracking survey and may be monitored throughout their stay. There are two contrasting methods of informing visitors of an ongoing study that are widely used. Some researchers prefer a personal approach of telling individual groups they have been selected for a study and asking for their consent. Others prefer a more general approach of posting a sign on the door stating that all visitors may be selected at random for a tracking survey. Signs typically have information on how a visitor may opt out of the survey if they do not consent to be followed throughout the exhibits (Yalowitz & Bronnenkant, 2009). The general approach of posting a sign is typically preferred due to ease as well as ensuring accurate data.

A study in which the visitor is aware they are being observed is referred to as an active study. The data collected from this type of study can be compromised and possibly skewed due to the fact the visitors are aware, which may cause visitors to alter their behavior unknowingly. A study in which the target population is unaware is referred to as a passive study. The data collected from this type of study is more accurate in that the visitors do not know they are being observed and will act as they normally would (Bickersteth & Ainsley, 2011). The only way for this type of study to be compromised is if the researcher conducting the study is caught in the act by the visitor. It is important to take extreme caution while following a group in order to keep the integrity of the study intact. Keeping a maximum distance from the observed group will minimize the risk of being spotted. If the desired outcome of the study is data on tracking and timing only, then observers can stay far from the group. However, in order to record data on behavioral factors, the observer must follow the group at a shorter distance (Yalowitz & Bronnenkant, 2009).

2.4. Evaluating Visitor Engagement Through Behavioral Indicators

Traditionally, museums have evaluated exhibits using methods that track the pathways of visitors and the time spent at each exhibit, as well as by conducting pre-visit and post-visit

interviews to gauge the visitor's understanding of the exhibits. However, these methods alone do not provide a full understanding of the engagement or enjoyment the visitor experiences, as they do not capture the behavioral and social aspects that contribute to a well-rounded evaluation. In addition, when evaluating the experience of families and young children, interviews often do not properly portray the amount of knowledge that was gained from an exhibit, as children may not be able to sufficiently verbalize their museum experience (Sanford, 2010). When experiencing an exhibit, children often subconsciously express their levels of engagement and enjoyment through a series of behavioral indicators, which can be analyzed to gain a better understanding of visitor learning and the value of the exhibit. According to a study conducted by Baruch and colleagues (2016), these indicators can be placed into three categories: verbal responses, facial expressions, and body movements (Baruch, Mashal, & Spektor-Levy, 2016).

2.4.1. Verbal Responses

As visitors interact with an exhibit, they often demonstrate their emotions, judgments, and learning through their verbal commentary, exclamations, and communication. The interest and enjoyment of a visitor at an exhibit can be characterized by their volume, frequency, and rate of speech (Baruch, Mashal, & Spektor-Levy, 2016). A visitor who is enjoying their experience and is excited about the exhibit will typically speak more frequently at a louder volume and faster rate than a visitor who is not engaged or is disinterested in the exhibit. The vocal sounds of children can be used to evaluate their reaction to an exhibit at as early as two months old, as it is around this age that children begin to cry, coo, and grunt to express their emotions (Child Development Institute, 2011). The content of visitor commentary also provides significant insight into their learning and engagement, and can be evaluated for children starting at around one to two years old, at which time most children have developed a vocabulary of more than 200 words (Child Development Institute, 2011). For example, positive exclamatory remarks show interest and engagement, while negative remarks show that a visitor is unengaged by the exhibit. In addition, it has been found that children between the ages of one and two years old begin to spontaneously generate metaphors and similes when presented with a new situation or learning experience in an effort to relate the new experience to a familiar experience. These comparative phrases demonstrate their quality of understanding of the exhibit and their emotions towards the new experience (Baruch, Mashal, & Spektor-Levy, 2016).

Another important aspect of the verbal responses of visitors is their conversations with others, as conversation is one of the main mechanisms through which learning takes place. Effective learning conversations contain talk that can be broken down into four categories: list, analyze, synthesize, and explain (Sanford, 2010). List is the lowest type of learning talk out of the four, and involves verbally listing or identifying the major features of the exhibit. The next three types of learning talk are considered to be indicators of higher-level interpretation of the exhibit, and involve figuring out how the exhibit features work, combining the ideas presented by the exhibit with outside ideas, and using outside experiences to explain and help understand the features of the exhibit. It has been found that more frequent engagement of a family or group in the three higher-level types of learning talk show a deeper engagement and understanding of the exhibit (Sanford, 2010). This was confirmed by a recent study that tested the effect of family conversation on children's learning at an interactive exhibit at the Chicago Children's Museum. During the study, selected parents were provided with information about the exhibit prior to visiting in an effort to encourage the parents to ask their children more open-ended questions, such as *Who, What, Where, Why,* and *How,* to stimulate child engagement and encourage children to think critically about the exhibit topics. The results of the study showed that providing caregivers with information was effective in promoting more in-depth conversations, which in turn led to an increase in learning and retention for the children (Haden, Jant, Hoffman, Marcus, Geddes, & Gaskins, 2014).

2.4.2 Facial Expressions

Facial expressions are used to convey one's emotions or thoughts on a particular situation or experience. A large variety of emotions, including joy, surprise, sadness, anger, disgust, and fear, can be interpreted from a seemingly infinite number of facial expressions. These expressions can be as discreet as the squinting of eyes or the movement of the mouth (Calistra, 2015). Heather Jennings, Professor of Psychology at Merer County Community College, notes that raised eyebrows, rounded mouths, and pursed lips are some of the key indicators of interest in small children (Jennings, 2009). These facial movements are just a small sample of the expressions that children demonstrate when interacting with a museum exhibit.

When children are first born, they use facial expressions to convey their "physiological states" such as hunger or pain to their caregiver, as they are not yet able to verbally communicate

(Jennings, 2009). At six to nine weeks old, children begin to use facial expressions to express their emotions towards objects and people. Evaluating facial expressions as behavioral indicators starts to become important at this stage, as children are learning how to accurately pair emotion with facial movements. Once children are four months old, they begin to associate their facial expressions with their physical and tactile experiences (Jennings, 2009).

As children continue to grow, they develop better control over their facial expressions and are able to display their emotions more accurately (Andrews, 2010). It is not until adolescence that individuals are able to fully control their facial features to hide their emotions, meaning that the facial expressions of young children display their genuine thoughts and emotions. Due to this fact, facial expressions of young children can be used as a reliable source of information that provides insight to the reactions and emotions a child feels towards an exhibit.

2.4.3. Body Movements

Visitors, especially children, tend to express their interest and engagement in a museum experience through sensorimotor responses such as looking, touching, approaching, and smelling (Baruch, Mashal, & Spektor-Levy, 2016). The actions of visitors can demonstrate both positive responses, which consist of frequent body movements and actions consistent with the intended exhibit activity, and negative responses, which consist of little body movements and an unwillingness to perform the intended actions. Engagement is commonly thought of as being closely related to how the designer planned for the exhibit to operate, and can be evaluated by how close the visitor gets to accomplishing the intended goal (Sanford, 2010). A recent study used body movements and physical actions to evaluate exhibit engagement by developing a scale specific to each exhibit activity that measured the extent to which the family completed the intended goal: completing the activity as intended resulted in a higher engagement score, while not interacting with the exhibit or not performing the activity as it was intended resulted in a lower engagement score (Sanford, 2010).

3. Methods

The goal of this project was to help the Melbourne Museum gain a better understanding of the use and educational value of the Pauline Gandel Children's Gallery by conducting a tracking and timing study, interviewing visitors about their experience, and observing and recording visitor behaviors. Throughout the studies, particular attention was paid to observing the behaviors of children between the ages of 0 and 5 at the exhibits. Repeatable methods were developed to assess the engagement and learning outcomes of this very young age group. The data gained from the studies and interviews was analyzed through the production of pathway overlays, graphs, and tables to identify the most enjoyable and engaging exhibits and determine whether or not the exhibits were meeting their intended goals. The following is a list of objectives created to assist in the completion of the project.

1. Achieve a full understanding of the goals of the exhibits in order to test and finalize the procedures and tools required to gather the desired data
2. Conduct a tracking and timing study to evaluate exhibit use, popularity, and holding power
3. Conduct interviews to evaluate learning outcomes and visitor engagement
4. Conduct observational studies in selected areas by observing and recording behaviors for specific age groups to identify commonly observed behaviors and evaluate educational value

3.1. Objective 1: Research Preparation

Upon arrival in Melbourne, the team's first task was to gain a full understanding of the environment of the Pauline Gandel Children's Gallery. While extensive background research provided the team with valuable facts and statistics about the gallery, first-hand experiences were required to gain a full understanding of the overall atmosphere and mood of the exhibition. During the first two weeks of project work, the team took guided tours of the gallery, observed visitor behavior and interactions, personally interacted with the exhibits, and met with exhibit designers and gallery staff. The team used the gathered information to reexamine and finalize the research plan, ensuring that it would result in an efficient and meaningful evaluation of the gallery.

To begin research preparation, Rebecca Hart, Education Placement Officer in Public Engagement at Museums Victoria, led the team on a guided tour through the gallery. The tour allowed the team to become familiar with the gallery exhibits and visually observe the gallery pathways and layout. The team also conducted two unguided walkthroughs of the gallery: one during gallery hours to allow the team to continue visitor observations, and one before gallery hours to allow the team to personally interact with the gallery exhibits. After the guided tour and walkthroughs, the team was able to begin simplifying the complex floor plan of the gallery shown in Figure 7 by separating the gallery into specific areas and exhibits. The team determined that in order to collect detailed data on trends in visitor stopping behaviors, the gallery needed to be separated into more timing areas than originally anticipated. In the first draft of the simplified map shown in Figure 8, the gallery was broken down into 13 different areas, each of which contained individual exhibits. The simplified map was created using Microsoft Paint and was developed to allow for clear, accurate results during the tracking and timing study. The first draft of the simplified map was continuously altered throughout the research preparation process as new information was gathered. Each area is outlined with a different color and identified by a letter, and the area letter and a number identify each individual exhibit within the area.

Figure 7: Original Gallery Floorplan

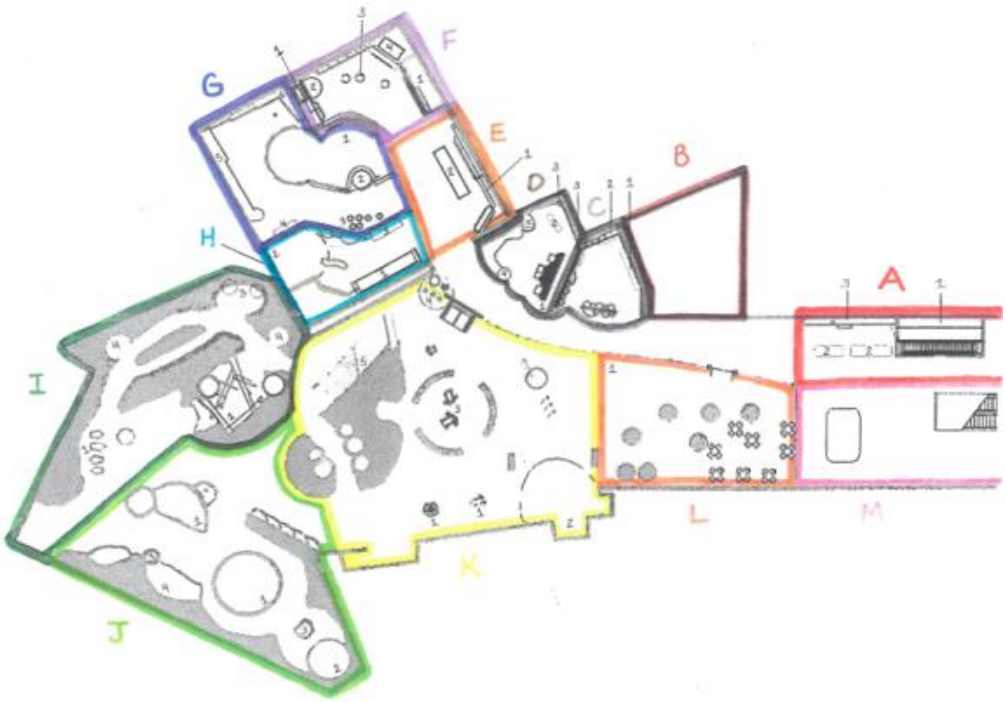

Figure 8: First Draft of Simplified Gallery Map

The team also used the guided tour and self-guided walkthroughs to observe how children and caregivers were interacting with exhibits and experience the culture of museumgoers in Melbourne. This allowed the team to determine trends in visitor behaviors that helped increase the efficiency of the tracking and observational studies, as well as provide insight into how visitors would react to being the subjects of the conducted studies. It was noted that the gallery has both high-energy and low-energy interactive areas to accommodate all children within the intended age range. For example, the Big Box area within the gallery, consisting of areas E, F, G, and H in Figure 8, contains both the low-energy lullaby nook and the high-energy climbing net structure, allowing for children of all ages and moods to comfortably participate within the same room. The team also noted the friendly and welcoming nature of the museumgoers, which suggested that most visitors would be willing to participate in the studies and interviews.

To gain information regarding of the intended uses of the exhibits and aid in the development of study procedures, the team met with members of the gallery staff. Meetings were held with the team's advisor Carolyn Meehan, Manager of Audience Insights at Melbourne Museum, Alexandra Price, Senior Program Officer at Museum Victoria, Kate Phillips, Science

Curator at Museum Victoria, and Pete Wilson, Senior Exhibit Designer at Museum Victoria. The team's first meeting was held with Carolyn Meehan, Alexandra Price, and Kate Phillips and addressed the initial procedures of the studies. Carolyn Meehan provided the team with information and procedures from past studies, as well as ideas for caregiver interaction rating scales and research instruments that were used in the tracking and timing study and interviews.

A follow-up meeting was held with Alexandra Price, who was involved with the educational aspect of exhibit design within the gallery. Alexandra led the team through the gallery, explaining the intended uses and learning goals of spaces and exhibits within the gallery and specifying which spaces she and her fellow designers were most interested in for the observational study. An additional meeting was held with Alexandra Price and Pete Wilson to gather more in-depth information regarding the learning goals and intended uses of the spaces that were evaluated in the observational study. Pete Wilson led the team on another guided tour through the gallery, where he explained the intentions of specific aspects of the gallery and shortcuts that children can take between exhibits. He displayed a strong interest in the tracking and timing study, as he was most interested in children's pathways through the high-energy indoor areas of the gallery.

Another important step in the research preparation phase was trialing the tracking and timing methods. The first trial consisted purely of tracking, during which all team members used the first draft of the simplified map to track the pathway of a 2-year-old boy for 30 minutes. All four team members tracked the same child in order to begin standardizing tracking styles. The second trial consisted of both tracking and timing, during which each team member chose a different child to track and time for 30 minutes. Similarly, the third and fourth trials consisted of both tracking and timing a child for a 30-minute period. To conduct these trials, two team members chose the same child to track and time in order to continue standardizing the tracking styles of the team members.

During the trials, important information was gathered that allowed the team to finalize the simplified map. Through the trials, the team identified commonly used activities within areas of the gallery that had been initially overlooked during walkthroughs and guided tours. To improve the accuracy of the tracking data, these activities were redefined as individual exhibits on the simplified map. The team also identified shortcuts within the Big Box area that children could use to move around the room. As the team tracked children within the Big Box area, it was noted

that the shortcuts allowed children to move quickly and easily between the four defined areas, and that it would be difficult to record every time a child entered and exited a separate area within the room. The team determined that breaking the room into three areas instead of four would simplify the tracking and timing data and help to more accurately track children within the Big Box. The final draft of the simplified map used in the study can be seen as Item 1 in Appendix A.

As the trials continued, the team also found ways to improve the timing sheet. After the first track, it was noted that more space was needed to record all of the locations and times of children throughout their visits. To add additional tables for recording location and timing data, the orientation of the timing sheet was changed from portrait to landscape. Additional trials also showed that weather greatly influenced the pathways of children, as the gallery contains a large outdoor area for children to explore. To account for weather, a "weather" section was added to the top of the timing sheet where the team members identified whether it was sunny, cloudy, or rainy during the track. The final version of the timing sheet used in study can be seen as Item 3 in Appendix A.

The trials also provided the team with valuable information involving how to most effectively carry and organize the timing sheet, simplified map, interview sheet, and stopwatch used during the study. During each trial, the team tested different setups that involved clipping the required research tools to a clipboard. It was determined that the most effective setup to was to clip multiple timing sheets, in case more than one sheet was required for a track, as well as an interview sheet under the main clip of the clipboard. The timing sheets were clipped on top of the interview sheet, as the interview was conducted after the track was complete. The stopwatch was also placed under the main clip of the clipboard next to the timing sheet, which allowed the team members to easily observe and record exact times on the timing sheet. To allow the team members to simultaneously track the pathways of the children, the simplified map was clipped to the back of the clipboard using binder clips in the reverse orientation of the timing sheet. This enabled the team members to easily flip back and forth from the timing sheet to the map, allowing for accurate and efficient recording of both tracking and timing data.

Through the trials, it was determined that each team member would need to memorize the separate areas and exhibits defined on the simplified map in order to accurately and efficiently track and time the children. To aid in the memorization process, the team created a set of virtual

flashcards using Quizlet, an online learning website that presents the flashcards in the form of games and tests. It was also determined that data collection would begin with babies and progress to 5-year-olds, giving the team members more time to practice the study procedures before tracking the older children, who were often more energetic and difficult to accurately track.

To finalize the methods for the tracking and timing study, the team tested the desired method for compiling the tracking data, which consisted of using Adobe Photoshop to overlay the recorded pathways and display them on one map. The team used the results of the four tracking trials to test this method by scanning and uploading the recorded pathways into the Photoshop program. After researching and testing different Photoshop techniques, it was determined that the most effective technique involved aligning each map on top of each other and making the white background of each map transparent. Using this technique, the four maps were successfully combined into a single map, shown below in Figure 9, that displays the pathways recorded in each trial. During each trial, the team members used different colored pens to draw the pathways on the simplified map, which allowed the team to compare the clarity of each pen after it is scanned into Photoshop. The resulting map showed that red ballpoint pen stands out clearly after being scanned into Photoshop while black pen fades and is not as noticeable, leading to the conclusion that red ballpoint pen should be used in the tracking study.

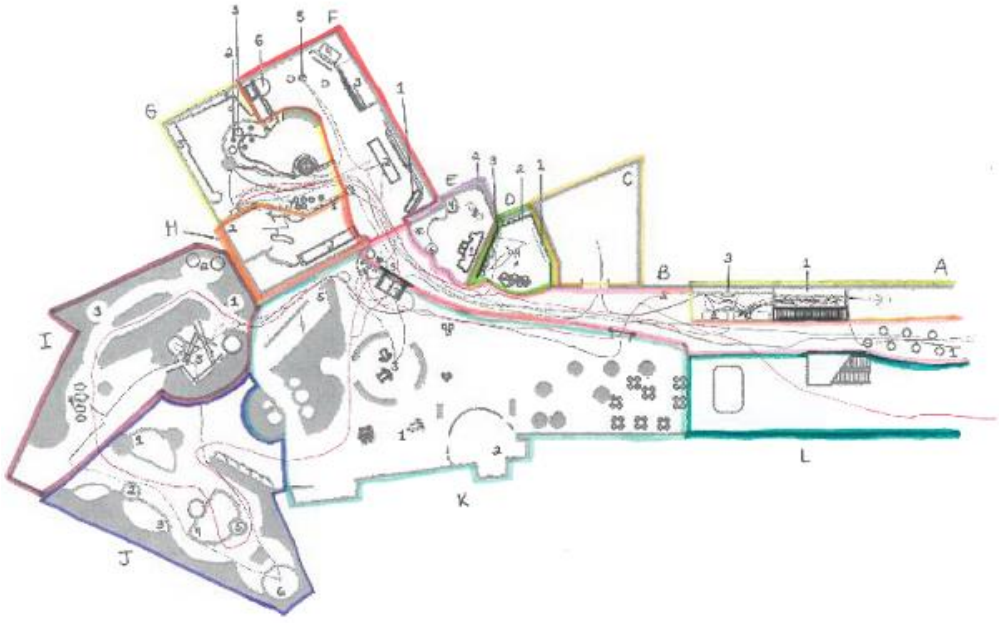

Figure 9: Track Map Overlay Using Photoshop

To conclude the research preparation phase, the team prepared the research instruments that were used in the observational study. From meetings with Alexandra Price and Pete Wilson, it was determined that the study would be conducted on the following areas: the Lullaby Nook Area, the Camouflage Disco, the Shapes Wall, the Upper Climbing Net, the Lower Net Area, the Butterfly Holograms, the Burrows, and the Light Torch. These areas were chosen because of their unique designs and potential to promote learning in children. Both designers played a large role in the development of the areas and were interested in whether or not they were being used as intended and providing beneficial learning experiences.

Alexandra Price and Pete Wilson provided the team with valuable information for the chosen areas of interest regarding each area's expected behaviors and intended uses. Alexandra supplied the team with tables of specific behaviors, shown as Items 4, 5, and 6 in Appendix B, that were expected to be observed within the lullaby nook, the climbing net area, and the camouflage disco. She also provided the team with informal observational notes that she had taken in January of 2017 on the camouflage disco, the butterfly holograms, the Burrows, the climbing net structure, and the lullaby nook. During the team's guided tour, Pete Wilson identified various intended uses of objects and structural features that revealed additional expected behaviors for the areas. In addition to the information gained from Alexandra and Pete, the team personally observed the behaviors of children within each area and compiled lists of behaviors that were commonly observed in each area.

The information provided by Alexandra Price and Pete Wilson and the lists compiled from the team's observations were then combined with a generalized list of observational behaviors, shown as Item 7 in Appendix B, that had been used in previous observational studies at the Melbourne Museum to develop checklists of behaviors for each area that were used in the study. The checklists were used for all ages at each area, and were intended to contain all possible behaviors that could be observed while a child is interacting with the area. The checklists contain general behaviors that could occur in any area as well as unique behaviors that are specific to each area in order to accurately capture how the areas are being used. The checklists were tested by the team members and modifications were made to ensure that the lists were comprehensive enough to account for all possible behaviors but concise enough to be easily navigated, as too many listed behaviors significantly increases the difficulty of the recording

process. Developing a standard checklist for recording observations allowed the team to eliminate any differences or biases in the recordings of different team members as well as create a standardized, repeatable method for conducting observational studies.

A summary of the information gathered throughout the research preparation process can be seen in Table 2 below. The findings from the various preparation methods were crucial to the development of effective procedures for the conducted studies. Using the developed methods, the team was able to collect accurate data that led to meaningful conclusions about the uses and educational value of the Pauline Gandel Children's Gallery.

Preparation Method	Findings	Revisions
Walkthroughs	Gallery layout, exhibit locations	Simplified complex floor plan
Guided Tours	Intended uses of exhibits	Identified exhibition areas for observational study
Tracking Trials	Identified overlooked exhibits and shortcuts between areas	Simplified the Big Box areas, added additional exhibits
Timing Trials	More space was required to record timing data, weather influenced data	Revised orientation and layout of timing sheet, added weather options
Observational Trials	Observed unique behaviors within each area, found that it was difficult to navigate through long checklists	Added specific behaviors for each area to the generalized checklists, organized checklists into subsections

Table 2: Summarized Findings from Research Preparation

3.2. Objective 2: Tracking and Timing Study

A full gallery tracking and timing study was conducted on 52 children in the Pauline Gandel Children's Gallery. The tracking and timing study consisted of following children's paths and recording their interactions within the exhibition in order to understand the usage of exhibits and determine trends in the flow of visitors. During the study, the team recorded the paths children took through the gallery, the time spent at each exhibit, and the level of interaction between the children and their caregivers. The data collected was then analyzed to evaluate the

popularity and holding power of exhibits, which helped to determine the effectiveness of the gallery as a whole.

The first step in conducting a successful tracking study is to gain visitor consent in order to eliminate legal issues and minimize any ethical concerns involved with conducting tracking studies on human subjects. To complete this step, the team posted signs at the entrance of the gallery, shown in Appendix C, to notify visitors of an ongoing study. The sign explained the details of the study and informed visitors how to opt out of the study if they did not want to participate. If a visitor entered the gallery and did not follow the instructions to opt out of the study, they had given their consent to be tracked throughout their visit. This general announcement method of gaining consent was useful in preserving the integrity of the collected data, as visitors who consented to the study remained unaware of whether or not they had been chosen to be tracked and continued to act naturally throughout their visit.

Developing a sampling scheme for selecting visitors is another important aspect of conducting a successful tracking study, as it helps avoid bias in the collected data. A preferred method by many researchers is to select an individual from every third group that enters the museum. This randomizes who is selected and prevents any unintentional patterns in demographics (Moussouri & Roussos, 2013). In the conducted study, the frequency of visitor selection was altered depending on the rate at which visitors were entering the gallery, and was determined by the team members at the time of the track. For example, when the museum was slow, the team tracked a child from every group that entered the gallery, while when the museum busy, the team tracked a child from every fifth group that entered the gallery. Due to the intended age range of the gallery, the visitors selected for the study were children between the ages of 0 and 5. Alexandra Price, an expert in early childhood development, used developmental stages to break down the intended age range into four separate age groups: babies (0 to 18 months), toddlers (18 months to age 3), ages 3 to 4, and ages 4 to 5. Children within the different age groups fall within different developmental stages and demonstrate different physical and mental capabilities, causing them to navigate the gallery and interact with the exhibits in different ways. To ensure accurate and comprehensive results, the team selected an equal number of children within each of the identified developmental age groups. In addition, to prevent any ethical and legal issues, the team made sure to only select children that were accompanied by an adult caregiver.

To gather tracking data, a team member observed the pathway of a selected child throughout the entire duration of the child's visit. The team member documented the pathway taken by the selected child through the gallery by tracing the child's pathway as a line on the final version of the simplified map shown as Item 1 in Appendix A with a red ballpoint pen. The pathway recordings were analyzed by overlaying the maps of the recorded pathways using Adobe Photoshop to produce map overlays displaying high and low traffic areas for each age range as well as trends in the flow of visitors.

To gather timing data, the team member started a stopwatch the moment the selected child entered the gallery. Throughout the child's visit, the team member recorded the time that the child entered and exited the areas of simplified map, as well as the time that the child began and ended their engagement with individual exhibits. This allowed the team to determine the total time the child spent in the gallery, the total time the child spent in each area, and the total time the child spent engaging with individual exhibits. To avoid the use of multiple stopwatches, the team member used the running time from one stopwatch to document the amount of time spent within the gallery, within each area, and engaging with each exhibit. This was accomplished by recording the time shown on the stopwatch when the child entered an area or started to interact with an exhibit, as well as the time shown when they left the area or exhibit. The times were recorded using the timing sheet shown in shown as Item 3 in Appendix A. If a child returned to an exhibition area or exhibit, the duration of their second stop was added to the duration of their first stop. After each track was complete, the times were manually imported into Microsoft Excel, where the total time spent by the child in each area and interacting with each exhibit was calculated by subtracting each start time from its corresponding stop time. After all of the data was collected and imported for the 52 selected children, the team used the Excel spreadsheet to calculate the average time spent at each exhibit, within each area, and within the gallery. The accumulated results from the timing studies showed the holding power and popularity of the exhibits and areas by displaying how many children stopped and the average length of each stop. Exhibits and areas with the greatest holding power had the highest average time spent by children, while exhibits and areas with the greatest popularity had the highest number of recorded visits. The results also showed which areas and exhibits of the gallery are the most popular with each developmental age group within the intended age range of the gallery.

Throughout the tracking study, the team member also recorded the level of interaction between the children and their caregivers to identify trends in caregiver involvement among different age groups. The interactions were recorded by rating the behaviors and actions of the accompanying caregiver while the child was engaged with an exhibit using the following scale:

1= Uninvolved, on a break

2= Watching the child

3= Interacting/playing with the child

4= Holding a meaningful learning conversation with the child

This study produced useful data for the children's gallery on how caregivers tend to engage with their children within specific exhibition areas compared to the intended design goals for the area.

To ensure accurate results, the team members focused on remaining unnoticed by the individuals that they were tracking, as carrying a clipboard and recording observations while following the same child for an extended period of time often became very noticeable. To reduce the frequency of being noticed by the selected child and their caregiver, the team predetermined locations within each area that allowed for easy data collection and kept the team member out of the direct view of the child and caregiver. Still, a plan of action was established for the situation when a team member was noticed and confronted by the child they were tracking. As recommended by Yalowitz and Bronnenkant (2009) in an article on tracking and timing studies, each team member carried the contact information of Carolyn Meehan, the sponsor of the study, and, if noticed by a subject of the study, planned to describe the details of the study to the caregiver and inform the caregiver that they could contact the sponsor if they had any questions or concerns. After a team member was noticed, no further data was recorded to prevent the data from being compromised. The team member simply made a note that he or she was spotted and preceded to track a different child.

3.3. Objective 3: Post-Visit Interviews

To gather more personal information regarding visitor experiences, the team conducted 50 post-visit interviews. The interviews allowed the team to evaluate the enjoyment and learning value of the exhibition based on the perspectives of the visitors, providing valuable qualitative data that was analyzed in conjunction with the quantitative data collected in the tracking and

timing study. The team conducted the interviews with the caregivers of the children, as children within the intended age range of the gallery were too young to accurately communicate their experiences. Of the conducted interviews, 24 interviews were conducted with the caregivers of children who were subjects of the tracking and timing study, which allowed the team to compare the conclusions of the tracking and timing data to the perceptions of the caregivers. The remaining interviews were conducted with caregivers of children who were not tracked.

Two methods were assessed when conducting the interviews. In the first method, a team member asked the caregiver of the child they had selected for tracking for their consent to conduct the interview before they began their visit, and asked the caregiver to meet the team member at a specified location before they departed. In the second method, the interviewer asked the caregiver for their consent to conduct the interview after their visit. After conducting several interviews using both methods, the team analyzed the results to determine which method provided the most useful information for the study. Although it was hypothesized that informing the caregiver of the interview before their visit would make the caregiver more aware and observant of their child's behaviors and would result in more detailed responses, it was found that both methods produced equally detailed responses. The team found that cueing the caregiver about the interview before the tracking began made them more aware of the tracking, as the caregiver now recognized the tracker and knew that they were conducting studies in the gallery. To avoid skewing tracking data, the team decided that the second method of asking caregivers for their consent to conduct the interview after their visit would be used for the remaining interviews.

The interview guide used during the interviews can be found in Appendix D. The interviews consisted of a semi-structured set of questions intended to gather information regarding the caregiver's views of their child's experience at the gallery. Key questions asked during the interviews included "Which exhibit is your child/grandchild's favorite?" and "Do you feel that the exhibits were educational?" Before the interview took place, the interviewer obtained oral consent from the visitor using the introductory statement shown in the interview guide. Once the visitor provided consent, the interviewer asked the visitor the predetermined questions and prompted the visitor to explain their answers when appropriate.

After the interviews were conducted, the team entered the responses into a Microsoft Excel file to identify major trends. For each question asked during the interview, the team

created a numbered code for the most frequent responses and used the coding system to convert the qualitative responses into quantitative data. The coded data from the Excel file was then inserted into the SPSS Statistics software program to further evaluate the data. The SPSS program allowed the team to draw conclusions for each age group and for all combined age group about favorite exhibits and educational value.

3.4. Objective 4: Observational Evidence of Learning Study

Analyzing the behaviors of children at exhibits is an effective method used to gather unbiased information regarding their engagement. However, the mental and physical capabilities of children between the ages of 0 and 5 vary greatly, causing them to perform different tasks at the same exhibit. In order to gather in-depth behavioral data for different age groups, the team established a repeatable method and performed observational studies on selected exhibition areas. During the studies, the team observed and recorded the behaviors of children of different ages as they interacted with an exhibit in order to identify trends in behavior and determine the current usage of the exhibition areas. The identified behaviors were then further analyzed to determine the learning value presented by each area. The research instruments used in the study can be found in Appendix B.

The studies were conducted on the following areas chosen by gallery designers Alexandra Price and Pete Wilson: the Lullaby Nook Area, the Camouflage Disco, the Shapes Wall, the Butterfly Holograms, the Burrows, the Light Torch, and the Climbing Net Structure, which was separated into the Upper Climbing Net and the Lower Climbing Net Area. Each team member was assigned two areas where they recorded observations of children within the four developmental age groups: babies (0-18 months old), toddlers (18 months to age 3), ages 3 to 4, and ages 4 to 5. This allowed each team member to thoroughly familiarize themselves with the checklists of their two specific areas to increase the efficiency and accuracy of data recording. To conduct the studies, the team members observed a randomly selected child for a maximum time of 30 minutes as they interacted with the exhibits in the specified area. During the observational period, the team member recorded the behaviors they observed every 15 seconds in the standardized checklist developed for the area. Each checklist consisted of behaviors organized into groups including general behaviors that were identical on all checklists and specific behaviors that were unique to each area. The checklists were designed so that the team members

were able to identify all general behaviors that were occurring along with all behaviors that were specific to the area during every 15-second interval. In doing so, each time interval identified the child's general behaviors regarding their facial expressions, verbal responses, and body movements, as well as how those actions related to the specific area. The team member also identified whether the child was interacting alone, with a caregiver, or with other children during each time interval. For example, at one 15-second time interval, a team member conducting a study on the Butterfly Holograms observed a child standing in front of a coloring station alone, randomly scribbling on the touchscreen to color their butterfly. To record this behavior, the team member checked off "Self" to indicate that they were interacting alone, "Playing with" to indicate their general interaction with the exhibit, and "Standing" and "Scribbling randomly on butterfly" to identify their specific interaction with the exhibit. To complete the study, 25 randomly selected children were observed within each selected area. To best represent the usage of each area, the team members selected any child who came to the exhibit, regardless of their age, instead of selecting a specific number of children from each age group; therefore, the data also showed which age group interacted with each area most frequently.

To analyze the recorded data, the team identified trends in the observed behaviors for each area to determine the most common behaviors for each age group. The team used the identified trends to develop a table of commonly observed behaviors for each of the areas, broken up by age group, to accurately describe how the exhibits are currently being used. The team also compared the tables of behaviors developed for the Climbing Net Structure, the Lullaby Nook, and the Camouflage Disco to the expected behaviors provided by Alexandra Price, shown as Items 4, 5, and 6 in Appendix B. As explained in a study evaluating the indicators of family learning in a museum setting, "the closer the visitor gets to the designers' intended goal, the greater the perceived quality of the experience" (Sanford, 2010). Therefore, a larger number of observed behaviors that matched the expected behaviors from the tables represented a more engaged and impactful experience and showed that the exhibits are successful in achieving their intended goals. After the commonly observed behaviors tables were developed for each area, the team assessed the behaviors to determine the learning value of the exhibits by comparing the observed behaviors to the behavioral indicators of learning found through background research.

4. Findings and Results

After completing the research preparation, tracking and timing study, interviews, and observational study, the team evaluated the collected data to gather results regarding the popularity, holding power, educational value, and current usage of exhibits. The following section presents the results of the team's four main project objectives, which further allowed the team to draw conclusions regarding the use and educational value of the Pauline Gandel Children's Gallery. To perform the analyses, the team utilized computer programs including Microsoft Excel, Adobe Photoshop, and IBM SPSS Statistics.

4.1. Gallery Design, Intended Uses, and Learning Outcomes

Guided gallery tours with Alexandra Price and Pete Wilson, two designers of the Children's Gallery, provided the team with valuable information regarding the intended uses and learning outcomes of exhibits and areas within the gallery. During the tours, the designers focused specifically on the following exhibits, which all present unique designs and learning opportunities: the Shapes Wall, Camouflage Disco, Lullaby Nook, the Climbing Net Structure, the Butterfly Holograms, the Burrows, and the Light Torch. The designers also explained the design of the gallery in terms of intended energy levels of different areas and pathways between areas.

4.1.1. Intended Uses and Expected Learning Outcomes of Major Exhibits

The Shapes Wall is located within the first major room of the gallery, which is a low-energy area intended for babies and toddlers. As Alexandra explained, this room is designed to hold educational programs in the future, and contains televisions and projectors to display educational content. The Shapes Wall is an interactive wall that encourages children to touch and explore, as touching certain areas results in specific light projections across the wall. The Shapes Wall is intended to promote caregiver-child interactions by encouraging children to show caregivers what they have found and encouraging caregivers to show and explain how different aspects of the wall work. The wall contains shapes and objects that the child can pull and twist, creating both tactile and sensory learning experiences for the child. A picture of the wall is shown below in Figure 10.

Figure 10: Shapes Wall (D1)

The Camouflage Disco, shown in Figure 11 below, is an animal-themed exhibit located in the back room of the gallery that is identified by staff as the Big Box. Within the disco, an hour-long soundtrack continuously plays throughout the day, consisting of both high- and low-energy music. The disco floor is a constantly changing projection that shows animal faces, footprints, patterns, and nature scenes, and is completely surrounded by mirrors. It is expected that children within the disco will respond to the projections on the floor and the sounds playing in the soundtrack, as well as interact with their reflection in the mirror. It is also expected that children will crawl around the disco floor, dance to the music, or follow the projections around the disco floor, depending on their age.

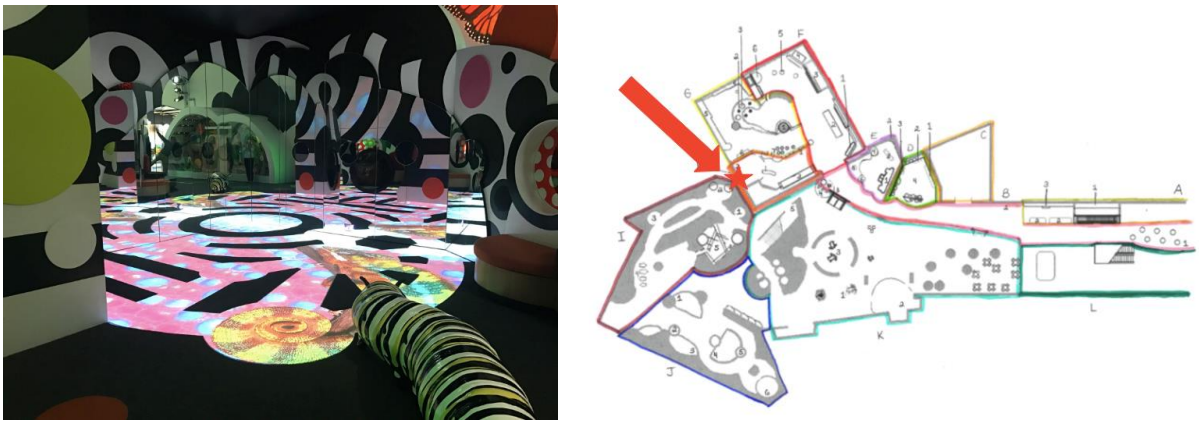

Figure 11: Camouflage Disco (H2)

The Lullaby Nook area, shown below in Figure 12, is a low-energy area located within the Big Box. It is a quieter area containing books, play blocks, and nooks intended for children to relax with their caregiver. The Lullaby Nook is a specific nook that contains a projection screen and plays lullaby music throughout the day. Although intended for relaxation with caregivers, Alexandra informed the team that children often run up and down the circular sides and play games within the nook.

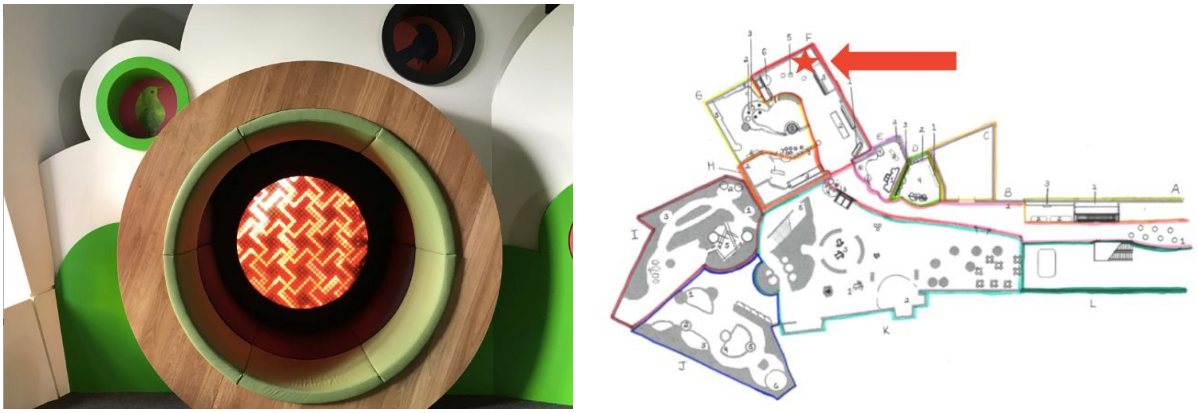

Figure 12: Lullaby Nook (F4)

The Climbing Net Structure, shown below in the top Figure 13, is a high-energy area located within the Big Box. The climbing net is intended for older children who are able to climb and explore the net. It is expected that children will push themselves out of their comfort zone to conquer the net, and may interact and play games with other children within the net. The net is capable of supporting adults, and museum staff welcome caregivers to climb up the structure with their children. Beneath the net is a lower-energy zone, shown in the bottom of Figure 13, which accommodates younger children who are not able to climb through the net structure. The zone includes a seating area with small net holes that children can play in, as well as net swing structures that children can climb or push.

Figure 13: Climbing Net Structure (G1,G2,G3)

The Butterfly Holograms, shown below in Figure 14, are lower-energy exhibits located within the Big Box. The exhibit consists of a touchscreen drawing pad that children can use to color a butterfly, which is shown in a hologram above the drawing pad. The children can draw with their caregiver, share with other children, or draw by themselves. It can be used by children of all ages, although children at the higher end of the 0 to 5-age range more commonly use it.

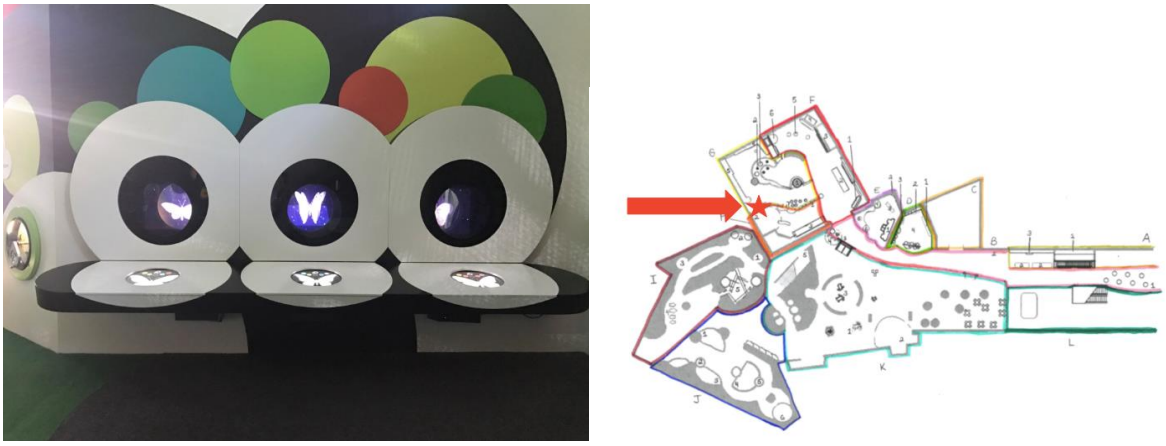

Figure 14: Butterfly Holograms (G6)

The Burrows, shown in Figure 15 below, is a higher-energy area located within the Big Box. The Burrows consists of a cushioned obstacle course where children can climb over and slide down hills and pegs that project from the wall. The wall behind the Burrows contains educational features including showcases of animals and other natural features.

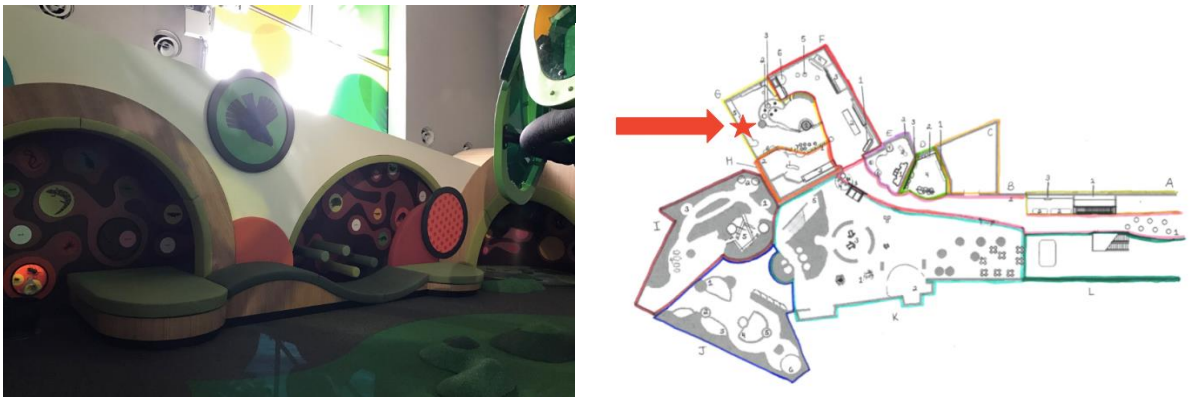

Figure 15: Burrows (G5)

The Light Torch, shown below in Figure 16, is another higher-energy exhibit located within the Big Box. It is an interactive exhibit where children can point a light torch at different pictures of animals, which then light up and make unique animal noises. This exhibit presents children with the opportunity to interact independently or play and learn with their caregiver.

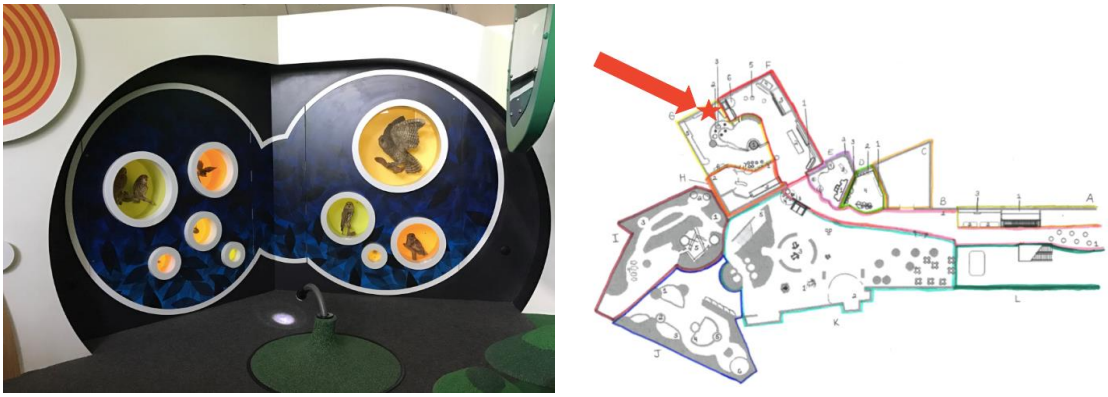

Figure 16: Light Torch (G4)

4.1.2. Gallery Energy Levels and Unique Designs

The team's guided tour with Pete Wilson, the lead designer of the gallery, yielded new information on potential routes within the gallery, the expected energy levels within each of the areas of the gallery, and the purposes of specific installations within the gallery. Throughout the entirety of the tour, Pete demonstrated the ways children can travel through the gallery, and explained that the pace at which children move through the gallery will vary in each area and may be affected by their initial reactions to the areas. For example, a child entering the Big Box may be initially overwhelmed by the large, chaotic area, which may cause the child to either

stand and stare at the various exhibits or become excited and sprint around to investigate the areas within the room. Most notably, Pete disclosed two unique passageways that were created to accommodate the exploratory and fast paced nature of young children. The first pathway, shown below in Figure 17, is a discrete circle-shaped opening in the wall between areas G and H within the gallery. The second pathway, shown below in Figure 18, is a low backing on the seating area under the climbing net in area G that gives children the opportunity to climb over the seating and gain access to area F and the rest of area G.

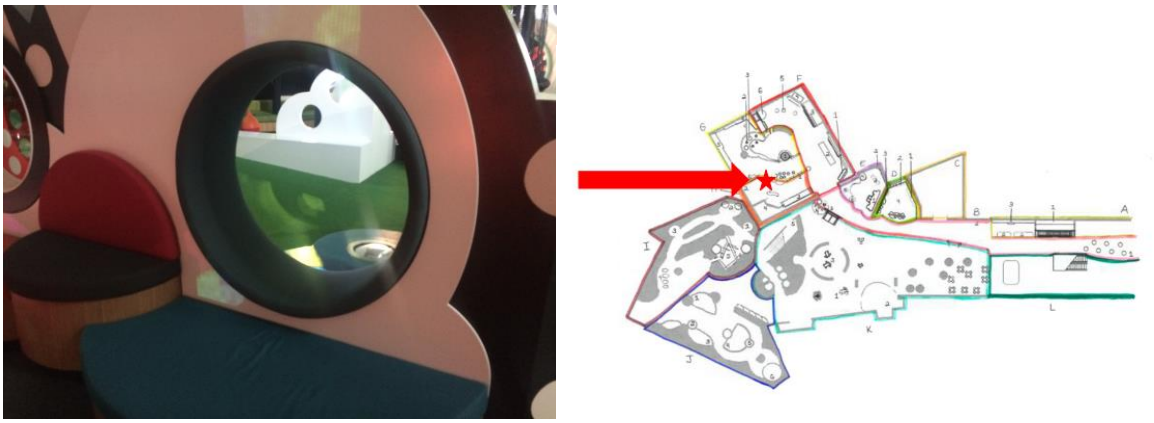

Figure 17: Pathway between Camouflage Disco Area (H) and Burrow Area (G)

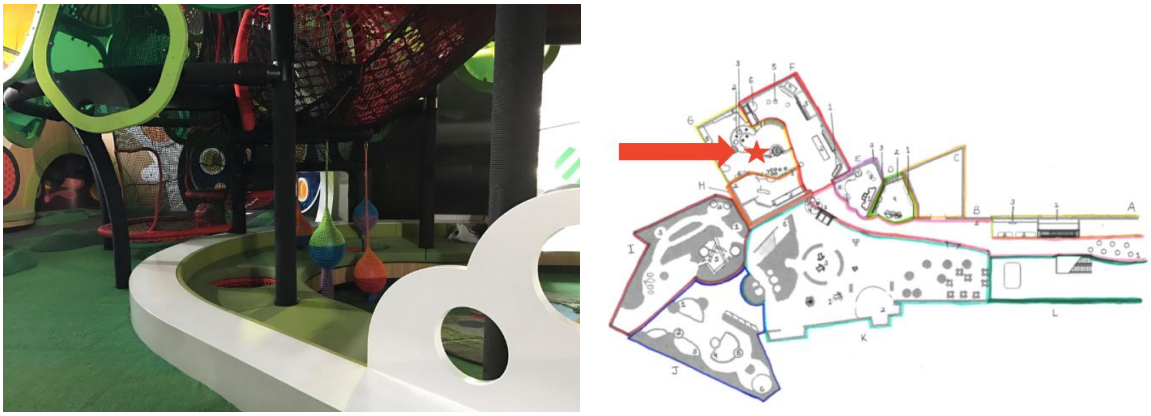

Figure 18: Pathway between Lower Net and Burrow (G)

The shortcuts created by the designers contribute to the expected high-energy of area G within the Big Box. Pete further explained that high-energy movement and play is also expected while playing with the Blue Blocks in area K in the outdoor area of the gallery. By identifying the areas of the gallery that were intended to be high- and low-energy, the team was able to

evaluate the areas using the collected tracking and timing data to determine if the areas were meeting their intended energy goals.

Additionally, Pete noted clever design aspects within specific exhibits in the gallery. The Rocks exhibit, located in area J of the gallery and shown in Figure 19 below, was created for a child to playfully hide from their caregiver. The five rocks, which stand parallel to one another, were strategically placed close enough to allow for playful hiding but far enough to eliminate the risk of a child attempting to climb and jump between the rocks. Another cleverly designed exhibit is the Curved Textured Structure located within area E of the gallery, shown in Figure 20 below. This exhibit, created for tactile play, also acts as an area for children to playfully hide from their caregivers by creating a small space for children to hide between the structure and the mirror wall. The mirror placed behind this wall ensures that the caregiver is able to see their child while they are hiding behind the wall.

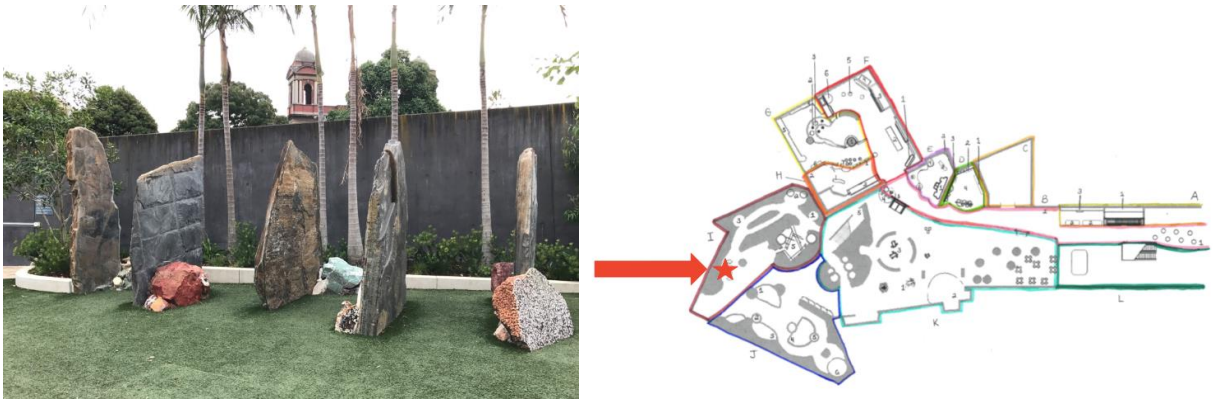

Figure 19: Rocks (I4)

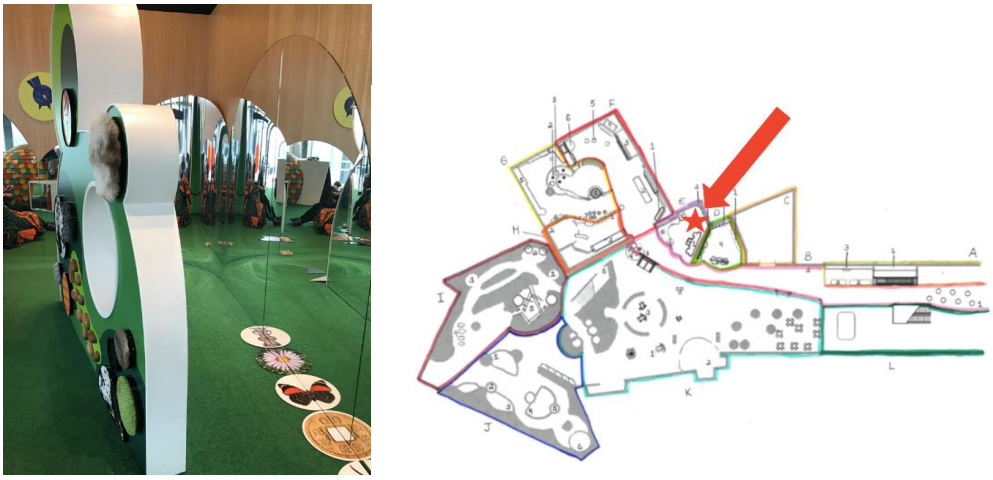

Figure 20: Curved Texture Structure (E3)

The team's meetings with Pete and Alex also showed that although each exhibit was intended for a specific use, children often find unexpected ways to play and interact with all aspects of the gallery. An example of an unexpectedly used item in the gallery is the Cobobonee Pod, pictured in Figure 21 below. The pod was originally designed as a decorative feature of the gallery, with a texture and pattern that younger children could touch and feel as they played on the surrounding exhibits. However, it was quickly discovered that children love to climb and jump on the pod, which has deformed the pod into its current shape. Now, the pod acts as more of a beanbag play-area for children to climb, jump, pull, and push than as the decorative feature it was designed to be. This showed the team that children's behaviors could be unpredictable, which helped the team in their design of the observational studies. When developing the behavioral charts, the team made sure to include a wide variety of possible behaviors to account for the unexpected behaviors of children.

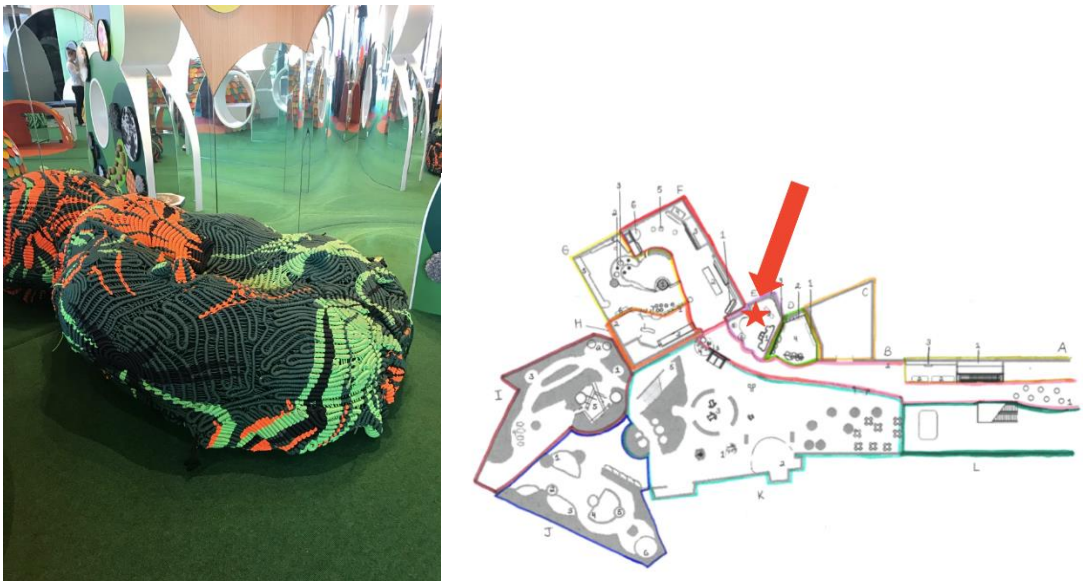

Figure 21: Cobobonee Pod (E4)

4.2. Visitor Pathways

To analyze the data collected during the tracking portion of the tracking and timing study, the pathways of the 52 completed tracks were scanned and compiled using Adobe Photoshop, allowing for the creation of pathway overlays. As the pathways were scanned, they were saved into files organized by gender, age group, and weather, enabling team to create separate overlays for each category. The resulting overlays were then evaluated and compared to determine the

effect each variable had on the trends in visitor flows. The team used the trends shown by the respective map overlays to make inferences about the preferred areas and exhibits of different age groups and genders as well as the effect of weather on exhibit usage.

4.2.1. Complete Tracking Overlay

The complete map overlay of all 52 tracks is shown below in Figure 22. The map appears to be entirely filled with red pathway tracings, demonstrating that the gallery floor space is being fully utilized by children. As a result, it can be inferred that the Pauline Gandel Children's Gallery is successful in providing children with a place to explore and play, as all children within the intended age range are using the entire gallery. The Big Box area, labeled as sections F, G and H on the map, specifically stands out as having high visitor flow, as it is close to being fully shaded in red. Besides the entrance and hallway, the Big Box area has the highest density of visitor pathways in the gallery. Although the high density of traffic throughout the room is largely due to the high volume of tracks that are being overlaid, it also indicates the high popularity of the room. The high concentration of traffic within the Big Box area can also be explained by its overall high energy level, as many children were recorded running and playing across the different areas within the room.

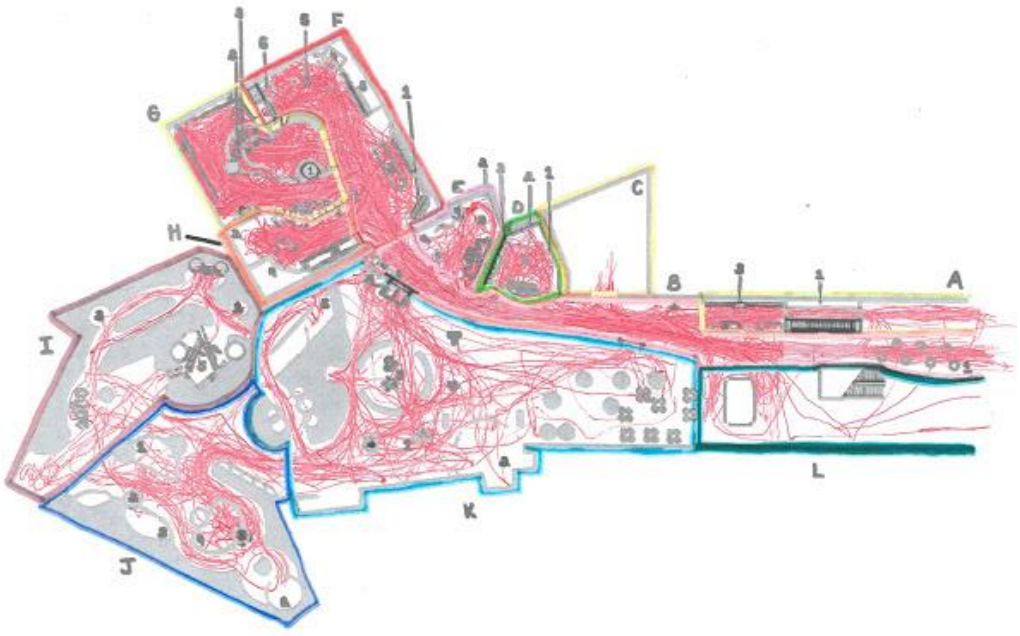

Figure 22: Complete Map Overlay

4.2.2. Tracking Overlays by Age Group

Figure 23, shown below, displays the overlay of 13 tracks of children between the ages of 0 and 18 months, classified as babies. Of the babies selected, seven were female and six were male. At this young age, most babies are either being carried or pushed in a pram, making their paths largely dependent on their caregivers. As a result, the map overlay displays that more babies enter the gallery through the hallway than through the Train Tunnel, as caregivers pushing or carrying their baby are less apt to walk through the tunnel than young children and are often trying to find a place to park their pram in the hallway. The map overlay also shows that the highest amount of traffic was recorded in the Hallway (area B), which is expected, as it is the main pathway through the gallery where caregivers park their prams. When evaluating interactive areas within the gallery, high amounts of traffic are seen within the Shapes Room and the Mirror Room (areas D and E), indicating that they are the most popular interactive areas for babies. This result shows that the areas are meeting their intended and expected uses, as areas D and E are designed to be low-energy areas where younger children can safely play, crawl, and explore. Another area that demonstrates a high attracting power for babies is the Lullaby Nook Area, located at the top of area F. This area is a low-energy area intended for children to relax and escape the surrounding high-energy areas. In addition, the overlay shows that babies do not often use the Upper Climbing Net Area, as there is little traffic going into the entrances of the net. However, there is a heavy concentration of traffic in the area under the climbing net, indicating that young children enjoy playing in the lower-energy area beneath the net. Lastly, the low levels of traffic within the outdoor areas of J, K, and I indicate that children of this age and their caregivers prefer to play inside rather than outside.

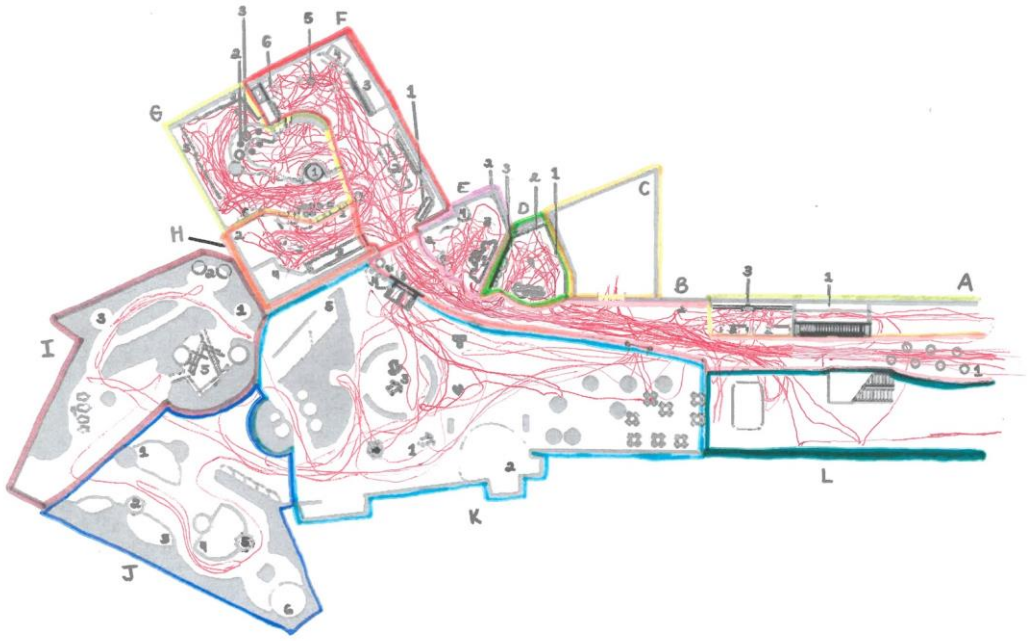

Figure 23: Map Overlay for Babies

Figure 24 shown below displays the overlay of 14 tracking studies conducted on children between the ages of 18 months and 3 years, classified as toddlers. Of the toddlers selected, six were female and eight were male. Throughout the tracking study, it was noted that children at this age are capable of walking on their own, which allowed them to choose their own path through the gallery instead of depending on their caregiver. As a result, a large number of toddlers entered the gallery through the Train Tunnel instead of the Hallway, which is shown on the overlay by the heavier pathway flow into the gallery through area A1 than through area B. The map overlay also shows that the highest traffic areas for toddlers are the Hallway (area B), the Big Box area (areas F, G, and H), and the Train Area (area A), while the Dinosaur Dig area (area I) and the Mirror Room (area E) have very little traffic. Other high traffic areas for toddlers include the Camouflage Disco (H2), Big Pattern Wall (F1), and the Spitting Frog (K1), indicating that these areas are also popular with toddlers. In addition, the density of tracks shown leading into the entrances of the Climbing Net Structure indicate that toddlers are beginning to experiment with the Upper Climbing Net; however, the density of tracks within the lower area of the net shows that the Lower Climbing Net Area remains more popular with younger children.

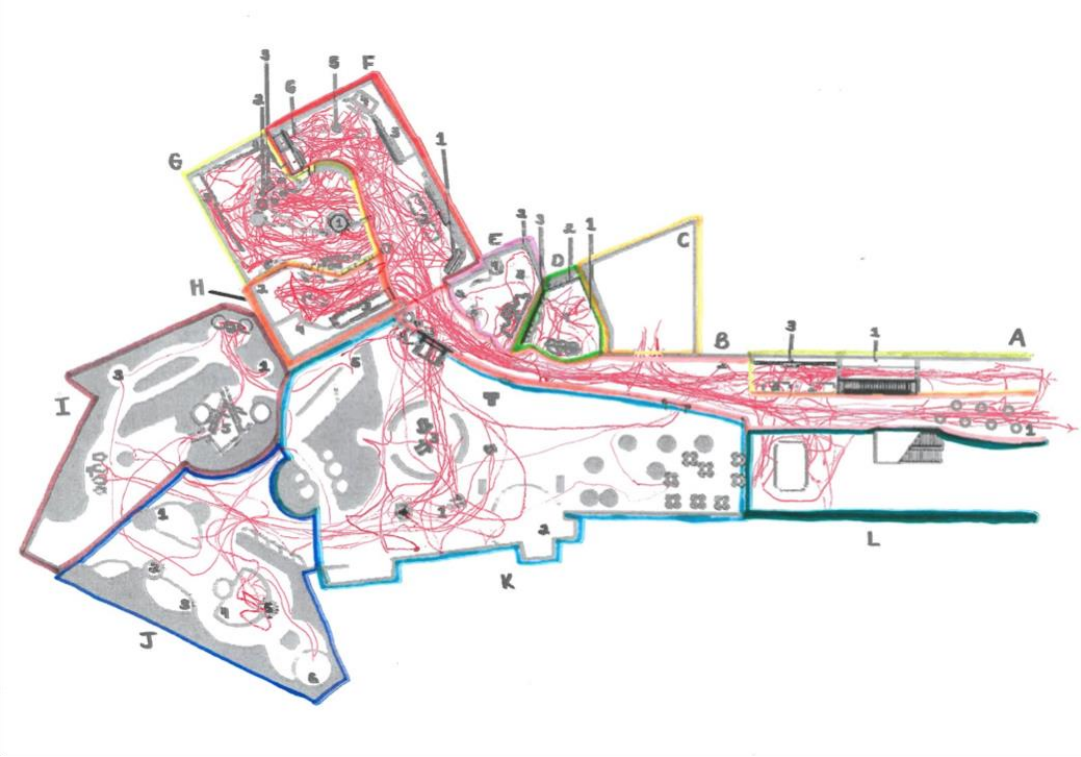

Figure 24: Map Overlay for Toddlers

Figure 25 shown below displays the overlay of twelve tracking studies conducted on children between the ages of three and four years old. Of the children selected for these studies, six were female and six were male. At a glance, it is clear that the Big Box area (areas F, G and H) is very popular with children of this age range, as it is nearly filled with visitor flow. Within this room, the Upper Climbing Net (G1), Camouflage Disco (H2), Burrows (G5), and Big Pattern Wall (F1) stand out as being especially popular among this age group based on the density of pathways leading to the different exhibits. Children of this age are drawn to the outdoor exhibits, as shown by the levels of traffic in areas J, K, and I. Of the exhibits within the outdoor areas, the Dinosaur Dig sand boxes (J1, J2, J4 and J5) are particularly popular.

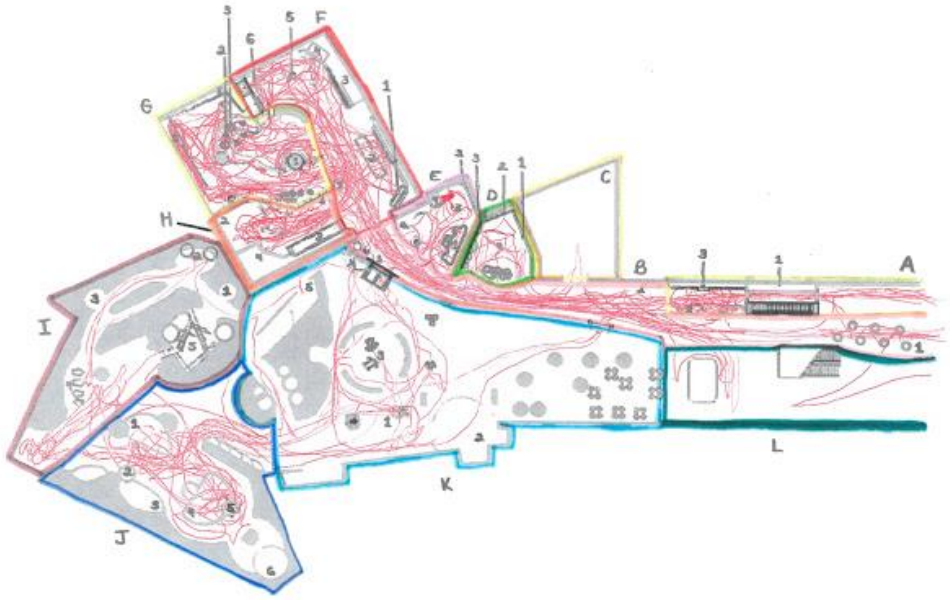

Figure 25: Map Overlay for Ages 3 to 4

Figure 26 shown below displays the overlay of 13 tracking studies conducted on children between the ages of four and five years old. Of the children selected for these studies, four were female and nine were male. A detailed analysis of this overlay proves that the designers of the gallery were successful in creating a space in which high-energy areas can coincide with low-energy areas. This is clearly shown by the high amount of traffic in the Climbing Net Area (area G) within the Big Box compared to the low amount traffic in the Lullaby Nook (area F), the Mirror Room (area D), and the Shapes Wall Room (area E). The Climbing Net Area was designed to be a high-energy area for children to run and play, which is evident in the high density of traffic from older children within this area. The high energy levels of this age group are also evident in the usage of shortcuts throughout the gallery, such as the shortcut connecting areas G and H, as well as the amount of children who climbed over obstacles to create their own unforeseen pathways. The concentration of traffic at the entrances to the Climbing Net Structure indicates that the Upper Net Area is very popular among this age group. Other exhibits within the Big Box area that have a high level of visitation from 4 to 5 year olds are the Camouflage Disco (H2), Ropes and Pattern Wall (F2), and the Lower Climbing net Area (G2). The outdoor areas had a high level of visitation from this age group, particularly the Dinosaur Dig Area (J) and Frog Area (K).

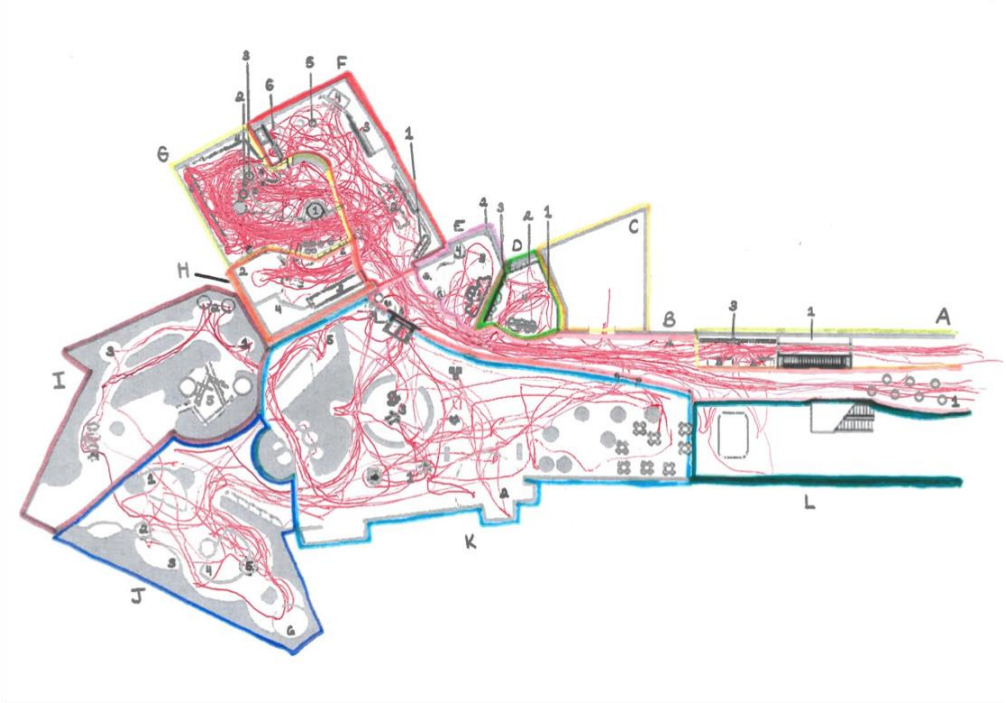

Figure 26: Map Overlay for Ages 4 to 5

4.2.3. Tracking Overlays by Weather

As the gallery consists of both indoor and outdoor exhibits, weather is an influential factor on exhibit use and the pathways of visitors. As shown in Figure 27 below, poor weather, including cold temperatures and rain, greatly reduces the use of the outdoor areas of the gallery. In turn, the indoor areas of the gallery become busier and more crowded during days of cold or rainy weather. It can also be noted that on poor weather days, the popularity of the Big Box area increases as it offers an alternative high-energy environment for children to play in. As can be seen in Figure 22 below, which displays eight random tracks recorded on sunny days, sunny weather has a positive effect on the visitation of the outdoor area. Of the visitors displayed in the sunny weather overlay, 75% went outside. Although the majority of the visitors visited the outdoor area on sunny days, it did not take away from a child's desire to play indoors, as all of the tracked visitors still visited indoor exhibits.

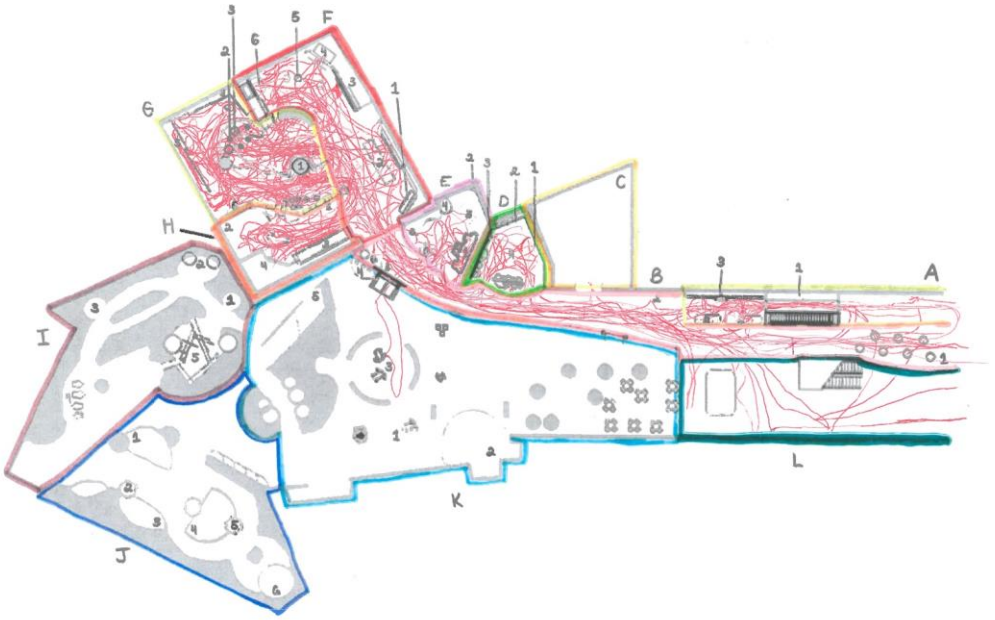

Figure 27: Map Overlay for Poor Weather

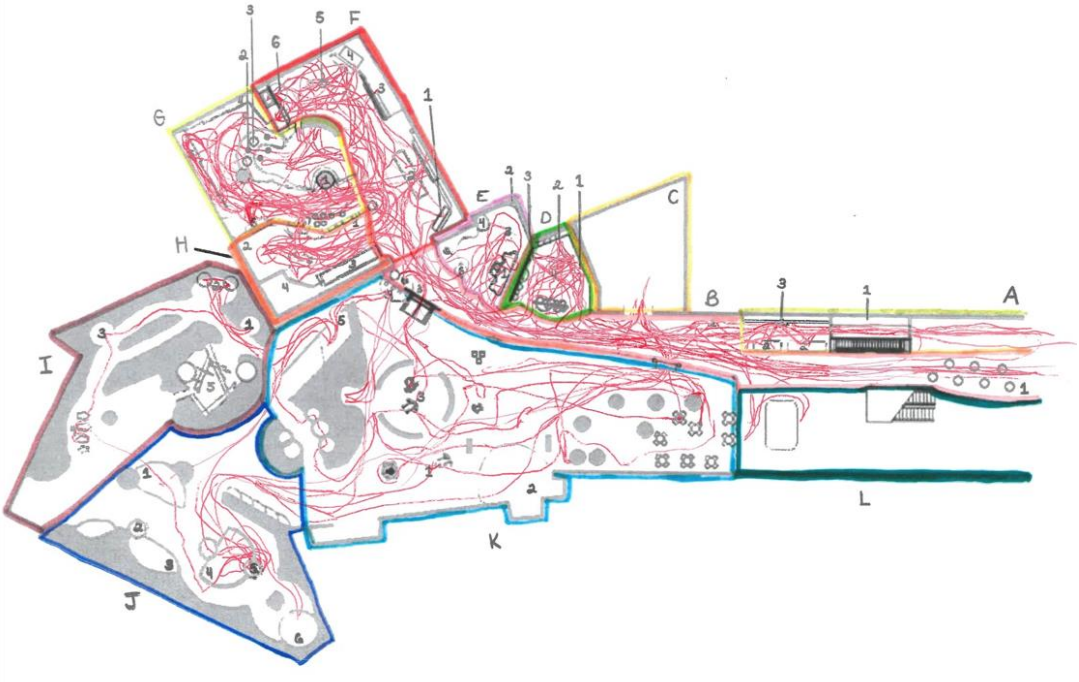

Figure 28: Map Overlay for Sunny Weather

4.2.4. Tracking Overlays by Gender

Of the 52 total tracks, 23 were conducted on females and 29 were conducted on males. The team created separate overlays for each gender in order to identify differences between the pathways of males and females.

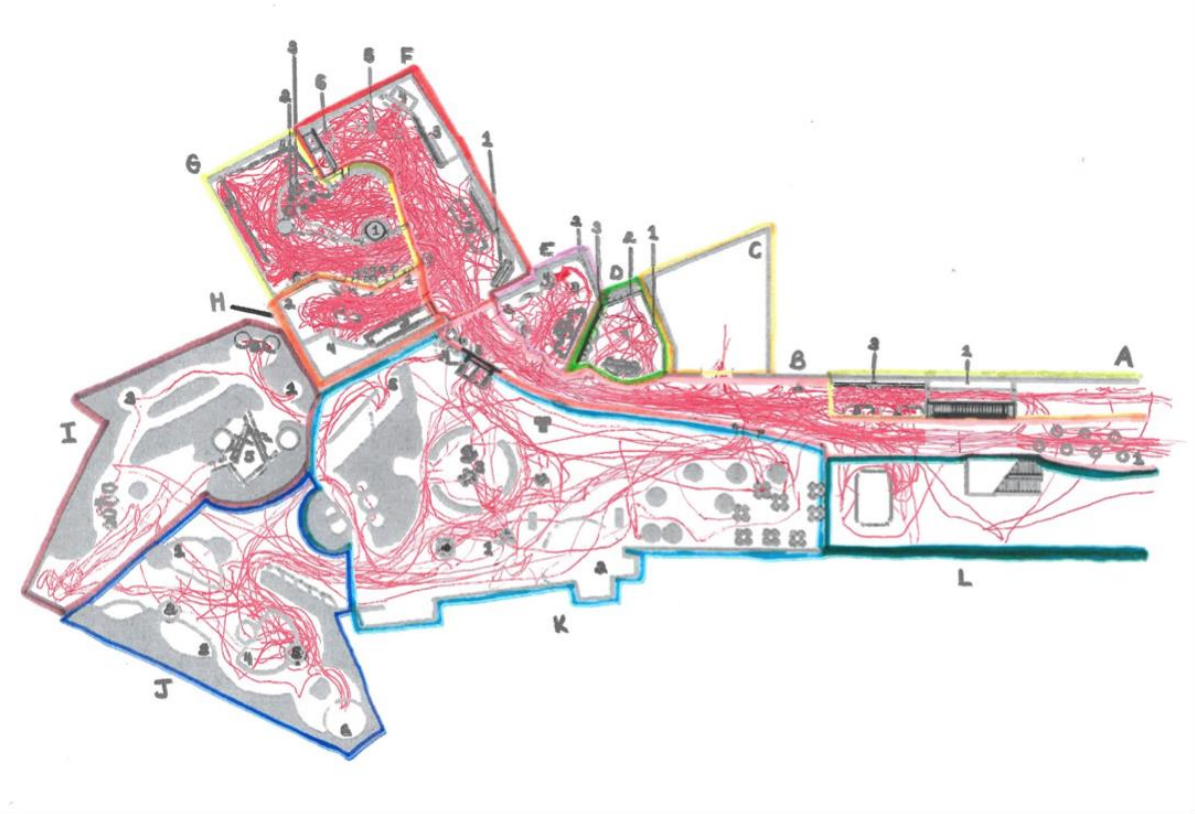

Figure 29: Map Overlay for Females

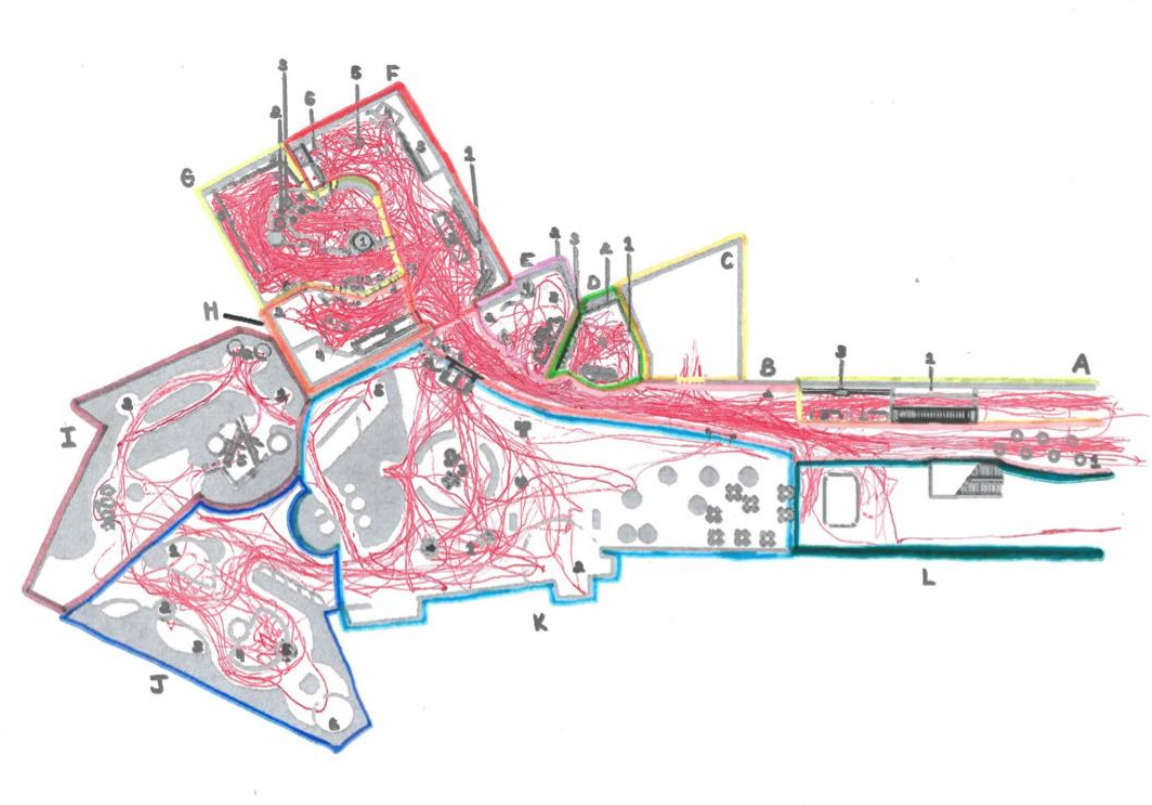

Figure 30: Map Overlay for Males

Figures 29 and 30 display the map overlays for female and male visitors, respectively. After a detailed analysis comparing the two overlays, the team concluded that there are no major differences between the two overlays, indicating that the behavior and pathways of children within gallery's the intended age range is not affected by the gender of the individual child. Separate overlays were also created for both genders of each age group, which can be seen as Items 16-23 in Appendix E. After the data set was divided into age groups and again split by gender, these overlays only contained between four and nine tracks each. The team decided that this data set was not large enough to make any true assumptions or statements about the trends in pathways.

4.3. Timing and Visitation

To conduct an in-depth evaluation of gallery and exhibit usage, the team analyzed the timing and visitation data collected during the tracking and timing study. Timing data was organized and evaluated by time spent within the gallery and at each exhibit, while visitation data was organized and evaluated by the number of visits within the gallery and at each exhibit,

the number of stops at each exhibit, and the number of repeat visitors at each exhibit. The team developed timing and visitation graphs to compare information and draw conclusions about each exhibit's popularity and holding power. In addition, caregiver interaction was evaluated within the gallery and at each exhibit throughout the duration of the visits.

4.3.1. Overall Gallery Statistics

During the tracking and timing study, 52 children were tracked throughout the duration of their visit to the gallery. Overall, the average duration of a recorded visit was 1 hour, 2 minutes, and 52 seconds. The longest recorded track lasted 3 hours, 15 minutes, and 57 seconds, while the shortest recorded track lasted 2 minutes and 40 seconds.

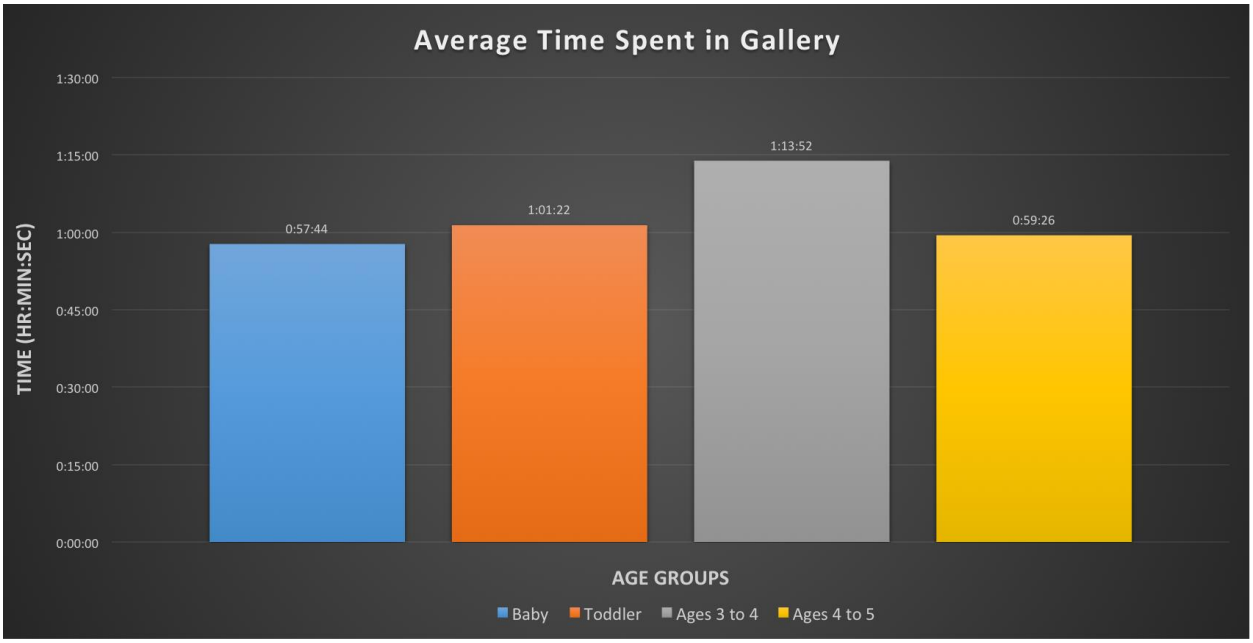

Figure 31: Average Time Spent in the Gallery by Age Group

Figure 31 displays the average times spent in the gallery for each developmental age group. The figure shows that children between the ages of 3 and 4 averaged the longest visit, spending an average of 1 hour, 13 minutes, and 52 seconds within the gallery. The average time spent in the gallery by babies, toddlers, and children between the ages of 4 and 5 all fell within a four-minute range, with the average visit duration for each age group being approximately one hour.

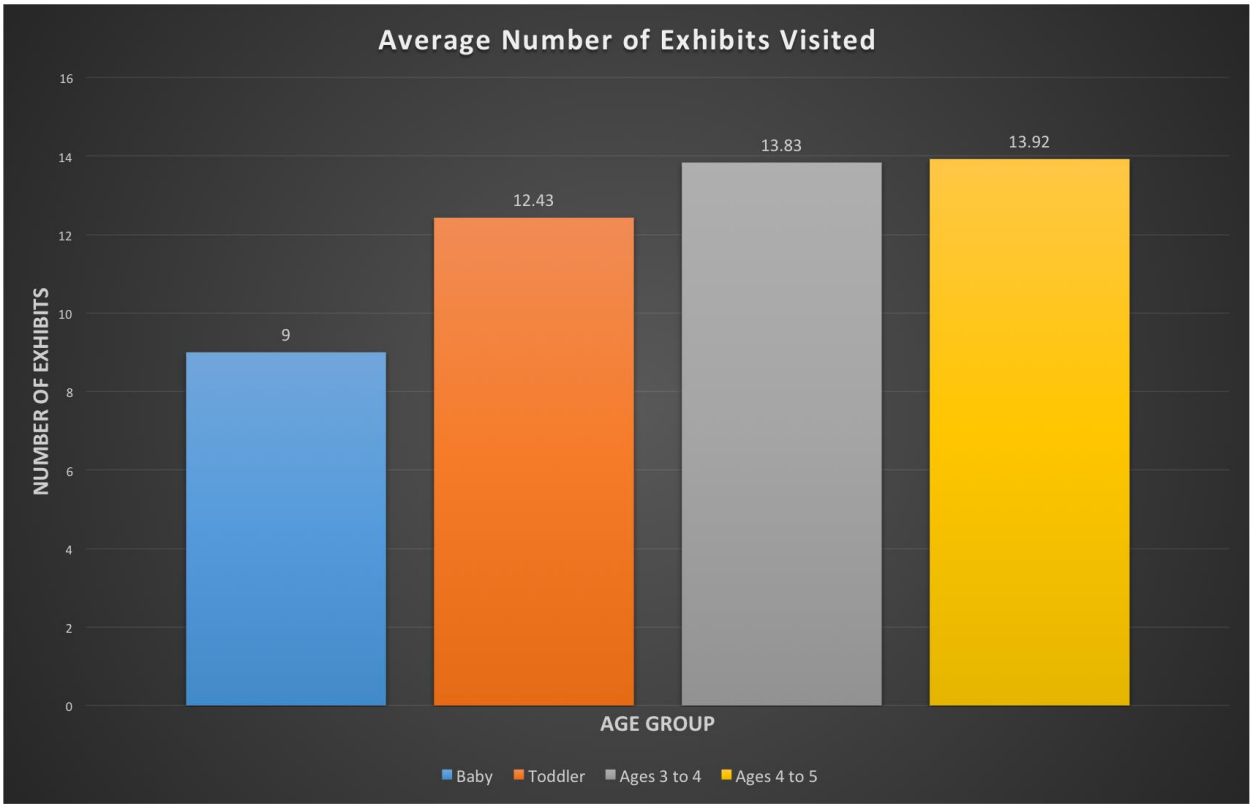

Figure 32: Average Number of Exhibit Visits by Age Group

As defined in the simplified map shown as Item 1 in Appendix A, the gallery consists of 49 different exhibits. On average, a child visited 12.9 of the 49 different exhibits, or 25% of exhibits, throughout their stay in the gallery. Figure 32 above displays the average number of exhibits that were visited by each age group throughout their time spent in the gallery. As the figure shows, children between the ages of 4 and 5 averaged the highest number of visited exhibits, visiting approximately 14 of the 49 possible exhibits, or 29%. Babies averaged the lowest number of visited exhibits, visiting only nine out of 49 exhibits, or 18% of exhibits.

4.3.2. Popularity

Popularity of an exhibit is defined by an exhibit's ability to attract visitors. To evaluate popularity, the team evaluated the number of visits each exhibit received. If a child interacted with an exhibit at any time during their stay in the gallery, it was counted as a visit to the exhibit; therefore, each exhibit could receive a maximum of 52 visits, as 52 children were tracked during the study. If a child returned to an exhibit multiple times during their stay in the gallery, each interaction with the exhibit was counted as a stop at the exhibit; therefore, each exhibit could

receive a varying numbers of stops depending on how many times children returned to the exhibit.

Exhibits within the children's gallery differ from exhibits within traditional museums in that they are intended for interaction and play instead of viewing and observing. Due to this fact, children often leave and return to an exhibit multiple times within their stay instead of simply visiting the exhibit, viewing the provided information, and moving on to the next exhibit. As a result, the team also took into account the number of children who returned to each exhibit after their first interaction and the total number of times children stopped at each exhibit when evaluating an exhibit's popularity.

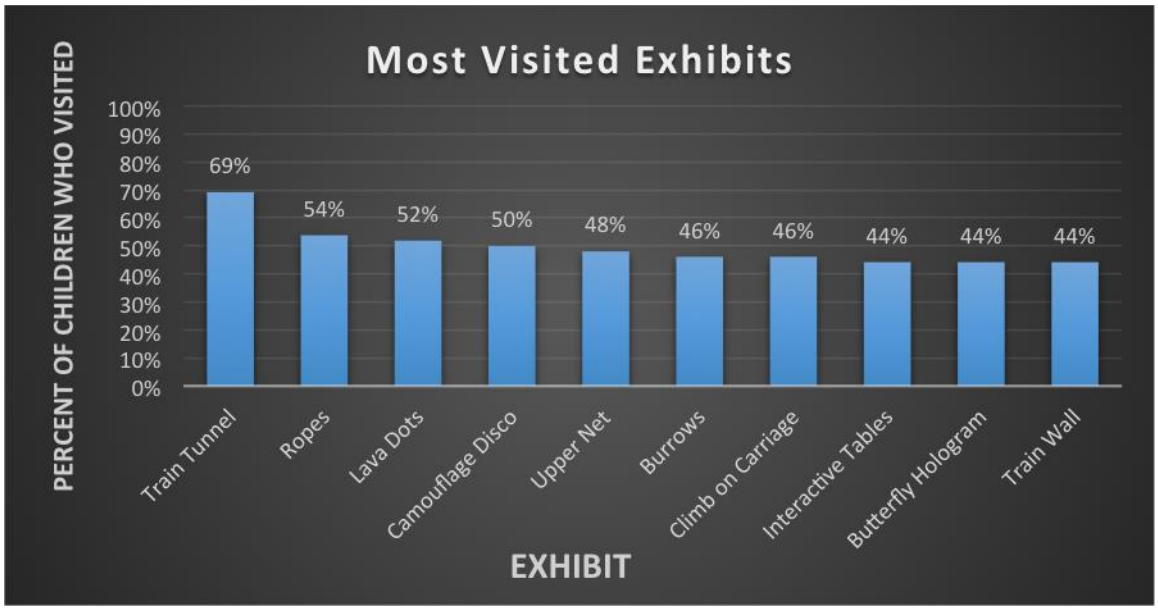

Figure 33: Most Visited Exhibits

The ten most visited, and therefore most popular, exhibits within the gallery are displayed in Figure 33, which shows the percentage of children who visited each exhibit during their stay in the gallery. The total number of visits of all exhibits within the gallery can be seen in Item 24 of Appendix F. Figure 33 shows that the Train Tunnel received the highest number of visits, with 69% of the children who were tracked visiting the exhibit. The ropes attached to the Big Pattern Wall received the second highest number of visits, followed by the Lava Dots and the Camouflage Disco. Out of the top ten most popular exhibits, seven are located within the Big Box area and three are located within the Train Area (Area A), showing that they are the most

popular areas within the gallery. The location of the Train Area at the entrance of the gallery had a large effect on its popularity, as it is the first fun and exciting area seen by children when they enter the gallery. In addition, the Train Tunnel acts as an entrance to the gallery, resulting in its high number of visits, as most children choose to enter the gallery through the Train Tunnel rather than through the hallway.

The ten most popular exhibits also fall within the top exhibits for the highest number of repeat visitors and the highest number of total stops. The number of repeat visitors for all exhibits can be seen in Item 25 of Appendix F, and the number of total stops for all exhibits can be seen in Item 26 of Appendix F. In addition to the ten most popular exhibits, the Bean Bag Swings and the Shapes Wall also fell within the top exhibits for repeat visitors and number of stops. While the two exhibits were not within the top ten for the highest number of visits, they both received the high amounts of repeat visitors and stops, showing that although they were not the most popular exhibits, most of the children who did visit the exhibits enjoyed their time and returned to interact again.

The Train Tunnel, which was the most popular exhibit by number of visits, was also one of the top three exhibits for repeat visitors and number of stops, showing that it has a high overall popularity. Although the high number of visits was largely due to the Train Tunnel being an entrance to the gallery, the high number of repeat visitors and stops shows that children often returned to the Train Tunnel during there stay, meaning that they enjoyed their initial visit and wanted to interact with the exhibit again. The Upper Climbing Net, which was the fifth most popular exhibit, received the highest number of repeat visitors and the highest number of stops, showing that children often came back to interact with the exhibit again during their stay. The Upper Climbing Net may have had a lower visitation due to its physical difficulty, as babies and younger children are unable to physically climb in the net. However, its high number of repeat visitors and stops shows that the Upper Climbing Net is one of the most popular exhibits within the gallery, as children enjoyed their time within the net and came back to interact again.

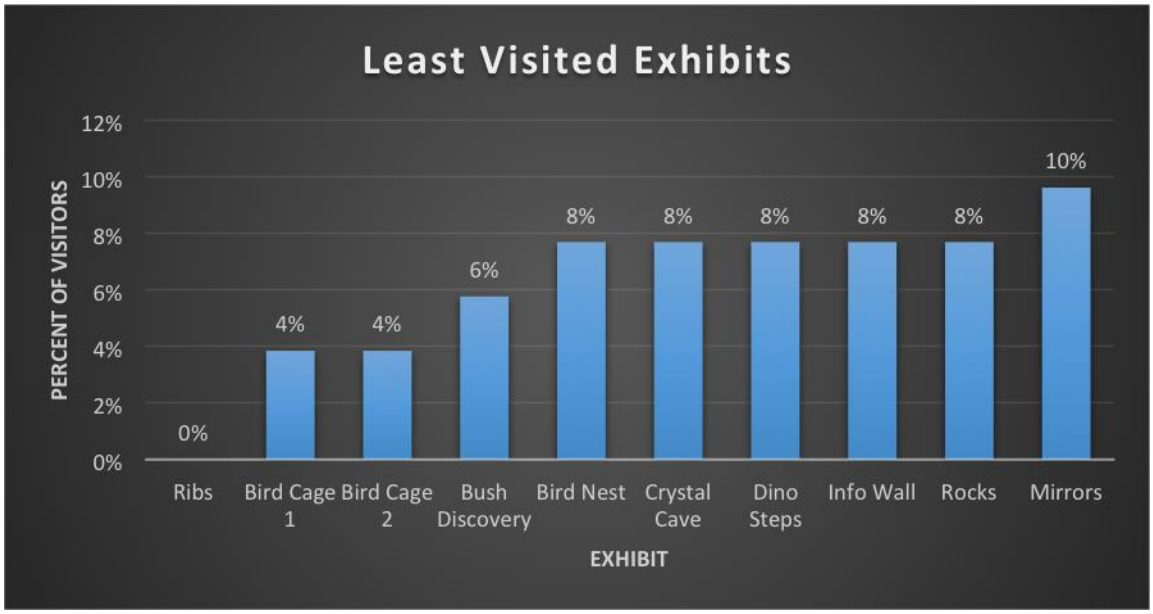

Figure 34: Least Visited Exhibits

Figure 34 shows the ten least visited, and therefore least popular, exhibits by percent of children who visited the exhibits. The least popular exhibit within the gallery is the Ribs, an outdoor structure near the Dinosaur Dig sand pits, which received no visits, no repeat visitors, and no stops. Eight out of the ten least popular exhibits are outdoors, with seven being located within the Gardens (Area I), showing that the Gardens is the least popular area within the gallery. The ten least popular exhibits also have the lowest values for number of repeat visitors and number of stops, showing that they are overall the least popular exhibits in the gallery, as few children returned to them after their initial visit.

The team also evaluated the most popular exhibits for each developmental age group. The number of visits to exhibits, the number of repeat visitors to exhibits, and the number of stops to exhibits for each age group can be found as Item 27, 28, and 29, respectively, in Appendix F. When analyzing the exhibits with the highest number of visits for each age group, the Train Tunnel is again the most popular exhibit with toddlers, children between the ages of 3 and 4, and children between the ages of 4 and 5, while the most popular exhibit with babies is the Mirror House. As previously mentioned, this is most likely due to the Train Tunnel being an entrance to the gallery. Children who are able to walk on their own and determine their own pathway through the gallery are immediately drawn to the Train Tunnel as they enter, while babies who

are carried or pushed in a pram by their caregivers are less likely to travel through the Train Tunnel to enter the gallery.

For children between the ages of 4 and 5, the Upper Net and the ropes beneath the Big Pattern Wall are the next most popular exhibits, with only one less visit than the Train Tunnel. The Upper Net has substantially larger values than other exhibits for the number of repeat visitors and the number of stops for children between the ages of 4 and 5, showing that overall, it is a very popular exhibit with children at the top end of the intended age range. The Bean Bag Swings is second to the Upper Net in number of repeat visitors and third in number of stops, which shows that it is also greatly enjoyed by children of this age group. The Upper Net and the Bean Bag Swings are both in the Net and Burrow Area (Area G) of the gallery, showing that Area G is very popular with children between the ages of 4 and 5.

For children between the ages of 3 and 4, the Interactive Tables within the Lullaby Nook Area, the Upper Net, the Bean Bag Swings, and the Camouflage Disco are the next most popular exhibits. These exhibits also displayed high values for repeat visitors and number of stops, showing that children of this age group were drawn back to the exhibit after their initial interaction. In addition, the Burrows also displayed a high number of repeat visitors and a high number of stops, showing that although it was slightly less popular in terms of visitation, the children who did visit enjoyed it enough to come back and interact again.

For toddlers, the next most popular exhibit was the Climb-on Carriage, followed by the Ropes, Lava Dots, and Camouflage Disco. The Climb-on Carriage displayed high values for repeat visitors and number of stops, showing that the Train Area is very popular with toddlers, as the most popular exhibit for toddlers is the Train Tunnel. The Ropes, Lava Dots, and Camouflage Disco displayed middle to low values for number of repeat visitors and number of stops, showing that although they were initially popular, children rarely returned to interact again. The Upper Net and the Interactive Tables, which were slightly below the Ropes, Lava Dots, and Camouflage Disco in number of visits, had high values for number of repeat visitors and number of stops, showing that although not as many children attended these exhibits, the ones who did often returned to interact again.

For babies, the Blocks and the Lava Dots are the next most popular exhibits in terms of visits, but had middle to low values for number of return visitors and number of stops. Although they were not in the top for the most popular exhibits for babies, the Interactive Tables and the

Lillipads had had values for number of repeat visitors and number of stops, showing that the children who interacted with the exhibits wanted to return.

Overall, the most popular exhibits for each age group match the expected and intended uses of the exhibits. Results showed that older children were more attracted to the high-energy, physically challenging exhibits including the Upper Net and the Bean Bag Swings, with the Big Box area being the most popular area for the older age range. Babies and younger children were more attracted to the low-energy areas including the Interactive Tables, the Blocks, and the Lillipads, which are located within the Mirror Room and the Lullaby Nook Area. Toddlers, who fall within the middle of the intended age range, showed an attraction to both high-energy and low-energy exhibits, such as the Upper Net and the Interactive Tables, showing that children within that age range enjoy both types of exhibits.

4.3.3. Holding Power

The team defined holding power as an exhibit's ability to engage a child and maintain their attention. If a child tends to engage with an exhibit for an extended period of time, the exhibit therefore has a high holding power. However, if a child does not spend a long time at an exhibit, it has a relatively low holding power. Holding power is a unique statistic that cannot be directly represented by a single metric or unit. Instead, an exhibit's holding power must be derived by comparing multiple data sets and statistics for the individual exhibit. The team decided that the most useful information for determining an exhibit's holding power is the number of stops to the exhibit and the total time spent at the exhibit, as this information allowed the team to identify how long an exhibit is capable of keeping a child engaged during a single interaction.

To visually analyze the relationship between time and stops, the team compared the graph of total number of stops at each exhibit to the graph of total time spent at each exhibit, shown in Appendix F (Graphs 26 and 30, respectively). To allow for a direct analysis of the relationship between these two graphs, the team created a combination plot of the two data sets overlaid using a bar graph and scatter plot.

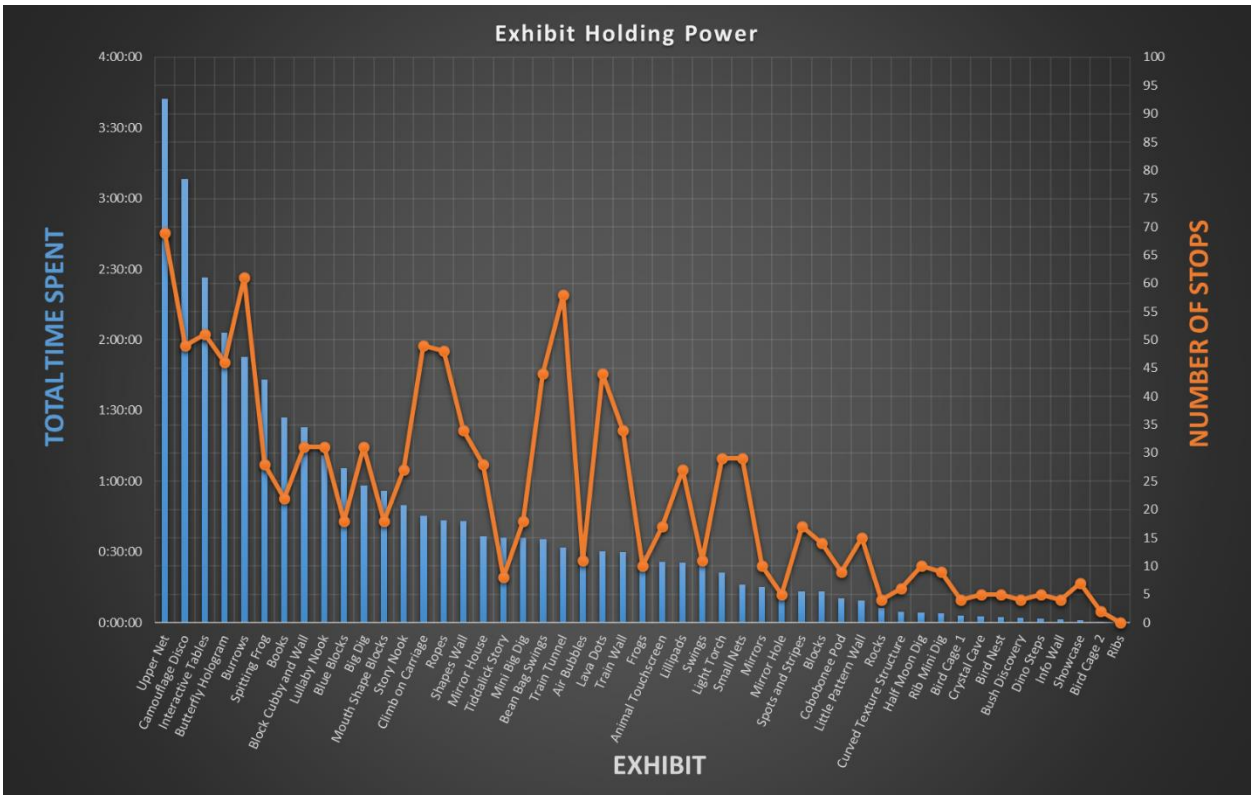

Figure 35: Exhibit Holding Power

The bar graph in Figure 35 shown above represents the total time spent at each exhibit by children. These values are sorted from greatest to least to more easily find the exhibits with the highest and lowest times spent. The orange scatter plot represents the total number of stops recorded at each of the exhibit. A comparison of these two values allows for an estimate of an exhibits holding power to be made. If an exhibit has a relatively high total time compared to the number of stops, the exhibit has a high holding power. This means that the children who went to the exhibit stayed there for a longer duration of time. If the number of stops is high compared to the total time at the exhibit, the exhibit therefore has a lower holding power. However, the two y-axes of the graph are in different units and therefore have no direct correlation. This means that all relationships and inferences made from this graph are relative, because changing the scale of one axis would change the relationship between the two plots. To eliminate the issue of the non-related y-axes, the team directly compared the values by creating a scatter plot of total time versus total stops.

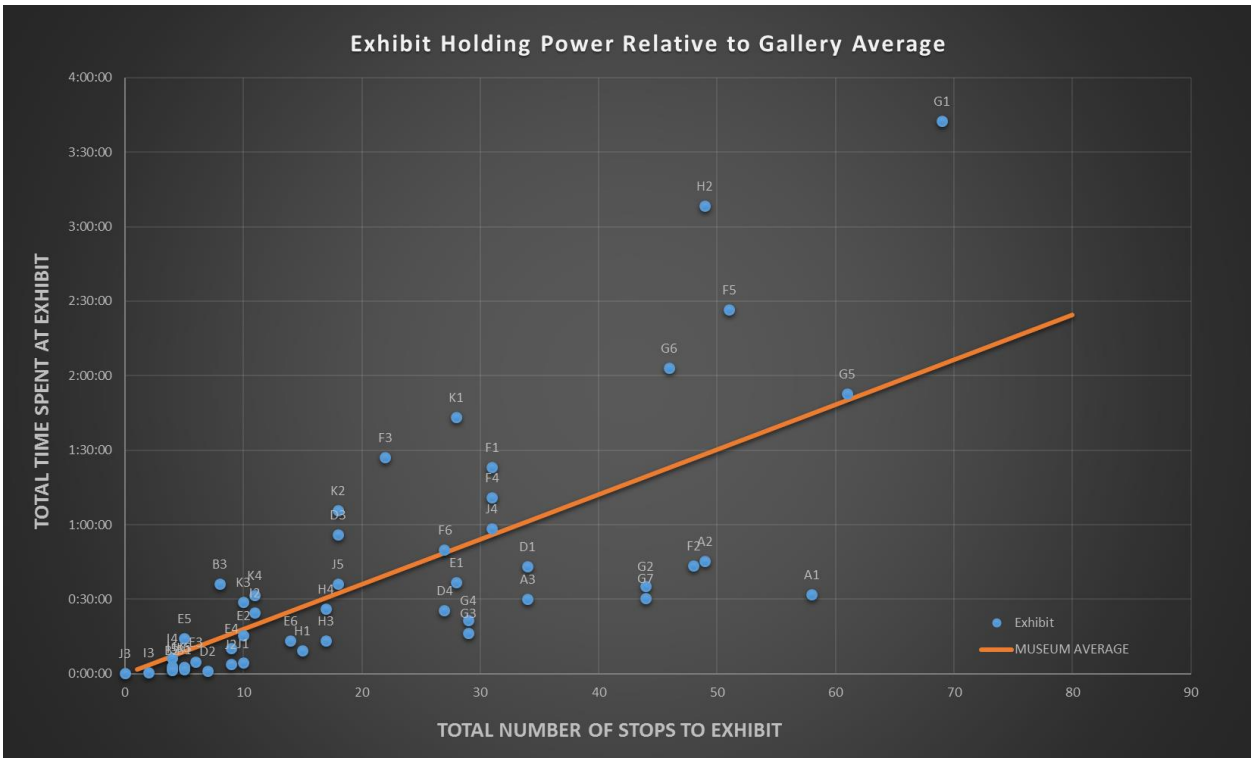

Figure 36: Exhibit Holding Power Relative to Gallery Average

Figure 36 shown above more directly represents the holding power of exhibits by plotting the total time spent at exhibits along the y-axis and the total number of stops to exhibits along the x-axis. The resulting scatterplot displays each of the individual exhibits represented by the blue data points. The holding power of exhibits can be inferred from this graph based on the location of the data points. As a higher holding power corresponds to a longer time spent per stop at an exhibit, it was determined that data points that are further along the x- and y-axis represent higher holding power. As a result, data points that are in the top right corner of the graph represent the highest holding powers. This can be further visualized connecting a line from the data point to the origin; a line with a greater slope represents a higher holding power.

To provide a unit for comparison, the team found the average duration of a child's interaction with an exhibit across the entire gallery by dividing the total time spent at exhibits (33 hours, 35 minutes and 37 seconds) by the total number of recorded stops at exhibits (1116). This resulted in an average gallery stop duration of 1 minute and 48 seconds. The average stop duration was then plotted onto the scatterplot as a line with a slope of 1 minute 48 seconds per stop, acting as a basis for comparing the holding power of exhibits to the gallery average. If an exhibit's data point falls above the line, the exhibit has an above average holding power across

the gallery, while if the data point falls below the line, the exhibit has a below average holding power.

Although the graph in Figure 36 represents if an exhibit had an average stop duration that was higher or lower than the gallery average, it is difficult to directly compare the holding powers of different exhibits. To solve this issue, the team created a plot displaying the holding power of each exhibit relative the gallery average.

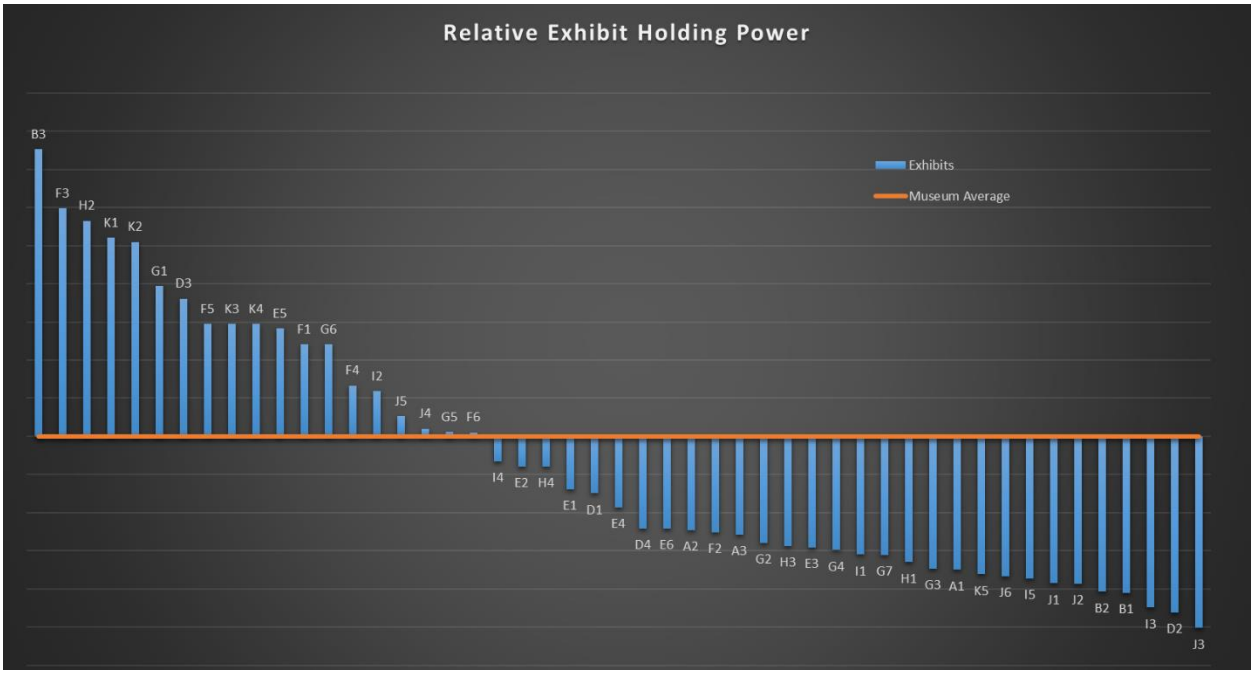

Figure 37: Relative Exhibit Holding Power

Figure 37 shown above allows for the direct comparison of exhibit holding powers based on their difference from the gallery average holding power. The orange line across the origin represents the gallery average stop duration, or the gallery average holding power, while the blue bars represent the holding powers of different exhibits compared to the gallery average found by subtracting the gallery average time per stop from the average time per stop at each exhibit. The values are organized from greatest to least to easily compare the holding powers of exhibits.

The exhibits that recorded the top 10 highest holding powers were the Tiddalick Story, the Books, the Camouflage Disco, the Spitting Frog, the Blue Blocks, the Upper Net, the Mouth Shaped Blocks, the Interactive Tables, the Frogs, and the Air Bubbles. These exhibits are engaging for children and compel them to play and interact for an extended period of time. Many

of the exhibits with high holding powers also have a high educational value for children. For example, the Tiddalick Story, which is an interactive video that tells the tale of Tiddalick the Frog from Australian Aboriginal mythology, has the highest holding power of all the exhibits in the gallery. Once children begin the story, they become invested and want to listen to the story in its entirety before leaving the exhibit. In fact, many children who stopped at the Tiddalick Story stayed for almost its entire duration, as the story lasts roughly 5 minutes and 45 seconds and the average stop time at the exhibit was 4 minutes and 31 seconds.

The Books exhibit also has a very high holding power, as caregivers are often reading with the children, encouraging them to stay and listen. The Upper Net surprised the team by ranking only sixth in holding power when it had by far the highest total time spent in an exhibit. After further analysis of the data, it was clear that this was due its high number of repeat visitors and number of stops per visit, meaning that although children did not spend as long at the exhibit during each individual interaction, they returned to play in the net more than once, which allowed for it to surpass all other exhibits in total time. While the Tiddalick Story had a higher holding power than the Upper Net, it did not have any repeat visitors. This is because once children watched the story, they had fully experienced the exhibit and wouldn't gain anything new from a second stop. This shows that holding power alone cannot be used to compare exhibits and their performances, and multiple data sets are required to fully analyze an exhibit's effectiveness.

The exhibits that ranked in the bottom ten for holding powers were the Showcase in the Shapes Wall Area, Bird Cage 2, Dinosaur Footsteps, Info Wall, Rib Mini Dig, Half Moon Dig, Bush Discovery Area, Bird Nest, Crystal Cave, and Train Tunnel. There are many reasons an exhibit may have a relatively low holding power, such as interest to children and exhibit design. If children do not find an exhibit particularly interesting or engaging, they will not spend a lot of time at that exhibit. On the other hand, some exhibits are specifically designed to have a short holding power, as children will gain the full experience of the exhibit after only interacting with it for a short time period. For example, the Train Tunnel exhibit was reported to be the most popular exhibit, however it fell in the bottom 10 exhibits in terms of holding power. This is due to the fact that children often use the tunnel as an entrance to the gallery and briefly walk through the exhibit rather than staying inside to play. Similarly, the Lava Dots and Dinosaur Footsteps exhibits are designed as small features for children to walk across; therefore, children can fully

experience these exhibits in a matter of seconds by hopping from dot to dot or footstep to footstep.

Although an exhibit may have a low holding power, it does not necessarily have a poor performance. All exhibits are designed with different ideas on how children will use the exhibit and how long the children will interact with the exhibit. Many exhibits with low holding powers are meeting their design intent and are being used as planned. To more accurately evaluate the performance of an individual exhibit, researchers often compare the intended length of interaction to the recorded average length of interaction; however, the team was unable to acquire data on the intended lengths of interactions for individual exhibits within the gallery.

4.3.4. Caregiver Interaction

During the tracking and timing study, the team made note of the level of interaction between the caregiver and their child at each exhibit. Caregiver interaction is an important metric that displays the level of caregiver involvement in their child's play and learning at the gallery. In addition, caregiver interaction provides insight into whether or not the exhibits are being used as intended, as some exhibits are intended for children to interact independently while others are designed to encourage caregiver-child interactions.

To evaluate caregiver interaction, the team developed a scale ranging from one to four, progressing from no interaction to maximum interaction, to describe how the caregiver was interacting with their child at an exhibit. If a caregiver was given a score of one at an exhibit, the caregiver was not interacting with their child and may have either been using their phone, speaking with another adult, or getting a coffee from the cafe. If a caregiver was given a score of two, the caregiver was watching but not directly interacting with their child. If a caregiver was given a score of three, the caregiver was playing with their child at the exhibit, but in a fun rather than educational manner. If the caregiver was given a score of four, the caregiver was actively teaching their child by explaining specific aspects of the exhibit or how to interact with it. When examining the recorded caregiver interaction data from individual tracks, the team decided that if a child stopped at an exhibit multiple times with different caregiver interaction scores for each stop, the maximum recorded caregiver interaction score would act as the overall score for that exhibit. For example, if a caregiver received a caregiver interaction score of four after teaching

the child how to use the exhibit but only watched the child play when they returned to the exhibit later in their stay, the exhibit would receive an overall score of four for that track.

After the team identified the caregiver interaction scores of the visited exhibits for each individual track, the team calculated the average caregiver interaction for each track by averaging the caregiver interaction scores at each visited exhibit. Results showed that out of the 52 tracks, 38 had an average caregiver interaction score between two and three, seven had an average interaction score less than two, five had an average interaction score greater than three, and two did not have an interaction score, as their children did not interact with any exhibits during their visit. When analyzing the overall data, the team evaluated whether the average caregiver interaction score was affected by the amount of time a child spent in the gallery. To determine if there was a correlation between times spent in the gallery and average caregiver interaction, the team created the graph shown below in Figure 38, which directly compares the two variables. As the graph shows, the 38 tracks that averaged a caregiver interaction score between two and three varied greatly in their time spent within the gallery; therefore, no correlation was seen between caregiver interaction and time spent in the gallery.

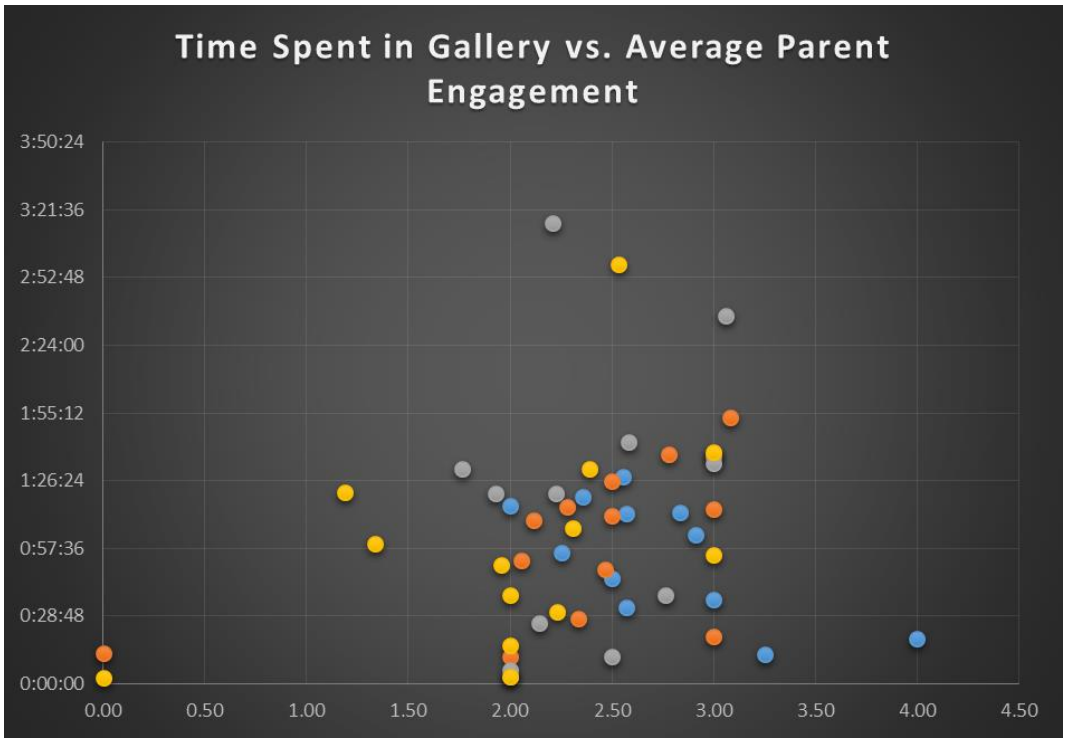

Figure 38: Time Spent in Gallery Relative to Average Caregiver Interaction

To compare the caregiver interaction at exhibits, the team calculated the average caregiver interaction scores for each exhibit by averaging the exhibit scores from each track. The results are shown in Figure 39 below, which displays a bar graph of the average caregiver interaction scores for each exhibit.

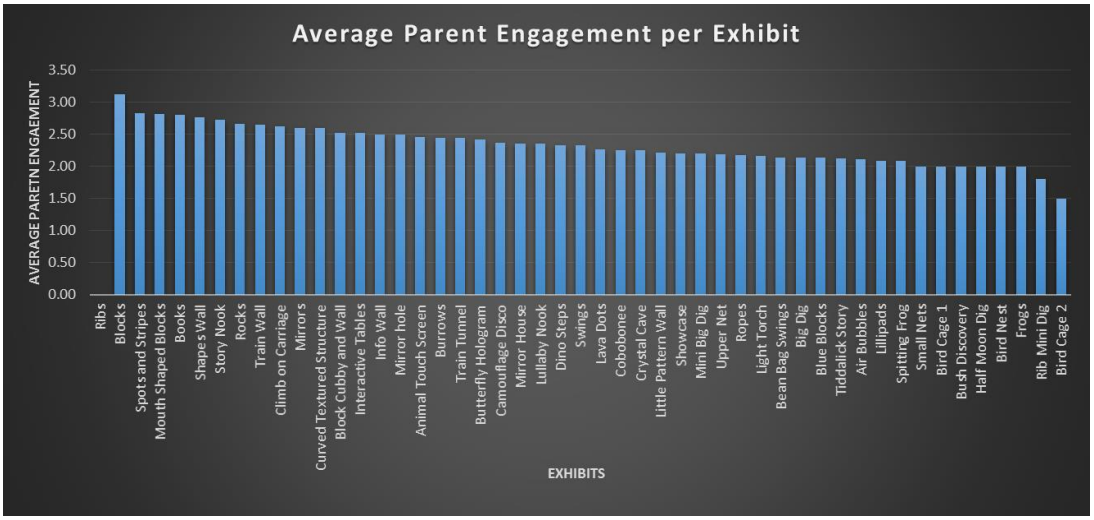

Figure 39: Average Caregiver Interaction at Exhibits

As shown in the graph, the Blocks exhibit had the highest caregiver interaction with an average score of 3.13, and was the only exhibit with a score greater than three. The Spots and Stripes Showcase had the next highest score of 2.83, followed by the Mouth Shaped Blocks, Books, Shapes Wall, and Story Nook, which all received scores above 2.7. The exhibits with the highest scores are all interactive exhibits that are intended to encourage caregiver-child interactions, as caregivers will often play with the blocks or read books to their children, which shows that the exhibits are meeting their intended uses. Many of the exhibits are also intended to be used by younger children and may require caregivers to teach their children how to use the exhibits or to use the exhibits with them, such as the Shapes Wall.

Bird Cage 2 and the Rib Mini Dig received the two lowest average caregiver interaction scores of less than 2.0, followed by the Small Nets, Bird Cage 2, Bush Discovery, Half Moon Dig, Bird Nest, and Frogs, which all received a caregiver interaction score of 2.0. Unlike the exhibits with high caregiver interaction scores, the lowest scoring exhibits are not directly intended to promote caregiver interaction. Most of the lower scoring exhibits are less interactive exhibits that do not require caregivers to explain or help their child interact, such as Bush

Discovery and the Bird Nest, or are exhibits that are attractive to children but not attractive for adults to play with their children, such as the sand pits at the Half Moon Dig and the water at the Frogs. The team also noted that the exhibits with the lowest average caregiver interaction scores are located within outdoor areas, which received fewer overall visits from children than indoor areas. With fewer overall visits, there is less data showing how caregivers typically interact with children at these exhibits, therefore more tracking is required to make concrete conclusions about caregiver interactions within outdoor areas.

To further analyze caregiver interaction data, the team evaluated the caregiver interaction scores for each developmental age group at each exhibit. The graph displaying the average caregiver interaction scores for each age group at each exhibit can be seen as Item 31 in Appendix F. Overall, babies have higher average caregiver interaction scores throughout the gallery, as they require more care and attention due to their young age. Babies received the highest caregiver interaction scores at the Train Wall, the Spots and Stripes Showcase, the Shapes Wall, and the Blocks. All four exhibits promote caregiver interaction, as the Shapes Wall encourages caregivers to show their child how to use the wall, the Blocks encourage caregivers to play and build with their child, and the Train Wall and the Spots and Stripes Showcase encourage caregivers to teach their child about the different aspects of the wall, including both tactile and educational aspects. Toddlers received the highest caregiver interaction scores at the Info Wall and the Lullaby Nook, which are also areas that promote caregiver interaction by encouraging caregivers to explain educational aspects to their children and providing a comfortable environment for them to interact together. Children ages 3 to 4 received the highest caregiver interaction scores at the Mouth Shaped Blocks and the Books, which are also exhibits that include activities that promote caregiver interaction. Lastly, children ages 4 to 5 received the highest caregiver interaction score at the Showcase located within the Shapes Wall Area, followed by other gallery showcases including the Little Pattern Wall and the Spots and Stripes Showcase, which encourage caregivers to explain and communicate with their children about their contents.

4.4. Interview Findings

Throughout the duration of the project, a total of 50 interviews were conducted with caregivers of children visiting the gallery. The team found that gallery visitors were willing to

participate in the interviews and provided thoughtful and insightful responses. The interviews provided valuable information regarding the most popular and enjoyable exhibits, as well as the perceptions of caregivers on the educational value of the gallery. For each question asked during the interviews, the caregivers were able to give multiple responses. To determine trends in the responses, the team coded the responses into commonly heard themes, which are displayed in the results below.

To begin the interview, the caregivers were asked the introductory question, "What brings you to the children's gallery today?" The responses to this question can be seen in Figure 40 below, which displays the most frequent responses for caregivers of children within each of the four developmental age groups. The figure shows that, overall, the most frequent response from caregivers was that they were visiting the gallery as something to do or to play and have fun with their children. Many caregivers also responded saying that they had come to see the rest of the museum and decided to stop by the children's gallery during their visit, or that they were first time visitors who had heard about the gallery through advertisements or from friends and family. Additionally, the results of the interviews showed that a majority of caregivers were repeat visitors who came back with their children because they had enjoyed the gallery so much during their first visit. After the introductory question was asked, the interview was then turned towards its main intents: favorite exhibits and educational value.

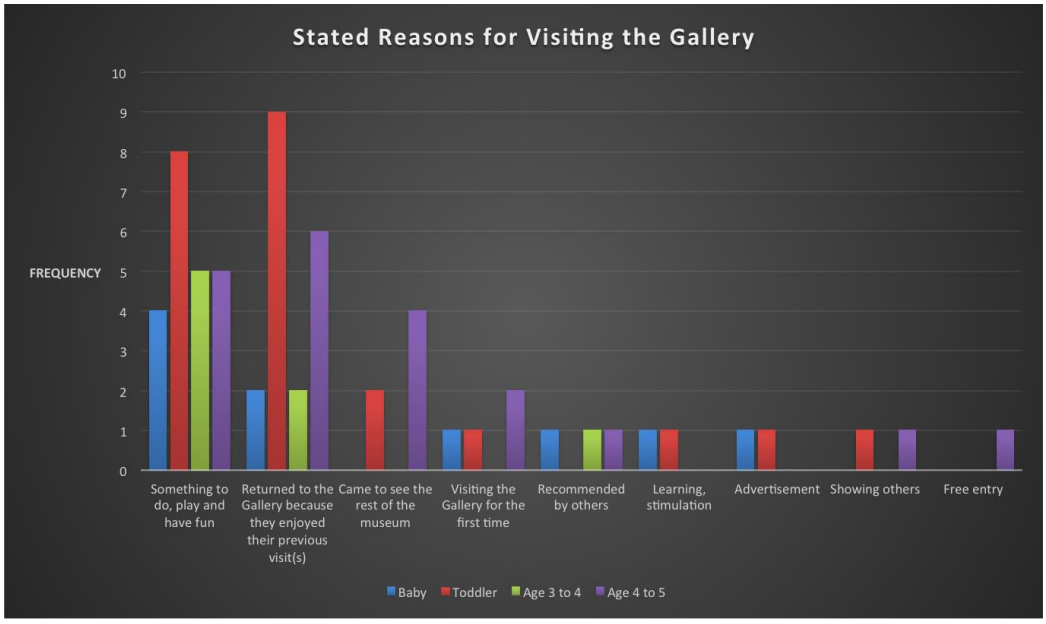

Figure 40: Stated Reasons for Visiting the Gallery by Age Group

4.4.1. Favorite Exhibits

To gather information regarding favorite exhibits within the gallery, the caregiver was asked, "Which exhibit was your child/grandchild's favorite?" and "Why?" The responses to these questions can be seen below in Figure 41 and 42, which display which exhibits were mentioned by the caregivers of each developmental age group as being one of their child's favorite exhibits and the reasons why the exhibits were their child's favorites, separated by each developmental age group.

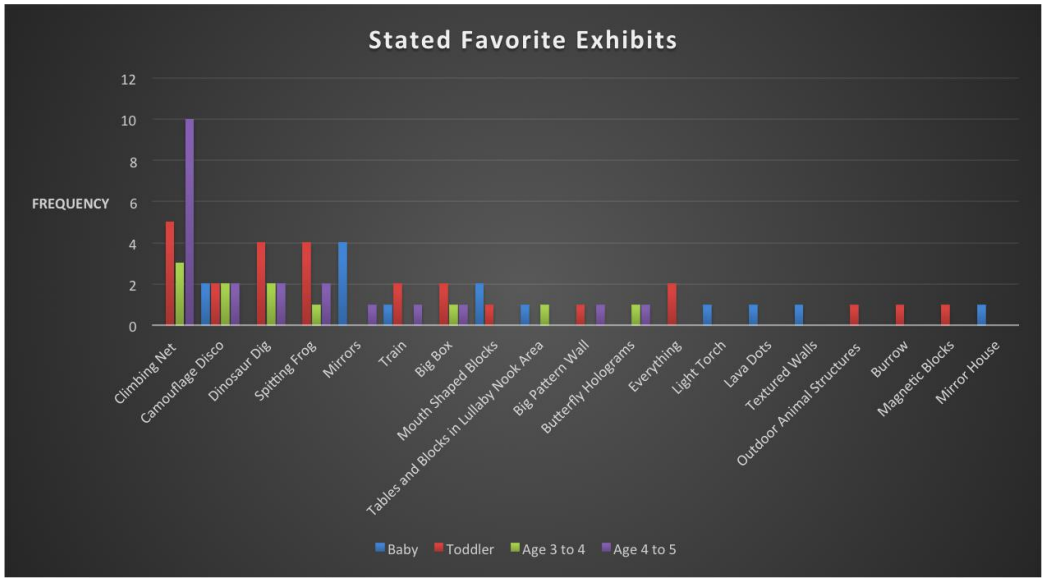

Figure 41: Stated Favorite Exhibits by Age Group

As Figure 41 shows, children of all age groups enjoy a variety of different exhibits, with a total of 19 different exhibits being mentioned as a favorite exhibit. The Climbing Net was the most frequently mentioned response, with 36% of caregivers mentioning it as one of their child's favorite exhibits. It is most popular with older children, as it was the most frequent response from the caregivers of children ages 4 to 5, ages 3 to 4, and toddlers. The mirrors within the Mirror Room (area E) of the gallery were the most frequent response from the caregivers of babies. The responses also show that toddlers, who fall in the middle of the intended age range, enjoy the greatest variety of exhibits within the gallery. The caregivers of toddlers mentioned twelve different exhibits as being one of their child's favorite exhibits, with two caregivers stating that they could not choose a favorite exhibit for their toddler, as they enjoyed everything within the gallery.

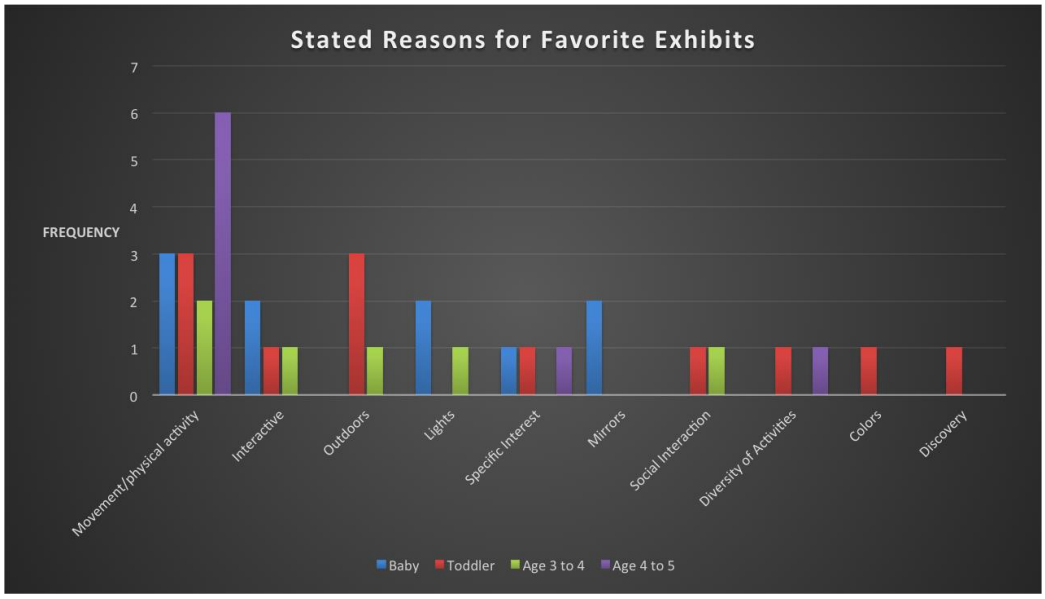

Figure 42: Stated Reasons for Favorite Exhibits by Age Group

Figure 42 shows that movement and physical activity involved with interacting with the exhibits, such as climbing on the Climbing Net Structure, was the most frequent response from caregivers of all age groups as why their child enjoyed their favorite exhibits. The caregivers of toddlers also frequently mentioned that their children loved being outdoors as a reason that their children enjoyed their favorite exhibits, as the dinosaur dig and the spitting frog were two frequently mentioned favorite exhibits of toddlers. The results again show that toddlers have the greatest variety of interests within the gallery, as the caregivers of toddlers gave the greatest variety of answers for why their child enjoyed their favorite exhibits. Toddlers, being the middle of the intended age range, enjoy both the climbing and physical activity that is geared more towards the older children as well as the sensory features that are geared more towards the younger children.

4.4.2. Educational Value

To gather information regarding the caregiver's perceptions of the educational value of the gallery, the caregivers were asked, "Do you feel that the exhibits were educational?" and "In what ways?" Overall, 82% of the caregivers that were interviewed stated that the exhibits were educational, while only 6% stated that they did not think the exhibits were educational. The remaining caregivers stated that their children were too young for them to determine if they were learning during their interactions.

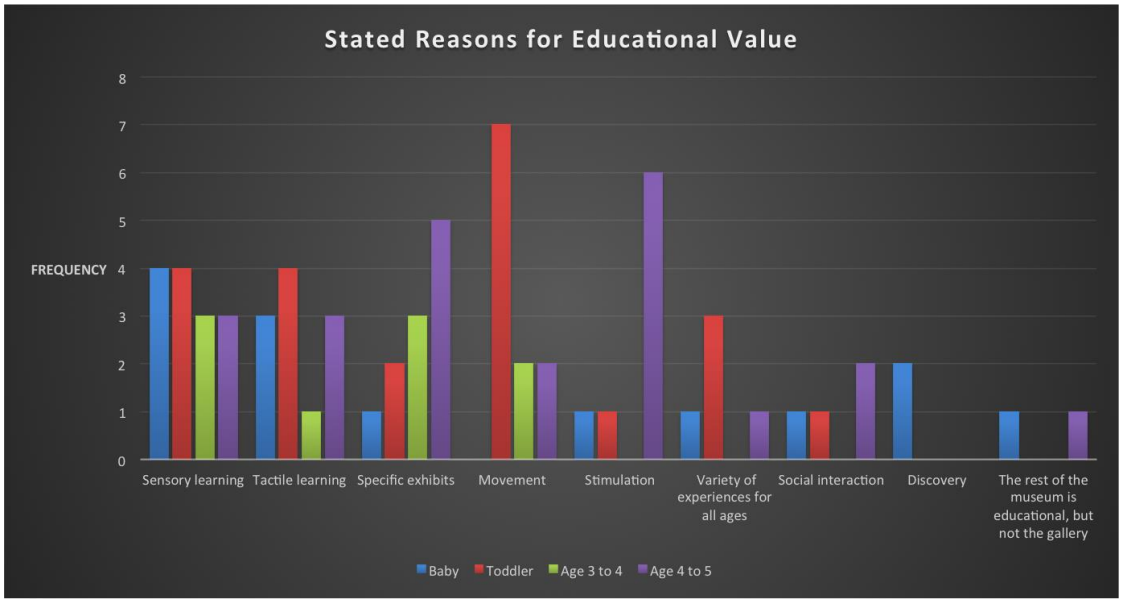

Figure 43: Stated Reasons for Educational Value by Age Group

Figure 43 displays the most frequent responses provided for why the caregivers thought that the exhibits were educational, separated by age group. The most frequent response across all age groups, provided by 28% of caregivers, was sensory learning experienced through interactions with the various shapes, sounds, lights, and colors that are present throughout the gallery. This was the most frequent response received from the caregivers of both babies and children ages 3 to 4. The most frequent response from the caregivers of toddlers was learning through movement, while the most frequent response from the caregivers of children ages 4 to 5 was mental stimulation.

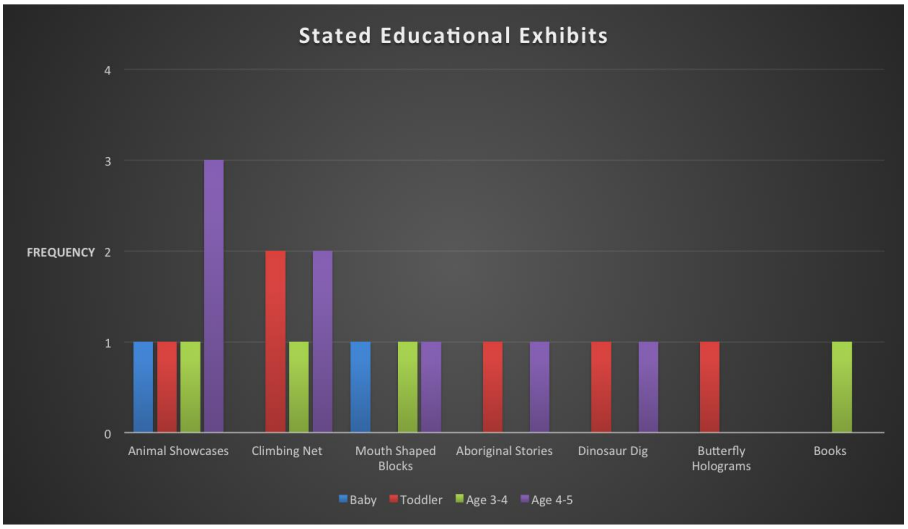

Figure 44: Stated Educational Exhibits by Age Group

In addition, Figure 44 displays the specific exhibits within the gallery that caregivers mentioned as providing educational value, which was the third most frequent response from caregivers across all age groups and tied for the most frequent response from the caregivers of toddlers. The Animal Showcases have the highest number of responses, as they present informative content that often prompt questions from children, followed by the Climbing Net, which offers physical aspects of learning for children. The Aboriginal Stories, the Dinosaur Dig, and the books provide historical and school-based learning content while the Mouth Shaped Blocks and the Butterfly Holograms provide sensory learning content, all in fun and interactive formats.

4.4.3. Additional Comments

At the end of each interview, the caregivers were asked if they had any additional comments about their experience in the gallery. The responses were overall positive and complementary of the gallery. Of the caregivers interviewed, 50% stated that they loved the gallery, with two caregivers quoted saying, "Wonderful, I love it!" and "The refurbishment is amazing." Additional positive comments included that the gallery was clean and well organized, and that the designers did an excellent job developing the exhibits for the intended age range.

In addition to the positive comments, caregivers also responded with suggestions for improvements. One caregiver commented that she found the seating area under the climbing net too dark to sit and read a book with her child, and suggested that additional lighting should be added to the area. Another caregiver commented that the sun can get harsh on children outside, and suggested that more shading should be added to the outdoor areas. Additionally, a caregiver mentioned that the net in the Climbing Net was hard on children's feet, and suggested that it would be beneficial to improve the material of the net. Multiple caregivers who were repeat visitors also commented saying that they would enjoy the addition of activities and program in the gallery, as well as the addition of new books and toys to add new aspects for frequent visitors. Lastly, multiple caregivers commented on the busyness of the gallery, specifically on the weekends. One of the caregivers recommended that to help with the busyness, the staff should better promote the pram parking, as most visitors do not use the pram parking and park their prams in the hallway of the gallery, further crowding the area.

4.5. Observational Study

To evaluate the behaviors of children at main areas and exhibits within the gallery, the team conducted observational studies at the Burrows, the Light Torch, the Lullaby Nook Area, the Upper Climbing Net, the Lower Climbing Net Area, the Butterfly Holograms, the Shapes Wall, and the Camouflage Disco. The studies identified the most frequent behaviors that children exhibit when interacting with each area, which allowed the team to create tables of commonly observed behaviors for each of the four developmental age groups at each area. For applicable areas, the team compared the commonly observed behaviors tables to the expected behaviors provided by gallery designer Alexandra Price in order to evaluate whether children are using the exhibits as the designers had intended. In addition, the team compared the commonly observed behaviors to established behavioral indicators of learning to identify the learning value of each exhibit.

During the studies, the team observed 25 children across each of the four developmental age groups using the checklists provided as Items 8-15 in the Area-Specific Behavioral Checklist section of Appendix B. While conducting the observations, the team members checked off all behaviors that the child was exhibiting every 15 seconds, meaning that each behavior on the checklist had the potential to be observed once every 15-second interval. In order to accurately weight the recorded behaviors, the team divided the total number of times a behavior was exhibited by the maximum number of times the behavior could have been exhibited, which is equal to the total number of 15-second intervals that the child was interacting with the exhibit. The calculated values represent the percentage of the total interaction time that a child spent performing a specific behavior. For example, if a child interacted with an exhibit for four 15-second intervals and was recorded climbing during two of the four intervals, the child spent 50% of their interaction time climbing. To determine the commonly observed behaviors, the percentages for observed behaviors were averaged for each age group at each area. The team determined that any behavior exhibited for more than an average of 10% of the total time spent at an area would be classified as a commonly observed behavior.

4.5.1. The Shapes Wall

The Shapes Wall is an exhibit located within the Shapes Wall Area that consists of an interactive touch screen with lights, buttons, gears, cranks, and sliding pins within three-

dimensional shapes. The wall also contains more traditional museum style features including three showcases containing various items and fossils for children to touch and feel. Of the 25 children that were observed while interacting with the Shapes Wall, nine were babies between the ages of 0 and 18 months, then were toddlers between the ages of 18 months to 3 years, three were between the ages of 3 and 4, and three were between the ages of 4 and 5. The results from the observations showed that babies spent an average of 88.3 seconds interacting with exhibit, toddlers spent an average of 52.5 seconds, children ages 3 to 4 spent an average of 75 seconds, and children ages 4 to 5 spent an average of 30 seconds. The higher number of recorded observations as well as the longer interaction times for babies and toddlers proves that the gallery designers were successful in creating an exhibit intended for younger children. After randomly selecting 25 children, 19 fell between the ages 0 to 3 while only six fell between the ages of three and five. Also, the younger children spend longer at the exhibit, as babies spent an average of 88.3 seconds while children ages 4 to 5 spend an average of 30 seconds. To compare the behaviors of the different age groups at the exhibit, the team created a bar graph of the behaviors from the checklist that were recorded at least once while observing the 25 children. This bar graph can be found in Appendix G as Item 32. The results from the bar graph were analyzed and compiled into Table 3 below to display the commonly observed behaviors of children at the Shapes Wall.

Shapes Wall Commonly Observed Behaviors			
Babies	**Toddlers**	**Ages 3 to 4**	**Ages 4 to 5**
Play by themselves	Play by themselves	Play by themselves	Play with caregivers
Play with caregivers	Play with caregivers	Play with caregivers	Copy caregiver's actions
Play with other children	Play with other Children	Show exhibits to others	Standing
Listen to caregivers	Show exhibits to others	Standing, kneeling	Looking at traditional showcases
Copy caregivers' actions	Standing	Looking at, turning on, and touching wall projections	Looking at, turning on, and touching wall projections
Use pieces of wall to pull themselves up	Watching others play	Moving pin in 3D slot	Moving pin in 3D slot
Crawling, Standing	Looking at Traditional Showcases	Spinning crank	Turning gears
Watching others play	Move pin in 3D slot	Pressing buttons	Spinning Crank
Looking at Traditional Showcases	Spin Crank	Touching Fossils	Pressing Buttons
Looking at, touching, and turning on wall projections	Pressing Buttons, turning on projections		Touching Fossils
Moving pin in 3D slot			
Turning gears, Spinning Crank			

Table 3: Shapes Wall Commonly Observed Behaviors

The results of the observational study show a trend correlating the age of a child to level of caregiver interactions. At this exhibit, there is a clear trend that as children become older, they interact more independently, while younger children interact with their caregiver. This can be visibly seen in Item 32 of Appendix G, as the bars showing self-interaction increase with age, and the bars showing caregiver interaction decrease with age. The 4 to 5 age group is an exception to this trend, however this may be due to the low number of children observed within this age range as well as the short duration of their interactions at the exhibit. On average, babies spent 71% of their time with their caregivers, toddlers spent 54% of their time with their caregivers, and children ages 3 to 4 spent 45% of their time with their caregivers. It was also

noted that younger children spend more of their time watching, listening to, and copying their caregivers, which indicates they are directly learning through interactions with caregivers. Older children, however, spend more time interacting with the exhibit alone, as they do not need to be taught how to use the features of the exhibit.

Although no expected uses for the Shapes Wall were provided from the designers, the team concluded that the exhibit is being used as intended. This conclusion is backed by the lack of unexpected observed behaviors, as all demonstrated behaviors were present on the previously created behavioral checklist. In addition, the higher number of babies and toddlers who interacted with the exhibit and the longer interaction times of the younger age groups further proves that the exhibit is being used as intended, as Alexandra Price informed the team that the Shapes Wall Area was intended to be a lower energy area for younger children.

4.5.2. The Lullaby Nook

The Lullaby Nook Area is a low-energy space located within the Big Box. The area consists of different exhibits including interactive tables, relaxing nooks, books, and a magnetic wall with blocks. Of the 25 children that were observed during the study, only one child fell within the 0-18 month age range, therefore commonly observed behaviors could not be determined for babies within the area. For the remaining observed children, eight were toddlers, six were children between the ages of 3 and 4, and ten were children between the ages of 4 and 5. The results of the study are displayed in Item 33 of Appendix G, which displays the percentage of time each age group spent demonstrating the observed behaviors. The graph was then used to develop a table of commonly observed behaviors for each age group, shown below in Table 4.

Lullaby Nook Area Commonly Observed Behaviors		
Toddlers	**Children Ages 3 to 4**	**Children Ages 4 to 5**
Play by themselves	Play by themselves	Play by themselves
Play with caregiver	Play with caregiver	Play with caregiver
Play with other children	Demonstrate calm and relaxing behavior in the nooks	Play with other children
Call for caregiver	Look at the screen in the lullaby nook	Focused, intense stares while playing with magnetic wall, blocks, and interactive tables
Show excited expressions towards accomplishments	Look, touch, and play with face puzzle table	Strategically place magnets on wall
Focused, intense stares while playing with magnetic wall, blocks, and interactive tables	Strategically place magnets on wall	Play with blocks
Strategically and randomly place magnets on wall	Sit and read at the reading nook	Look, touch, and play with face puzzle table
Stand while playing at tables and magnetic wall	Focused, intense stares while playing with magnetic wall, blocks, and interactive tables	Watch aboriginal story within nook
Sit and read with caregiver at the reading nook		Run and climb in the Lullaby Nook
Build blocks with a purpose		
Look, touch, and play with face puzzle table		
Demonstrate calm and relaxing behavior in the nooks		
Play on white windowsill ramp		

Table 4: Lullaby Nook Area Commonly Observed Behaviors

Results showed that children within all age groups interacted both independently and with others. Toddlers were particularly interested in playing and interacting with their caregivers, spending an average of 41% of their time in the area with their caregiver. The behaviors demonstrated by toddlers showed that they were engaged in all that of the exhibits they participated in, which also indicates that the area is successful in promoting learning and meeting its intended uses. When a toddler visited the magnet wall or blocks table, they strategically placed the blocks more often than they randomly placed the blocks when playing, and maintained a strong focus in order to accomplish their desired design. Additionally, it was noted that toddlers were focused while interacting with the Face Shapes Puzzle tables located within

the area. After a toddler had accomplished their goal at any of the exhibits within the area, their facial expressions showed that they were excited and proud of their accomplishment, and were likely to show their accomplishment to their caregiver. Observations also showed that toddlers specifically enjoyed the Face Shaped Puzzle Tables, and displayed relaxed behaviors in the Lullaby Nook, Aboriginal Nook and Reading Nook. Children ages 3 to 4 demonstrated similar behaviors to toddlers in terms of how they utilized the exhibits, but did so more independently from caregivers. On average, children in this age group interacted by themselves 71% of the time. The use of exhibits within the area was evenly spread within this age group, as children used all exhibits equally.

Children ages 4 to 5 displayed higher energy within the Lullaby Nook Area, with only 9% displaying relaxed behaviors. Children within this age group were able to build more complex structures with the blocks and finish the Shapes Face Puzzles faster than children within the younger age groups. Additionally, children ages 4 to 5 used the Lullaby Nook exhibit as an area to run and climb the walls of rather than a place to lie down, relax, and listen to music. They also visited the Aboriginal Nook more than any other age group, as they have a much higher attention span.

Gallery designer Alexandra Price provided the team with expected behaviors specifically for the Lullaby Nook within the Lullaby Nook Area, which can be seen as Item 5 in Appendix B. Overall, children observed during the study demonstrated the behaviors that were expected by the designers, showing that the exhibit is being used as intended. However, children ages 4 to 5 were observed running and climbing up and down the walls of the Lullaby Nook, which is an additional behavior that was not expected by designers. This behavior shows that children find unexpected ways to utilize exhibits, making it impossible to fully predict an exhibits exact usage.

4.5.3. Upper Net Structure

The Upper Net Structure is the large climbing net located in the Big Box area. Of the 25 children that were observed interacting with the exhibit, one was a baby, twelve were children between the ages of 3 and 4, and twelve were children between the ages of 4 and 5. Results shows that children spent a longer amount of time interacting with the Upper Net compared to other gallery exhibits, as the baby interacted with the exhibit for 3 minutes and 45 seconds, children ages 3 to 4 interacted for an average of 2 minutes and 9 seconds, and children ages 4 to

5 interacted for an average of 2 minutes and 31 seconds. Due to the lack of observations for babies and toddlers, the commonly observed behaviors were not determined for these age groups. The bar graph representing the average percentage of total time each age group spent exhibiting observed behaviors in the Upper Net can be found as Item 34 in Appendix G. The bar graph was then used to create the commonly observed behaviors table shown below in Table 5.

Upper Net Commonly Observed Behaviors	
Ages 3 to 4	**Ages 4 to 5**
Play by themselves	Play by themselves
Play with other children	Play with caregiver
May exhibit nervous and scared expressions	Smile and show excited expressions
May smile and show excited expressions	Climb slowly and carefully with a focused expression
Climb slowly and carefully with a focused expression	Climb quickly and actively
Climb quickly and actively	Enter and exit through the back exit
Enter and exit through the back exit	Stand and sit in net
Stand in net	Sit in lower nets in the back exit
Enter and quickly leave due to fear	Enter and quickly leave due to fear

Table 5: Upper Net Commonly Observed Behaviors

The results of the study showed that children ages 3 to 4 spent 70% of their time interacting by themselves and 30% of their time interacting with other children, while children ages 4 to 5 spent 47% of their time interacting by themselves, 31% of their time interacting with other children, and 15% of their time interacting with their caregiver. As no caregivers were observed playing in the net with their child, their interaction with their child consisted of speaking to the child from underneath the net. A notable behavior that was repeatedly seen throughout the observations was that children of both age groups avoided the front entrance of the net by entering and exiting through the lower nets located towards the Burrows. Children often displayed scared or nervous expressions when trying to climb up the front entrance of the net, as it is a greater physical challenge due to its height. When climbing within the net, children ages 3 to 4 climbed slowly and carefully more often than quickly and actively and also displayed nervous and scared expressions when climbing, showing that they are more hesitant and uncomfortable with their climbing abilities. In addition, 24% of children ages 3 to 4 entered the net and exited quickly with scared expressions due to fear. Alternatively, children ages 4 to 5

climbed quickly and actively more often than slowly and carefully and did not frequently display scared or nervous expressions, showing that they are more confident in their climbing abilities. However, 19% of children ages 4 to 5 were also recorded entering and exiting the net quickly due to fear, showing that some children within this age range are still hesitant and uncomfortable with their climbing skills.

Although the Upper Climbing Net is not directly educational in the same way as showcases or books within the gallery, it promotes learning through physical movement and play. As there are often many children playing within the gallery at once, the Upper Climbing Net teaches children how to interact with others in a friendly and polite manner. It also helps children build confidence in themselves and push their limits. This was demonstrated through their facial expressions and physical actions while interacting with the exhibits; although children showed scared and nervous expressions while entering the net, they often pushed themselves to continue and meet the challenge the net presented. In addition, the physical challenge presented by the net helps children develop motor skills, and improvements in physical ability and motor skills were directly observed in the study, as children ages 4 to 5 were more confident in the net than children ages 3 to 4.

The study also shows that the Upper Climbing Net is generally being used as expected, as the commonly observed behaviors found through the study match the expected behaviors provided by gallery designer Alexandra Price. Children ages 3 to 4 were observed interacting by themselves and with other children within the net, and children ages 4 to 5 were observed interacting by themselves, which is what the designers expected. However, the designers expected children ages 3 to 4 to show signs of being territorial and playing next to others as opposed to playing with others, which was not observed by team members during the study. In addition, the designers expected children ages 4 to 5 to engage in imaginative play within the net, which was also not observed by team members. However, this could be due to the small sample size of children that were observed, and additional observations are required to determine that children interacting within the net do not demonstrate the behaviors.

4.5.4. The Lower Net Area

The Lower Net Area is located in the Big Box and beneath the Upper Climbing Net. This area is constructed as a lower-energy area with seats and smaller climbing exhibits, designed to

accommodate children who younger children who are unable to climb or older children who are not comfortable with climbing within the Upper Climbing Net. The results of the study showed that children spent an average time of 53 seconds interacting within the area. Of the 25 children that were observed, three were babies, 13 were toddlers, six were children between the ages of 3 and 4, and three were children between the ages of 4 and 5. The percentage of time each age group spent demonstrating each observed behavior is displayed in Item 35 of Appendix G. The results of bar graph were then used to develop the table of commonly observed behaviors for each age group, which is shown below in Table 6.

Lower Net Area Commonly Observed Behaviors			
Babies	**Toddlers**	**Ages 3 to 4**	**Ages 4 to 5**
Play under the net with caregiver	Play under the net with caregiver	Play under the net with caregiver	Play by themselves
Carried by caregiver	Move around space by running and walking	Stand still and listening to caregiver	Move around space independently by running and walking
Sit and lay down	Climb and jumping off of seating area and surrounding objects	Walk to move around area	Play in Net Holes
Play on the seating area	Smile and show excited expressions	Play on the seating area	Play on Bean Bag Swings
Playing on the Bean Bag Swings		Smile, laugh, and scream due to excitement	
Crawl through the space			
Play on the baby bumps			

Table 6: Lower Net Area Commonly Observed Behaviors

The results showed that babies spent an average of 85 seconds interacting within the Lower Net Area, with most of their time spent interacting with their caregiver. Babies were observed playing primarily on the seating areas, but were also seen crawling around to other areas within the space. Due to their young age, baby's actions are reliant on their caregivers, and therefore can only stay as long as their caregivers stay. Toddlers spent the least amount of time in the Lower Net Area, averaging an interaction time of 37 seconds and spending an average of 62% of their time interacting with a caregiver. During their interaction time, toddlers were

frequently observed climbing and testing their own physical abilities. Children ages 3 to 4 spent an average of 43 seconds interacting with the exhibit, and were observed to be interacting with their caregiver 89% of the time. Children within this age range were not as sporadic as other age groups and spent a large amount of time in conversing with their caregiver. Children ages 4 to 5 spent an average time of 110 seconds within the Lower Net Area and were very independent, spending 77% of their time interacting by themselves. During their interaction time, the children were often observed using the Bean Bag Swings and the Nets Holes.

The physical activity and body movements of children within the Lower Net Area indicate that the area is succeeding in promoting sensory learning and the development of motor skills. Babies are able to crawl through the area and feel the textured rug and baby bumps, experiencing new textures and interacting with others within the area. Older children are able to walk, run, and climb throughout the area, improving their confidence while developing in their physical capabilities and learning how to use their bodies to climb and interact with the exhibits.

4.5.5. The Light Torch

The Light Torch is a smaller exhibit consisting of a large flashlight that, when pointed at different animal showcases located on the adjacent walls, causes the showcases to light up and make the noise of the animal. Of the 25 children that were observed at the Light Torch, four were babies, eight were toddlers, six were children ages 3 to 4, and seven were children ages 4 to 5. Children spent a relatively short amount of time interacting with the exhibit, as babies spent an average of 45 seconds or 3 15-second intervals, toddlers spent an average of 30 seconds or 2 15-second intervals, children ages 3 to 4 spent an average of 66 seconds or 4.4 15-second intervals, and children ages 4 to 5 spent an average of 90 seconds or 6 15-second intervals. The bar graph representing the average percentage of total time each age group spent exhibiting each observed behavior at the Light Torch can be found as Item 36 in Appendix G, and again includes only the behaviors from the checklist that were observed at the Light Torch. The bar graph was used to create the commonly observed behaviors table for the Light Torch, shown below as Table 7.

Light Torch Commonly Observed Behaviors			
Babies	**Toddlers**	**Ages 3 to 4**	**Ages 4 to 5**
Play with caregivers	Play by themselves	Play by themselves	Play by themselves
Listen to caregivers	Play with caregivers	Focus, intensely stare at animals	Focus, intensely stare at animals
Focus, intensely stare at animals	Listen to caregivers	Stand while using light torch	Stand while using light torch
Stand while using light torch	Focus, intensely stare at animals	Aim the light torch and look at the animals	Aim the light torch and look at the animals
Walk to and touch animal showcases	Stand while using light torch	Walk to and touch animal showcases	
Aim the light torch and look at the animals	Point torch randomly		
	Aim the light torch and look at the animals		

Table 7: Light Torch Commonly Observed Behaviors

Results showed that babies spent a large majority of their time at the exhibit interacting with their caregiver, while toddlers, children ages 3 to 4, and children ages 4 to 5 typically interacted independently. When caregivers interacted with their children, who were usually babies or toddlers, they were often showing their child how to use the exhibit and pointing out the animals that were lighting up within the showcases. When this occurred, the babies and toddlers would listen and watch, and the toddlers would often then try to use the light torch on their own. When using the light torch, children most frequently stood and pointed the light torch directly at the animals, looking intently at the animal showcases and focusing on listening to the animal noises. Some children, mostly toddlers, pointed the torch around randomly in addition to pointing it at the showcases, while others, mostly babies and children ages 3 to 4, walked up to and touched the animal showcases to get a closer look.

The behaviors displayed at the Light Torch, including children's interactions with caregivers, facial expressions, and body movements, indicate that the exhibit is succeeding in promoting learning. The exhibit is encouraging caregiver-child interactions involving meaningful explanations and conversations, where caregivers are explaining how to use the exhibit and what the child is seeing in the animal showcases. Children also display learning through their facial expressions, as they are focused and intensely staring at the animal showcases while they are

interacting with the exhibit. In addition, the body movements exhibited by children, including walking up to the showcases and touching and pointing at the animals within, demonstrate that children are engaged and learning while interacting with the exhibit by showing that they are interested and surprised by what is inside.

4.5.6. The Burrows

The Burrows is an area located behind the Climbing Net in the Big Box area, and consists of a cushioned obstacle course, educational showcases, mirrors, and a small nook with a textured rug. Of the 25 children that were observed while interacting with the Burrows, eight were babies between the ages of 0 and 18 months, nine were toddlers between the ages of 18 months and 3 years, five were children between the ages of 3 and 4, and three were children between the ages of 4 and 5. Results showed that children spent around one minute interacting with the Burrows, with babies spending an average of 67.5 seconds or 4.5 15-second intervals, toddlers spending an average of 68.3 seconds or 4.6 15-second intervals, children ages 3 to 4 spending an average of 66 seconds or 4.4 15-second intervals, and children ages 4 to 5 spending an average of 55 seconds or 3.7 15-second intervals. The bar graph representing the average percentage of total time each age group spent exhibiting each observed behavior within the Burrows can be found as Item 37 in Appendix G. The graph includes only the behaviors from the checklist that were exhibited at least once by the 25 children that were observed. The results of the graph were then used to create the table of commonly observed behaviors shown in Table 8 below.

Burrows Commonly Observed Behaviors			
Babies	**Toddlers**	**Ages 3 to 4**	**Ages 4 to 5**
Play by themselves	Play by themselves	Play by themselves	Play by themselves
Play with caregivers	Play with caregivers	Play with caregivers	Sit, walk, and crawl on cushioned ramp
Listen to caregivers	Listen to caregivers	Walk and crawl on cushioned ramp	Look at and spin lower showcase
Focus on animal showcases	Walk, crawl, and climb on cushioned ramp	Climb over and under peg wall	Climb over and under peg wall
Stand, sit, walk, and crawl on cushioned ramp	Look at and spin lower showcase	Avoid peg wall	Jump off seats and cushioned ramp
Look at and spin lower showcase	Climb over and under peg wall		
Look at and spin upper showcase			
Look into showcase on the floor			

Table 8: Burrows Commonly Observed Behaviors

The results of the study showed that children older than 18 months frequently play independently at the Burrows, as toddlers played independently 69% of the time, children ages 3 to 4 played independently 88% of the time, and children ages 4 to 5 played independently 100% of the time. Babies spent a slightly higher percentage of their time interacting with their caregiver, as they spent 52% of the time interacting with their caregiver and 48% of their time interacting independently. However, even when interacting independently, caregivers closely watched their babies. It was also noted that babies spent more time observing and interacting with the showcases located at the far left of the Burrows, while the older age groups spent more time crawling, walking, and climbing on the cushioned ramp and the peg wall inside the burrow.

Overall, children used the Burrows as the team had expected, with all observed behaviors being previously included on the checklist. Babies were always accompanied by their caregiver, and were typically sitting, standing, or being held while either playing on the cushioned seating or viewing the showcases. Toddlers were more frequently interacting by themselves, although they were accompanied by adults 32% of the time, and spent most of their time actively playing on the cushioned ramp. The interactions between babies and toddlers and their caregivers indicate that the exhibit is promoting learning, as caregivers were often observed showing and explaining the contents of the showcases to their children and encouraging them to play and

explore within the Burrows. Children ages 3 to 4 and 4 to 5 played independently during most of their time spent at the Burrows and gravitated towards the peg wall, which presents a greater physical challenge for children. The body movements of older children indicate learning within the Burrows, as they are exploring and discovering how to control their bodies while improving their motor skills. It is important to note that the mirrors and the textured rug located at the far right end of the Burrows did not receive any use from children, which are two additional learning aspects of the Burrow.

4.5.7. The Butterfly Holograms

The Butterfly Holograms are an exhibit located in the back of the Big Box next to the Burrows and the Climbing Net. The exhibit consists of three touch screens that children can use to color butterflies, which are then displayed in real time as animated holograms. To determine the commonly observed behaviors at the Butterfly Holograms, the team observed 25 children as they interacted with the exhibit. Overall, children spent an average of 2 minutes and 31 seconds interacting with the exhibit, showing that it is a more engaging exhibit that holds children for a longer period of time. Of the 25 children that were observed, there were nine toddlers, ten children between the ages of 3 and 4, and six children between the ages of 4 and 5. During the observational period, no babies interacted with the exhibit, showing that the exhibit is more attractive to older children. The results of the study are shown in Graph 38 of Appendix G, which displays the percentage of time children of different age groups spent performing each observed behavior. The graph was then used to develop a table of commonly observed behaviors for the Butterfly Holograms, shown in Table 9 below.

Butterfly Holograms Commonly Observed Behaviors		
Toddlers	**Ages 3 to 4**	**Ages 4 to 5**
Play with a caregiver	Play by themselves	Play by themselves
Play with other children	Stand while drawing	Stand or Kneel while drawing
Listen to or copy caregiver	Watch others draw on the touch screen	Draw with a purpose on touchscreen
Stand while drawing	Draw with a purpose	Focused while drawing with a purpose
Scribble with different colors on the touch screen	Focused on drawing	
Show excited expressions and voices, including smiling, laughing, and excited screaming	Scribble on touchscreen	

Table 9: Butterfly Holograms Commonly Observed Behaviors

The results of the study showed that toddlers interacted with the Butterfly Holograms for an average of 2 minutes and 10 seconds, spending an average of 65% of their time interacting with either their caregiver or other children. Although some toddlers used the exhibit on their own, many spent a majority of their time listening to and mimicking the actions of their caregiver. As caregivers showed children how to use the touch screen, children would get visibly excited and start drawing on the butterfly with different colors, showing that they had understood what their caregiver had explained. This observation demonstrates that the exhibit is promoting educational conversations between caregivers and children, showing that the exhibit is succeeding in promoting learning.

Children within the older age groups interacted more independently at the exhibit, as children ages 3 to 4 spent an average of 67% of their time interacting by themselves while children ages 4 to 5 spent an average of 64% of their time interacting by themselves. Children ages 3 to 4 spent the shortest amount of time interacting with the exhibit, averaging an interaction time of 1 minute and 45 seconds. Children within this age group spent more time watching others than they did drawing on the screen themselves, which could have led to their short interaction times, as they were not always immersed in the exhibit. Children ages 4 to 5 spent the longest amount of time interacting with the exhibit, averaging an interaction time spent of 4 minutes and 20 seconds. Children within this age group were more focused on their drawing, frequently drawing with a purpose and using patterns to color their butterflies. This is likely the reason that the older kids spent more time at the exhibit, as they demonstrated behaviors that showed that they were fully engaged with the exhibit.

4.5.8. The Camouflage Disco

The Camouflage Disco is an exhibit within the Camouflage Disco Area of the Big Box area. This exhibit is unique in that it is intended for children of all ages to play and be fully engaged. The exhibit consists of high-energy music and projections for older children, as well as mirrors and low-energy soundtracks for younger children, making it common to see babies and five-year-old children interact with the exhibit simultaneously. Of the 26 total children observed, five were babies, seven were toddlers, 11 were between the ages of 3 and 4, and three were between the ages of 4 and 5. The results from this study showed that children spent an average of 1 minute 31 seconds playing within the camouflage disco. Among the age groups, babies spent the shortest time with an average of 72 seconds, toddlers spent an average of 96 seconds, children ages 3 to 4 spent the longest time with an average of 99.5 seconds, and children ages 4 to 5 spent an average of 80 seconds. The behaviors of children interacting within the Camouflage Disco were recorded using the behavioral checklist found as Item 15 in Appendix B. The results from these observations were compiled into a bar graph to determine the most common behaviors from children of each age group. The bar graph can be found as Item 39 Appendix G and was used to create the commonly observed behaviors table for the Camouflage Disco, shown below as Table 10.

Camouflage Disco Commonly Observed Behaviors			
Babies	**Toddlers**	**Ages 3 to 4**	**Ages 4 to 5**
Interacting with self	Interacting with self	Interacting with self	Interacting with self
Interacting with Caregiver	Interacting with Caregiver	Interacting with Caregiver	Interacting with other Children
Sitting, Standing	Interacting with other Children	Interacting with other Children	Playing with others
Crawling, Walking	Copying Others	Playing with others	Walking, Running, Jumping
Reacting to Projections	Showing excited expressions	Standing	Dancing
Looking at self in mirror	Sitting, Standing	Running, Jumping	Reacting to Projections
Pointing at Mirror	Walking, Running	Dancing	Reacting to animals
Touching Mirror	Dancing	Reacting to Projections	Naming projections/animals
Reacting to Animals	Pointing	Reacting to music	Performing imaginative play
	Reacting to Projections	Reacting to animals	
	Looking at self in mirror		
	Reacting to animals		
	Making animal noises		

Table 10: Camouflage Disco Commonly Observed Behaviors

An analysis of the results from the observational study on the Camouflage Disco showed that children tend to interact independently of their caregiver more often as they grow older. This is demonstrated by the trend in the bar graph as well as by the simplified behavioral tables. The observed children between the of ages 4 and 5 spent 100% of their time interacting without their caregiver, while the observed babies averaged only 65% of their time interacting without their caregiver. The analysis also shows that children interact and play with one another more often as they grow older. Babies did not interact with other children during the observations, while toddlers spent 10% of their time with other children, children ages 3 to 4 spent 13% of their time with other children, and children ages 4 to 5 spent 33% of their time with other children.

During the observations, there was a clear separation between the behaviors of younger and older children as they interacted with the exhibit. As babies are still very early in the developmental stages, they do not have the required motor skills to exhibit the same behaviors as children ages 4 to 5. Instead, most babies crawled or sat on the floor and observed the space

around them. Although they were too young to move with ease, they often reacted to the projections on the floor by pointing or slapping at the insects or animals. Babies took a particular interest to the mirrors, often crawling over and touching their reflections on the mirror. Older children preferred the high-energy aspects of the exhibit by running through the open floor space and dancing to the music. The older children often reacted to the floor projections by chasing them across the floor and jumping onto the projections. Children ages 4 to 5 were observed naming the different projections on the floor, verbally stating names such as "footprints" and "snake!" The verbal responses of children demonstrate that children are engaged and learning while interacting with the exhibit, as they are learning about various animals and speaking in loud and excited tones. Another observation unique to the 4 to 5 age group is the use of imaginative play. Although only one of the 25 observed children were recorded displaying this behavior, the observer noticed other children ages 4 to 5 engaging in this type of play while recording behavior data on a different child.

Children of all ages showed scared or excited expressions during a particular soundtrack and projection, during which foot prints would lead children towards a realistic lion that would then light up and roar. However, this particular soundtrack and projection combination only occurred twice during the observation period and therefore is not sufficiently represented in the data. If a child is engaging with the Camouflage Disco exhibit during the time of this sequence, it can be expected that the child will show scared or excited expressions and possibly begin to cry, depending on age.

The commonly observed behaviors table created from the results and analysis of the observational study on the Camouflage Disco very closely replicates the expected behaviors table provided by Alexandra Price, shown as Item 6 in Appendix B. Both tables show clear trends in the decreasing caregiver interactivity with age, as well as an increase in interactions between children with age. The provided expected behaviors predict that babies will crawl across the floor, stimulated by the projections on the walls floor and the mirrors. Both of these statements are proven to be true by the team's analysis of the observation study above. The expected behaviors table shows older children will dance and react to the projections, which was also proven to occur by the observational study. The high level of similarity between the expected behaviors and observed behaviors for the Camouflage Disco exhibit indicates that this exhibit is successful in achieving its intended goals.

5. Conclusions and Recommendations

5.1. Specific Exhibit Analysis

Gallery designers Alexandra Price and Pete Wilson identified the following eight areas of the gallery as major exhibits that contain designs that warrant in-depth analyses: the Burrows, the Light Torch, the Camouflage Disco, the Shapes Wall, the Butterfly Holograms, the Lullaby Nook Area, the Upper Climbing Net, and the Lower Net Area. To evaluate each area, the team combined results from the tracking and timing study, the observational study, and the interviews to draw comprehensive conclusions about their popularity, holding power, and educational value.

5.1.1. The Shapes Wall

The Shapes Wall falls in the middle range for popularity being the 16th most popular exhibit by visits. 18 of the 52 (35%) tracked children were recorded engaging with this exhibit. The results of the tracking map overlay show a moderate level of traffic within the Shapes Wall Area and leading to the Shapes Wall. A further detailed analysis of the data shows that a majority of this traffic is from babies and toddlers, which shows the intended age range of the area and the exhibits within. From the responses to interview questions, no caregivers stated that the Shapes Wall was their child's favorite exhibit. This further supports the ranking of the exhibit in the middle range of exhibits within the gallery.

The Shapes Wall has a holding power slightly below the gallery average according the results and analysis of the timing study. On average children are spending 1 minute and 16 seconds interacting with the wall, while the gallery average time per stop is 1 minute 48 seconds. From the observational study it was recorded that children spent an average of 1 minute and 5 seconds interacting with the wall. This further proves the exhibit has a holding power below the gallery average. The fact that no caregivers reported the Shapes Wall as their child's favorite exhibit further indicates a low holding power, in that a child's favorite exhibit is likely where they are spending the majority of their time.

The observational study conducted on the Shapes Wall revealed many different educational aspects of the wall that provide learning opportunities for children. The interactivity of the wall gives children the opportunity to explore and discover as they try to find new projections and reactive areas of the wall. The wall also provides more traditional learning

techniques with the showcases for children to look and name the objects inside. Tactile learning is a major theme of this exhibit with the gears, cranks, buttons, fossils, and the sliding pins in 3D slots. Children are able to touch and feel objects and learn how to use the interactive features of the wall. Although no caregivers mentioned the Shapes Wall directly as an educational exhibit during interviews, the results of the observational study of the exhibit proved its educational value. The stimulation, tactile learning, and sensory learning opportunities presented by the Shapes Wall were all mentioned as reasons for why exhibits within the gallery were educational.

5.1.2. The Lullaby Nook Area

The Lullaby Nook Area is a low-energy area located in the Big Box. The area contains picture books, interactive tables with blocks, the Lullaby Nook, which has a large projection screen and plays different lullaby tunes, and the Story Nook, which has a large projection screen that plays aboriginal stories. The Interactive Tables placed the highest in popularity among the four exhibits within the Lullaby Nook Area, ranking eighth out of the 49 exhibits with visits from 44% of tracked children. The Interactive Tables also ranked the highest among the four exhibits in number of repeat visitors and number of stops and were in the top ten within these categories among all exhibits within the gallery, showing that children frequently returned to the Interactive Tables after their first stop. The data is further proved through the interview responses, as three caregivers mentioned the Interactive Tables and Blocks as being among their child's favorite exhibits. The Lullaby Nook was the next most popular exhibit within the area, ranking 14th out of the 49 exhibits with visits from 37% of tracked children. The Lullaby Nook received the next highest values for number of repeat visitors and number of stops among the four exhibits within the area, ranking 18th overall for number of repeat visitors and 14th overall for number of stops, showing that children often returned to the Lullaby Nook during their visit. The Books and the Aboriginal Nook were the least popular exhibits within the area, ranking 17th and 18th out of the 49 exhibits with visits from 33% of tracked children. The two exhibits also had the lowest values among the four exhibits for number of repeat visitors and number of stops and ranked within the middle range among all exhibits, showing that the exhibits were not among the top exhibits for drawing back visitors.

In terms of age groups, the area proved to be the most popular among toddlers and children ages 3 to 4. Visitation data showed that all four exhibits were the most popular with

toddlers and children ages 3 to 4, which was further proved by pathway overlays which showed that toddlers had the most dense recording of pathways in the area, closely followed by children ages 3 to 4. The area is the least popular with children ages 4 to 5, which was proved by both the visitation data for each exhibit within the area and the map overlays, as the exhibits had the fewest number of visits and the pathways recordings were the least dense of children within this age group. Babies fell within the middle in terms of popularity, as they had the fewer visits to exhibits than the older age groups but also showed a higher density of pathway recordings within the area than children ages 4 to 5.

In addition, the Books and Interactive Tables ranked among the top ten exhibits for highest holding power within the gallery. The Books ranked second with an average time per stop of 3 minutes and 58 seconds, which is 2 minutes and 10 seconds above the gallery average. The Interactive Tables ranked eighth with an average time per stop of 2 minutes and 52 seconds, which is 1 minute and 4 seconds above the gallery average. Both holding times show that the exhibits are successful in keeping children engaged during their interaction. The Lullaby Nook and the Story Nook had slightly lower holding powers, ranking 14th and 19th out of the 49 exhibits, respectively. The Lullaby Nook had an average time per stop of 2 minutes and 17 seconds, 29 seconds longer than the gallery average, while the Story Nook had an average time per stop of 1 minute and 51 seconds, 3 seconds longer than the gallery average. Although lower than the Books and the Interactive Tables, the holding powers of the two nooks still ranked within the middle and the top among all exhibits in the gallery and do not contain material that is intended to engage children for as long as the Books and the Interactive Tables, showing that they are still successful in meeting their intended usage.

The Lullaby Nook Area also contains some of the most educational exhibits within the gallery, as caregivers specifically mentioned the Books and the Story Nook during interviews as the most educational exhibits within the gallery. During the interviews, caregivers also mentioned mental stimulation, tactile learning, and sensory learning as ways in which the gallery promotes learning, which are all presented by the exhibits within the Lullaby Nook Area. The Books, the Interactive Tables, and the Story Nook all present content that promote mental stimulation, while the Interactive Tables also promote tactile learning with the use of blocks and the Lullaby Nook promotes sensory learning with the music and lights from the large projection screen. In addition, the area is designed to encourage caregiver-child interactions, as it contains

activities that are common for caregivers to participate in with their children, such as reading books and building with blocks. Parent interaction leads to educational conversations and promotes the building of a strong attachment bond between the caregiver and child.

5.1.3. Upper Climbing Net

The Upper Climbing Net is the center point of the Big Box area. The results showed that it was the fifth most popular exhibit, receiving visits from 48% of tracked children. The Upper Net received the highest number of repeat visitors and the highest number of stops of all the exhibits, showing that children who interacted with the exhibit wanted to come back and experience the exhibit again. When looking at its popularity among age groups, its popularity increases with age, as it is the most popular with children ages 4 to 5 and the least popular with babies. Only one baby was recorded as visiting the Upper Net, which could have resulted in its slightly lower ranking in number of visits, as babies and younger children frequently do not visit the exhibit because they are not physically able to climb in the net. The pathway overlays support the popularity results, as the pathways entering the net are the most dense for children ages 4 to 5, followed by children ages 3 to 4 and toddlers, and are the least dense for babies, who have almost no pathways entering the net. The results are also supported by the interview responses, as 18 caregivers stated that the upper net was among their child's favorite exhibits in the gallery, with ten being the caregivers of children ages 4 to 5, three being the caregivers of children ages 3 to 4, and five being the caregivers of toddlers. In addition, of the 25 children that were observed during the observational study, twelve were children ages 4 to 5 and twelve were children ages 3 to 4, further showing that the upper net is most popular with the older age groups.

The results of the tracking and timing study also showed that the Upper Net had one of the highest holding powers, ranking sixth among the other gallery exhibits. The exhibit had an average holding power of 3 minutes and 13 seconds, which is 1 minute and 25 seconds greater than the gallery average. The exhibit's high holding power was further displayed by the results of the observational study, which showed that the average time children spent within the net was 2 minutes and 23 seconds. A high holding power indicates that the exhibit is being used as intended, as children are spending time climbing and playing within the net.

Although the Upper Net does not specifically contain educational features, such as books or showcases, it provides children with other aspects of learning. In the interviews, five

caregivers specifically mentioned the exhibit as being educational, and the exhibit also promotes physical movement and social interactions, which were frequently mentioned responses from caregivers for why the gallery exhibits are educational. The behaviors seen in the climbing net also show that the exhibit provides educational value, as children are improving their motor skills and gaining confidence while they are learning to play with other children.

5.1.4. The Lower Net

The Lower Net Area is an area within the Big Box area that is popular with children of all ages. This area contains the Bean Bag Swings and Small Nets exhibits, as well as a tactile rug and Baby Bumps for younger children to crawl and climb over. The Bean Bag Swings and Small Nets both fall within the top 20 exhibits for popularity by visitation, with 38% and 27% of children visiting the exhibits respectively. The results of the tracking and timing study as well as the observational study both report a trend in increasing visitation to these two exhibits with increasing age of the children. This shows that these two exhibits are more popular and attractive to older children than they are to babies. The map overlays show a similar trend with visitation to the area by the increasing density of the visitor flow within the area as the age of children increases. A more detailed analysis of these overlays shows that the older children are drawn towards the back half of the area, containing the Bean Bag Swings, Small Nets, as well as a short cut to the rest of the Net and Burrows Area. Babies however are more drawn to the middle of the room and front section, which contain the tactile rug and baby bumps. The timing study was unable to produce results on the visitation to these aspects in that they were not considered as exhibits during the study. The observational study, however, was very successful in recording the usage of these two items within the room, showing they are particularly attractive to babies. Overall, the results of the three studies show the Lower Net Area contains aspects and exhibits that are popular to all age groups, making the area as a whole successful in attracting children of all ages.

The holding power of the Lower Net Area itself cannot be directly determined in that it is not a single exhibit but rather a collection of exhibits and design aspects. The holding powers of the exhibits within the area are relatively low, falling far below the gallery average. The Small Nets have an average time per stop of 34 seconds, and the Bean Bag Swings have an average time per stop of 48 seconds. The lower holding power of these exhibits does not indicate a poor

performance in that not all exhibits are designed with the intent of engaging children for a long period of time. The intended duration of child interaction from the gallery designers must be known in order to truly compare the performance of the exhibits. These two exhibits stand out in terms of number of repeat visitors, with 50% of children who visited the Small Nets returning at least once and 70% of the children who visited the Bean Bag Swings returning at least once. The observational study reported that children spent an average of 58.4 seconds per stop within the area. This data in addition to the low holding powers of the individual exhibits show that the Lower Net Area as a whole has a relatively low holding power for children.

The Lower Net Area is an energetic area for children to climb and play that does not contain any traditional museum aspects such as showcases. Although it may not seem educational at first glance, this area is full of opportunities for tactile learning and for children to improve their motor skills. The observational study of the Lower Net Area reported a high percentage of children's time being spent running, walking, crawling, and climbing, which are all methods of improving motor skills. Children were also often recorded playing with the texture rug and Bean Bag Swings which provide the opportunity for tactile learning. Although no caregivers directly mentioned the Lower Net Area as an educational part of the gallery, both motor skills and tactile learning were themes often mentioned as to why the gallery as a whole is educational for children.

5.1.5. Light Torch

The Light Torch is an interactive exhibit within the Big Box that contains a large flashlight that activates light-up animal showcases. The Light Torch was the 19th most popular exhibit, receiving visits from 37% of tracked children. In addition, the exhibit was 14th in repeat visitors and 17th in number of stops, showing that overall, it fell within the middle range for popularity with children. In terms of popularity for each age group, results showed that the Light Torch is the most popular with children ages 4 to 5, as they had the highest values for visitors, repeat visitors, and number of stops as well as the highest number of observations during the observational studies. The exhibit was the second most popular with babies, as they had the second highest values for visitors, repeat visitors, and number of stops, followed by children ages 3 to 4 and toddlers. This result is supported by the pathway overlays for each age group, as the pathways towards the Light Torch increased in density from toddlers who had the fewest tracks

near the Light Torch, to babies and children ages 3 to 4 who had similar amounts of tracks near the Light Torch, and finally to children ages 4 to 5 who had the most tracks near the Light Torch. During interviews, the caregiver of one baby mentioned the Light Torch as a favorite exhibit, further demonstrating that it is not among the top exhibits in the gallery for the most popular or the most enjoyable.

Results from the tracking and timing study also showed that the Light Torch has a relatively low holding power, ranking 34th out of the 49 exhibits. The average time per stop at the Light Torch is 44 seconds, which is 1 minute and 4 seconds less than the average gallery holding power. The low holding power was further confirmed by the observational study, during which the average time children spent interacting with the exhibit was 56.4 seconds. The Light Torch contains only one specific activity, which involves pointing the light at the animals to make the animal showcases light up and make their unique animal noise; therefore, once a child performs the activity, they have experienced the exhibit and tend to leave. Due to this design, the team determined that the low holding power matched the intended design, showing that the exhibit is meeting expected usage.

The Light Torch also contains features that provide educational value for children. Although the exhibit was not specifically mentioned as an educational exhibit by caregivers during interviews, the observational studies showed behaviors that indicate learning. The exhibit contains showcases that feature specific animals and make the unique sounds of each animal, acting as the main educational features of the exhibit. In the observational studies, children were observed staring intently at the showcases, as well as walking up to the showcases to touch and point at the animals, showing that children are engaged and learning about the animals as they interact. In addition, the exhibit prompted teaching and educational conversations between caregivers and their children about how to use the Light Torch and what animals were encased in the showcases, further demonstrating its educational value.

5.1.6. The Burrows

The Burrows is an obstacle-course area containing showcases, mirrors, and a textured rug that is located in Area G of the Big Box. The results of the tracking and timing study showed that it is the sixth most popular exhibit in the gallery, receiving visits from 46% of tracked children. The exhibit also received the second highest values for number of repeat visitors and total

number of stops, further proving its popularity by showing that children enjoyed their first interaction at the exhibit and returned to interact again. When looking at the breakdown of visits by each age group, the results showed that the popularity of the Burrows increases with the age of the child. Of the 24 total visits to the exhibit, nine were children ages 4 to 5, six were children ages 3 to 4, five were toddlers, and four were babies. This trend was also seen in the pathway overlays for each age group, as the pathways within the Burrows for children ages 4 to 5 and 3 to 4 were the most dense, the pathways for toddlers were slightly less dense, and the pathways for babies were the least dense. During the observational study, it was noted that babies interacted with the showcases more frequently while the older age groups played more within the burrow itself, which was also confirmed by the pathway overlays. However, the Burrows was only mentioned by the caregiver of one toddler during the interviews as a favorite exhibit, showing that although it was popular in that many children visited the exhibit, it may not be one of the most enjoyable exhibits for children.

The Burrows, although it ranked as one of the top most popular exhibits, ranked only 18th for holding power. Results of the tracking and timing study showed that the average time per stop at the exhibit was 1 minute and 51 seconds, which is only 3 seconds greater than the gallery average time per stop. However, the Burrows is designed as more of an active play area that does not contain any specific activity that children would interact with for a significant amount of time, leading the team to conclude that the holding power matches its intended use. The low holding power was also seen during the observational study, for which the average time spent at the exhibit was 1 minute and 6 seconds.

In addition to popularity and holding power, the Burrows also contain design aspects that add to its educational value. Although the Burrows was not specifically mentioned as an educational exhibit by caregivers during interviews, the exhibit contains features that were mentioned by caregivers as reasons for educational value. For example, caregivers stated that exhibits that promote physical movement and tactile exhibits demonstrated a high educational value. The Burrows contains an obstacle course and cushioned ramp that encourages physical activity, as well as showcases with spinning objects and a textured rug that promotes tactile learning. In addition, it was observed during the observational study that the showcases promote teaching and educational conversations between caregivers and children, further showing the educational value of the Burrows.

5.1.7. The Butterfly Holograms

The Butterfly Holograms exhibit was the ninth most popular exhibit within the gallery with 23 recorded visits by children, or 44% of the 52 total children tracked. When broken down by age group, this exhibit is popular among children of all ages, however slightly more popular with children ages 4-5, as there were nine visits from this age group compared to seven from babies. The demographic breakdown of the observational study agrees with this trend for all age groups except babies. The observer did not observe or record any babies engaging with the exhibit during the observational period. From the interview data, two caregivers mentioned the Butterfly Hologram as their child's favorite exhibit, one of which was the caregiver of a 3 to 4 year old and the other was a caregiver of a 4 to 5 year old.

Being a very interactive and engaging exhibit by nature, the Butterfly Holograms exhibit has a very high holding power. The exhibit ranked 13th in time per stop, with children spending an average of 2 minutes and 40 seconds per interaction, nearly an entire minute longer than the gallery average. The analysis of data from the observational study conducted on the Butterfly Holograms revealed the reasons behind the high holding power of the exhibit. The average time spent by children at the exhibit during this study was 2 minutes and 31 seconds, very similar to the result of the timing study. Children were recorded spending a significant amount of time focused and concentrating on their work, drawing with a purpose, and showing off their work. This shows that children are very engaged with their work and put forth a lot of effort. This leads to children spending longer periods of time interacting with the exhibit. Even when children were not engaging directly with the exhibit, there was a significant amount of time spent watching other children draw on the touchpads. This shows that the exhibit has the ability to hold the attention of children who were not using the exhibit first-hand.

The Butterfly Holograms exhibit is a highly educational exhibit, containing sensory, stimulation, and social learning opportunities for children. During interviews, the exhibit was mentioned by a caregiver as an exhibit that stands out as an educational exhibit. The touchpad of the exhibit gives children the ability to use their imagination and draw anything they desire onto a butterfly. The hologram of the butterfly and various colors provide an excellent source of stimulation for younger children. This exhibit showed to be an excellent method of promoting social interaction between children, as the three drawing pads are very close to one another. Children from toddlers to ages 4-5 were recorded spending roughly 25% of their time interacting

with children around them. Children were also often recorded watching others draw and even showing off their own artwork.

5.1.8. Camouflage Disco

The Camouflage Disco exhibit is the fourth highest visited exhibit within the gallery, with 50% of children that were tracked having played with the exhibit. Although it is not the most popular exhibit by number of visits, the Camouflage Disco is unique in that it is popular among children of all ages. Of the 26 children that were recorded playing in the Camouflage Disco during the timing study, five were babies, eight were toddlers, seven were children ages 3 to 4, and six were children ages 4 to 5. This even spread of visitors was also noticed during the observational study conducted on the Camouflage Disco, where the observer noted children from each age group playing within the exhibit simultaneously. Analysis of the map overlays from the tracking data shows a clear usage of the exhibit from all age groups by the high density of pathways within the exhibit. Results from the interviews conducted on caregivers of children also support the high popularity among all ages of the Camouflage Disco. Of the responses recorded, the Camouflage Disco was mentioned the second most often as the favorite exhibit of children with eight total responses. These responses were evenly distributed among the age groups, as two caregivers of children from each age group reported the Camouflage Disco as their child's favorite. This shows that children of all ages not only interact with the exhibit, but also are enjoying their time and having a positive experience. This is also shown by the number of repeat visitors to the exhibit, in that of the 26 children who visited the disco, 14 (54%) stopped more than once during their time in the gallery. This is the second highest number of repeat visitors across the entire gallery. The results of the tracking and timing study, interviews, and observational study all prove that the Camouflage Disco is successful in attracting children of all ages as well as being one of the most popular exhibits within the gallery.

In addition to its high popularity, the Camouflage Disco recorded the third highest holding power of the exhibits. The argument can be made that this exhibit has the highest holding power of interactive exhibits in the gallery, as the exhibits with top two holding powers were the Tiddalick Story and Books, which are more educationally focused exhibits where children sit down to listen to a story. The observational study conducted on the Camouflage Disco revealed that the exhibit contains factors attractive to all age groups, making it capable of

drawing and holding children's attention for a significant period of time. Younger children, specifically babies, were especially drawn to the mirrors where they would spend a significant amount of time looking at their reflections and hitting or touching the mirror. Older children, however, were drawn to the projections and music and would often spend their time running and dancing across the room. These interactive and engaging factors are some of the main reasons behind the high holding power of this exhibit. This exhibit is unique in its ability to hold the attention of both babies as well as children ages 4 to 5. On average, babies spent 2 minutes 53 seconds playing in the disco, while children ages 4 to 5 spent 2 minutes 34 seconds. This difference of only 19 seconds is by far the smallest gap between times spent by age groups of any exhibit within the gallery.

In addition to having a high popularity and holding power, the Camouflage Disco also contains design aspects that create an educational value. Although no caregivers mentioned the disco as an educational exhibit during interviews, the results of the observational study of the exhibit proved its educational value. This exhibit excels in developing motor skills for children of all ages as well as being interactive. For babies, the lights and mirrors within the disco provide the opportunity for sensory learning, while older children are provided with the opportunity to engage with other children and learn through social interaction, which were both specifically mentioned by caregivers during interviews as reasons why exhibits within the gallery were educational. Therefore, even though no caregivers mentioned the Camouflage Disco directly as being educational, it contains many key elements that provide the opportunity for learning, giving the exhibit its educational value.

5.2. Design Analysis

Prior to conducting the studies, the team met with gallery designers to gather more information about the gallery's exhibits and designs. The team met with Pete Wilson, Senior Exhibit Designer at Museum Victoria, who discussed design aspects, specifically shortcuts between different exhibits, that were intended to create certain energy levels within areas of the gallery. The team also met with Kate Phillips, Science Curator at Museum Victoria, who was the designer of the educational showcases present within the gallery. Both designers requested the team to use the data gathered through the performed studies to evaluate the use and effectiveness of the shortcuts, energy levels, and educational showcases.

5.2.1. Shortcuts through the Gallery

During the guided tour with Pete Wilson, the team learned of three shortcuts placed within the Big Box area that offer children exciting and exploratory ways to navigate through the gallery. The major shortcuts that were discussed were the large cutout circle between areas H and G, an area of low-backed benches connecting the Lower Net Area and the Burrows Area, and a white arch connecting the Lullaby Nook Area and the Lower Net Area, pictured below in Figures 45, 46, and 47, respectively. Each figure also includes a zoomed-in image of the overall pathway overlay at the locations of the three shortcuts, highlighted by a black circle. Although the Photoshop overlay eliminated the pathway tracings over the colored borders of each area, a trend of visitor movement toward the shortcuts can be seen within the pathway tracings, indicating their extensive usage.

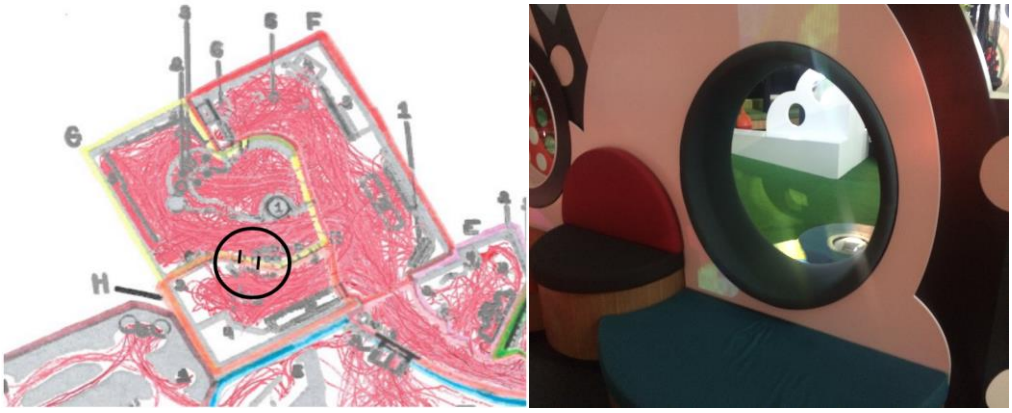

Figure 45: Shortcut Between Net and Burrows (G) and Camouflage Disco (H)

Figure 46: Shortcut Between Lower Net Area and Burrow Area (G)

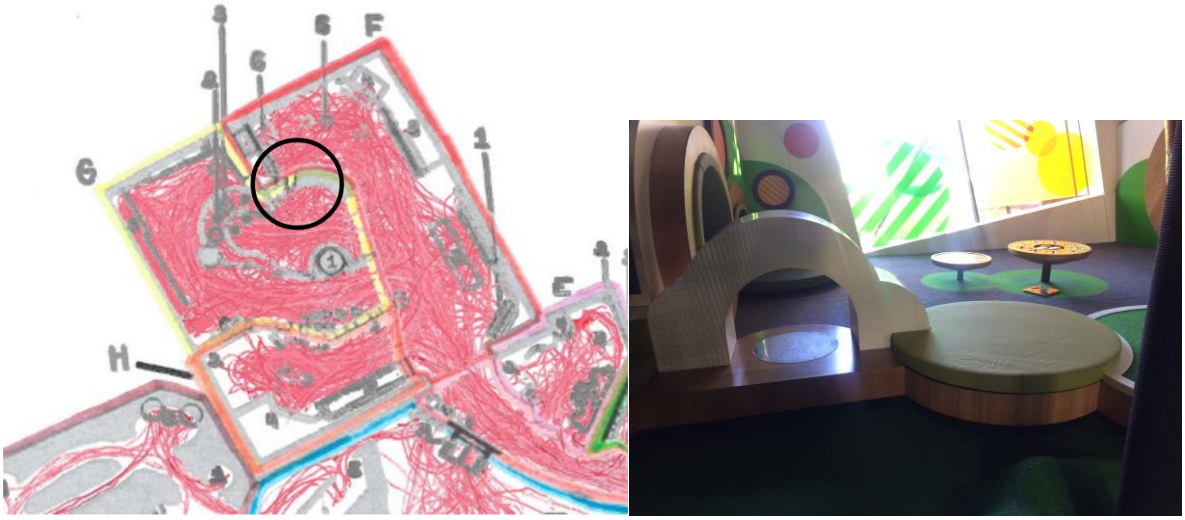

Figure 47: Shortcut Between Lullaby Nook Area (F) and Lower Net Area (G)

To analyze the use of shortcuts by different age groups, the team evaluated the separate map overlays for the four developmental age groups, which are shown in Figures 27 through 30. Looking at Figure 27, which displays the map overlay for babies, it can be seen that only one baby utilized the shortcut between areas H and G. Comparison of the map overlays of the four age groups show that the amount of children utilizing the shortcut increases with age. This trend is also seen when comparing the use of the shortcut highlighted in Figure 46, however it is not seen when comparing the use of the shortcut highlighted in Figure 47, as all age groups use the shortcut in Figure 47 equally. The difference in shortcut usage between age groups is largely due to their differences in physical capabilities, as younger children are not able to run and explore as easily and freely as older children who are more capable of climbing and moving around the gallery. Babies are particularly restricted in their exploration of the gallery, as they are often carried or pushed in a pram by their caregiver and are therefore limited to moving where their caregiver wants to go, causing them to use the shortcuts less frequently.

The frequent use of shortcuts within the Big Box also indicates that the design was successful in creating high-energy within areas G, H, and the front section of area F. The pathway overlays show that areas G, H, and the section of area F around the Big Pattern Wall were heavily used by children ages 4 to 5, who frequently demonstrate the highest energy as they are the most physically capable children within the intended age range. In addition, timing and visitation data showed that the exhibits within those areas received the highest number of stops

and the highest number of repeat visitors, as well as holding powers of only one to 2 minutes. This shows that children were frequently moving between exhibits and only spending a short amount of time at each stop, further demonstrating the high-energy play taking place within the areas. Alternatively, areas D, E, and the Lullaby Nook Area within area F are rarely visited by older children and have fewer overall pathway recordings than within areas G, H, and the front section of F. This shows that designers were successful in promoting more low-energy activities used by younger children within those areas.

5.2.2. Traditional Showcases

Although the Pauline Gandel Children's Gallery has a large number of interactive exhibits that promote learning through hands-on experiences, it also contains customary museum exhibits that offer a more traditional style of learning. Kate Phillips, Melbourne Museum Science Curator, created two main traditional exhibits in the gallery: the Spots and Stripes Showcase (H3) and the showcases within the Shapes Wall (D1). The Spots and Stripes Showcase is a full traditional museum-style showcase, while the Shapes Wall has both traditional showcases and a large, interactive touch wall. Kate and other educational exhibit designers at Melbourne Museum are specifically interested in evaluations of the traditional exhibits, as visitors are typically drawn towards the larger, more exciting features such as the Climbing Net and the Camouflage Disco, and the designers want to ensure that the more traditional exhibits are still receiving use from visitors. To conduct the evaluations, the team examined the data collected from the tracking and timing study.

Figure 48: Spots and Stripes Showcase

Figure 48 above depicts the Spots and Stripes Showcase, located within the Camouflage Disco Area of the Big Box. Results of the tracking and timing study showed that of the 52 visitors that were tracked, only 23% visited the Spots and Stripes Showcase. The exhibit ranked 24th for the highest visitation and 27th for both number of repeat visitors and number of stops at an exhibit, indicating that it has a low popularity among children. In terms of holding power, the exhibit ranked 32nd out of the 49 exhibits with an average time of 44 seconds per stop, which is 1 minute and 4 seconds shorter than the gallery average time per stop. Due to its design as an educational exhibit with a variety of different animals and objects, children would have to spend a longer amount of time than was found through the tracking and timing study to fully experience the exhibit, leading the team to conclude that the showcase was not meeting its intended holding power goal. However, when caregivers were asked which exhibits they believed were the most educational during interviews, the Spots and Stripes Showcase was the most frequently mentioned exhibit, showing that caregivers are aware of its importance to their child's learning and believe that it has a strong educational value.

In addition, the Camouflage Disco Area was designed for children to progress from one exhibit to the next by starting at the Spots and Stripes Showcase, moving to the Touchscreen Animal Wall, and progressing to the Camouflage Disco. However, both the Spots and Stripes Showcase and the Touchscreen Animal Wall received visits from only 21% of tracked children while the Camouflage Disco received visits from 50% of tracked children, showing that most children were entering the Camouflage Disco without stopping at the Sports and Stripes Showcase or the Touchscreen Animal Wall. This was further proved through the observational studies, as children were recorded most often entering the area and traveling straight to the Camouflage Disco.

Results showed that the Shapes Wall exhibit was more popular with children than the Spots and Stripes Showcase, as 35% of tracked children visited the exhibit during their stay in the gallery. The exhibit ranked 16th out of the 49 exhibits for number of visits, 10th for number of repeat visitors, and 11th for number of stops, showing that it has a relatively high popularity overall. In terms of holding power, the exhibit ranked 24th out of the 49 exhibits with an average time of 1 minute and 16 seconds per stop, 32 seconds less than the gallery average time per stop. This placed the exhibit within the middle range for holding power, showing that children were experiencing parts of the exhibit and quickly leaving instead of exploring all aspects of the wall.

During the observational study, all age groups were recorded interacting with the Shapes Wall, and a portion of each age group was recorded specifically interacting with the traditional showcases within the wall. Toddlers and babies had the highest interaction with the traditional showcases, as 58% of toddlers and 21% of babies were observed interacting with the traditional exhibits during their stop at the Shapes Wall. Although no caregivers mentioned the Shapes Wall as an educational exhibit during the interviews, they did mention many aspects that the wall contains as reasons why exhibits within the gallery were educational. For example, caregivers stated that their child learned through sensory and tactile aspects of exhibits, which are contained on the wall through the various cranks, gears, buttons, and fossils that are available for children to touch and play with on the wall, as well as the projections that children can begin by pressing certain areas of the wall.

When comparing the Shapes Wall data to the Spots and Stripes Showcase data, it is clear that the Shapes Wall is the more popular exhibit. The interactivity of the Shapes Wall is most likely the cause of its higher popularity, as the Shapes Wall contains both interactive and traditional aspects while the Spots and Stripes Showcase only contains traditional aspects; however, although the interactive portions draw children to the exhibit, it is important to note that a significant number of children were observed interacting with the traditional showcase portions of the wall. In order to increase the popularity of the Spots and Stripes Showcase, the team recommends altering the visual attraction of the showcase. As can be seen in Figure 48, the lighting within the showcase is dim, making the exhibit easy to overlook and contributing to the low attracting power of the exhibit. The team concluded that increasing the brightness of the spotlights in the exhibit and adding additional spotlights to highlight specific animals within the exhibit could increase its attracting power. The addition of lighting could also help to increase the holding power of the exhibit by allowing visitors to better the details of the animals within the showcase. This would most likely result in increased durations of stops at the exhibit, as the exhibit would be more visually appealing and interesting.

5.3. Methods Analysis

The research preparation objective proved to be a crucial step in creating a successful method for analyzing the performance and educational value of the Pauline Gandel Children's Gallery. This objective allowed the team to fully understand the environment and atmosphere

that the study was being conducted in. The team was also able to fully test and refine the research tools being used throughout the studies, allowing for a smooth data collection process. It is highly recommended for future project teams conducting similar studies to set aside a period of time to allow for a similar research preparation phase. This objective allowed for the development of a highly successful data collection and analysis method that could easily be replicated within similar museum environments or continued for further research within the Pauline Gandel Children's Gallery.

After completion of the tracking and timing study, the team compiled recommendations for conducting similar studies in the future. The team's first recommendation is to standardize data collection techniques among group members, specifically regarding the amount of detail used when recording visitor pathways. If one team member traces the child's every movement throughout the gallery while another team member only traces a direct path from one exhibit to the next, the pathway overlays may display false data. The team's second recommendation is to identify the goals of the study and determine a plan for data analysis prior to beginning data collection. This will allow the team to find a data entry format suitable for synthesizing the desired metrics before they are overwhelmed with data.

Through the trialing of different interviewing methods, the team was also able to compile recommendations for future studies regarding the interview process. At the beginning of the interview process, the team conducted both cued and non-cued interviews in order to gauge which method provided the most useful data for the study. After conducting a series of both types of interviews, the team decided to use the non-cued method for the remainder of the interviews. The non-cued method ensures that the caregiver remains unaware of their involvement in any ongoing studies, therefore eliminating any chance of collecting skewed data. The team recommends that non-cued interviews be used for future studies. Additionally, the team recommends that a two-person team be used when more in-depth responses are desired. By having one team member ask the interview questions while the other records responses, the information will be more accurately recorded.

The team also recommends future use of the research tools and methods developed for the observational study, as they proved to be both repeatable and successful within the Pauline Gandel Children's Gallery. The behavioral checklists used during the study contain general behaviors that can be matched with behaviors specific to the exhibit on which the study is being

conducted, allowing for detailed and unbiased recordings of behaviors. In the creation of the behavioral checklist, it was crucial to include a wide range of behaviors to account for all unexpected observations. It was also important to organize the checklist into categories in order to help the observer easily and efficiently navigate through the checklist to record their observations. The setup of the behavioral checklist allows for the study to be easily repeated at various different exhibits. As the general behaviors section of the checklist can be used for any exhibit, the only edit required to use the checklist at different exhibits is the alteration of the specific behaviors section.

The research preparation, tracking and timing study, interviews, and observational study objectives proved to create a very successful method for analysis of the performance and educational value of the Pauline Gandel Children's Gallery. The only limitation the team found was the time restriction on the study, limiting the sample size of the data. The team believes the methods could easily be repeated in the future to continue the evaluation of the Pauline Gandel Children's Gallery. Further data collection would allow for more accurate and detailed representation of the performance of the gallery. The team recommends that similar studies in the future should allow more time for data collection in order to eliminate any bias in the data as result of a small data set.

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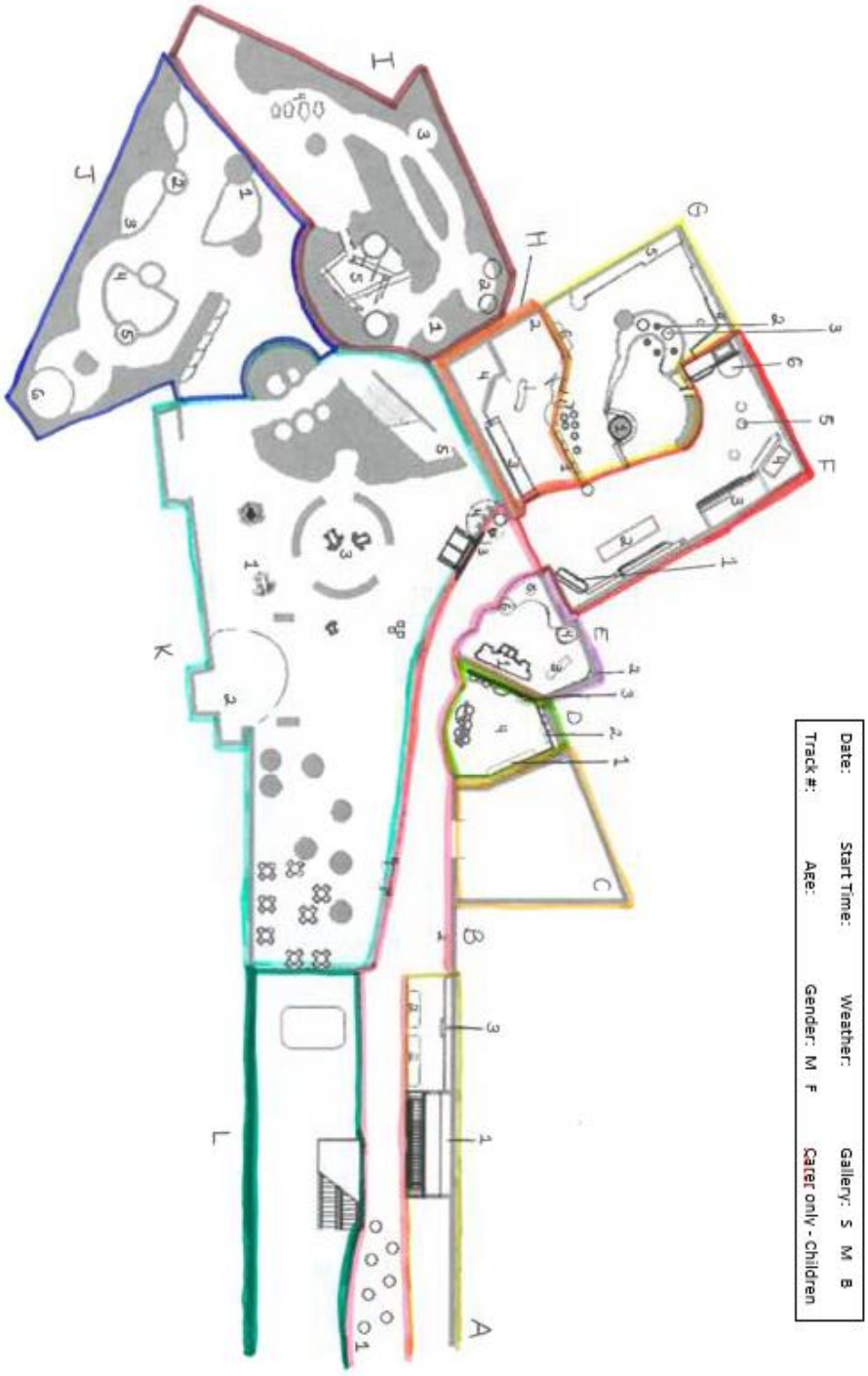
Appendix

Appendix A: Tracking and Timing Study Research Instruments



Item 1: Simplified Map of the Pauline Gandel Children's Gallery

A	Train Area	**E2**	Mirrors	**G3**	Small Nets	**I5**	Bush Discovery Area
A1	Train Tunnel	**E3**	Curved Texture Structure	**G4**	Light Torch	**J**	Dinosaur Dig Area
A2	Climb on Carriage	**E4**	Cobobonee Pod	**G5**	Burrows	**J1**	Half Moon Dino Dig
A3	Train Wall	**E5**	Mirror Hole with Faces	**G6**	Butterfly Hologram	**J2**	Rib Mini Dig
B	Hallway	**E6**	Blocks	**G7**	Lava Dots/Wall	**J3**	Ribs
B1	Dino Steps	**F**	Lullaby Nook/Pattern Wall	**H**	Camouflage Disco Area	**J4**	Big Dig
B2	Info Wall	**F1**	Block Cubby and Wall	**H1**	Little Pattern Wall	**J5**	Mini Big Dig
B3	Tiddalick the Frog Story Corner	**F2**	Ropes/Big Pattern Wall	**H2**	Camouflage Disco	**J6**	Bird Nest
C	Child Care	**F3**	Books	**H3**	Spots and Stripes Showcase	**K**	Frog Area
D	Shapes Wall Area	**F4**	Lullaby Nook	**H4**	Touchscreen Animal Wall	**K1**	Spitting Frog
D1	Shapes Wall	**F5**	Interactive Tables	**I**	Gardens	**K2**	Blue Blocks
D2	Showcase	**F6**	Story Nook	**I1**	Bird Cage 1	**K3**	Bench Area with Frogs
D3	Mouth Shaped Blocks	**G**	Net and Burrow	**I2**	Swings	**K4**	Air Bubbles
D4	Lillipads	**G1**	Upper Net	**I3**	Bird Cage 2	**K5**	Crystal Cave
E	Mirror Room	**G2**	Bean Bag Swings	**I4**	Rocks	**L**	Indoor Cafe
E1	Mirror House						

Item 2: Map Legend

Date: Age: Gallery: Slow Moderate Busy Time of Day: Adults Only

Track #: Gender: M F Weather: Other Children

Location	Time In	Time out	P.E.	Notes

Location	Time In	Time out	P.E.	Notes

Item 3: Timing Sheet

Appendix B: Observational Study Research Instruments

Climbing Net Structure Expected Behaviors			
Babies (0-18 Months)	**Toddlers (18 Months to Age 3)**	**Ages 3-4**	**Ages 4-5**
Placed inside lower structure of net	Crawl into lower structure	Playing in structure without an adult	Very active in structure, independent play
Touching/feeling net	Crawl into higher structure	Engage with other children	Imaginative play in the net structure
Use their mouth to explore	Pull net to stand and use net to assist with walking	Show signs of being territorial/playing next to but not with others	Only engages in locomotive play area
Carried by adult into structure	Parents assist younger children		
	Parent is close by but allowing older children to play independently		

Item 4: Expected Behavior Chart for the Climbing Net

Lullaby Nook Expected Behaviors			
Babies (0-18 Months)	**Toddlers (18 Months to Age 3)**	**Ages 3-4**	**Ages 4-5**
Mimic sounds of music	Could be engaged with adults or own their own	Could be engaged with adults or own their own	Could be engaged with adults, on their own, or with other children
Move to the music	Dance/move to the music	Dance/move to the music	Dance/move to the music
Engaged with adults	Clap/tap to reproduce rhythms	Note if movements are synchronized to music	Show a particular liking to songs with lyrics that ask them to do things
	May enjoy individual participation with others nearby		

Item 5: Expected behavior Chart for the Lullaby Nook

Camouflage Disco Expected Behaviors			
Babies (0-18 Months)	**Toddlers (18 Months-Age 3)**	**Ages 3-4**	**Ages 4-5**
Crawl across space (9-12 months old)	Sit and listen to music	Sit and listen to music	Sit and listen to music
Respond to projections on walls, mirrors, and/or floor	Roll around on floor	Roll around on floor	Roll around on floor
Scared by noises (begin to cry, etc.)	Crawl across space	Crawl across space	Crawl across space
Look for their caregiver	Follow pathway from showcase to digital images to disco area	Follow pathway from showcase to digital images to disco area	Follow pathway from showcase to digital images to disco area
	Dance	Dance	Dance
	Interact with projections	Interact with projections	Interact with projections
	Label animals and other objects (note if with or without adult)	Label animals and other objects (note if with or without adult)	Label animals and other objects (note if with or without adult)
	Afraid of some noises	Social interactions with other children	Social interactions with other children
	Look/ask for adult	Afraid of some noises	Look at written text
	Does not play or share with other children	Look/ask for adult	Ask adults questions about objects
	Playing independently but near caregiver	Ask adults questions about objects	

Item 6: Expected behavior Chart for the Camouflage Disco

Generalized list of observational behaviors used to develop area checklists

EVIDENCE OF LEARNING PROJECT - MELBOURNE MUSEUM

DATA NO: _____	Participant Details		gender:						Session Details:	worksheet:		Y	N									
Date: _____			age range							tuch trolley:		Y	N									
Campus: _____			class size:							CSO briefing:		Y	N									
Gallery: _____			group size:							fire drill:		Y	N									
Interviewer: _____	Gallery Conditions:																					
Start time: _____																						
Finish time: _____																						
Specific exhibit location																						
Time intervals	**Ttl**	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	###
Looking																						
l.1 at/reading text																						
l.2 at objects																						
l.3 at screen																						
l.4 at images																						
l.5 at worksheet																						
l.6 at other visitors																						
l.7 at directional signs																						
l.8 pointing																						
l.9 closeup examining/bending/leaning																						
l.10 global viewing – orientation																						
Recording																						
r.1 taking notes																						
r.2 drawing																						
r.3 taking photos																						
r.4 completing worksheet																						
Talking																						
t.1 with friend																						
t.2 with museum staff																						
t.3 with teacher/adult																						
t.4 to self																						
t.5 asking questions of friends/parents																						
t.7 reading to others																						
t.8 about non-relevant things																						
t.9 arguing																						
Handling																						
h.1 using hands-on exhibits as intended																						
h.2 using exhibits other than intended																						
h.3 handling roughly, destructively																						
h.4 helping others with hands-on																						
Listening																						
Li.1 to tape/film in exhibit																						
Li.2 to teacher directing/questions																						
Li.3 to teacher disciplining																						
Li.4 to museum staff																						
Moving																						
m.1 to join friends/family																						
m.2 being told to move																						
m.3 pulling others to see																						
m.4 being pulled to see																						
m.5 running																						
m.6 aimlessly wandering																						
m.7 slowly along exhibit																						
m.8 to new exhibit																						
m.9 quickly through exhibit																						
m.10 out of exhibition																						
Other actions																						
o.1 sitting/standing/not engaged																						
o.2 laughing																						
o.3 smiling																						
o.4 crying																						
o.5 non-exhibit elements																						

Item 7: General Behavior Checklist

Area-Specific Behavioral Checklists

			15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s
INTERACTIONS		SELF																
		PARENTS																
		CHILDREN																
		Playing with																
		Copying																
		Listening																
		Sharing																
		Showing the exhibit to																
		Refusing to play with																
BEHAVIORS	FACIAL	Smiling																
		Frowning																
		Scared Expressions																
		Excited Expressions																
		Focus, intense stares																
	VOCAL	Laughing																
		Excited Screaming																
		Crying																
		Scared Screaming																
		Calling for carer																
		Calling for friend																
		Asking Questions																
		Talking about exhibit																
	BODY	Standing																
		Sitting																
		Laying down																
		Running																
		Walking																
		Crawling																
		Jumping																
		Climbing																
		Kneeling																
		Hiding																
		Watching																
		Clapping																
		Dancing																
		Pointing																
		Babies: using wall pieces to pull themselves up																
		Reading																
SHAPES WALL BEHAVIORS		Looking at traditional showcases																
		Looking at wall projections																
		Turning on wall projections																
		Touching wall projections																
		Moving pin in slot on 3D shapes																
		Turning gears																
		Cranking crank																
		Pressing Buttions																
		Touching Fossils																

Item 8: Shapes Wall Behavior Checklist

			15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s
INTERACTIONS	SELF																						
	PARENTS																						
	CHILDREN																						
		Playing with																					
		Copying																					
		Listening																					
		Sharing																					
		Showing the exhibit to																					
		Refusing to play with																					
BEHAVIORS	FACIAL	Smiling																					
		Frowning																					
		Scared Expressions																					
		Excited Expressions																					
		Focus, intense stares																					
	VOCAL	Laughing																					
		Excited Screaming																					
		Crying																					
		Scared Screaming																					
		Calling for carer																					
		Calling for friend																					
		Asking Questions																					
		Talking about exhibit																					
	BODY	Standing																					
		Sitting																					
		Laying down																					
		Running																					
		Walking																					
		Crawling																					
		Jumping																					
		Climbing																					
		Kneeling																					
		Hiding																					
		Watching																					
		Clapping																					
		Dancing																					
		Pointing																					
		Babies: using wall pieces to pull themselves up																					
		Reading																					
LULLABY NOOK AREA BEHAVIORS	MAGNETIC WALL	Randomly placing magnets on magnet wall																					
		Strategically placing magnets on magnet wall																					
		Throwing blocks																					
		placing blocks in mouth																					
		Playing with blocks																					
		Building with blocks with a purpose																					
		Randomly picking up/putting down the blocks																					
		Looking at faces on table																					
		Touching faces on table																					
		Placing faces in holes																					
		Reacting to noises from face table																					
	NOOKS	Watching story in nook																					
		Playing in nook																					
		Running/climbing walls in nook																					
		Calm and relaxing behavior in nook																					
		Hiding from caregiver in nook																					
		Mimicking sounds from lullaby nook																					
		Touching screen in lullaby nook																					
		Looking at screen in lullaby nook																					

Item 9: Lullaby Nook Behavior Checklist

			15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s
INTERACTIONS		SELF																	
		PARENTS																	
		CHILDREN																	
		Playing with																	
		Copying																	
		Listening																	
		Sharing																	
		Showing the exhibit to																	
		Refusing to play with																	
BEHAVIORS	FACIAL	Smiling																	
		Frowning																	
		Scared Expressions																	
		Excited Expressions																	
		Focus, intense stares																	
	VOCAL	Laughing																	
		Excited Screaming																	
		Crying																	
		Scared Screaming																	
		Calling for carer																	
		Calling for friend																	
		Asking Questions																	
		Talking about exhibit																	
	BODY	Standing																	
		Sitting																	
		Laying down																	
		Running																	
		Walking																	
		Crawling																	
		Jumping																	
		Climbing																	
		Kneeling																	
		Hiding																	
		Watching																	
		Clapping																	
		Dancing																	
		Pointing																	
		Babies: using wall pieces to pull themselves up																	
		Reading																	
UPPER NET STRUCTURE		Entering through front entrance																	
		Entering through back entrance																	
		Climbing slowly and carefully																	
		Climbing quickly and actively																	
		Sliding/rolling down cargo net section																	
		Playing in mesh net room																	
		Sitting in lower exit nets																	
		Engaging in imaginative play/ games																	
		Gets stuck in net																	
		Exits through back entrance																	
		Enters, conquers, leaves																	
		Enters, plays, leaves																	
		Enters, quickly leaves																	

Item 100: Upper Net Behavior Checklist

			15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s
INTERACTIONS		SELF															
		PARENTS															
		CHILDREN															
		Playing with															
		Copying															
		Listening															
		Sharing															
		Showing the exhibit to															
		Refusing to play with															
BEHAVIORS	FACIAL	Smiling															
		Frowning															
		Scared Expressions															
		Excited Expressions															
		Focus, intense stares															
	VOCAL	Laughing															
		Excited Screaming															
		Crying															
		Scared Screaming															
		Calling for carer															
		Calling for friend															
		Asking Questions															
		Talking about exhibit															
	BODY	Standing															
		Sitting															
		Laying down															
		Running															
		Walking															
		Crawling															
		Jumping															
		Climbing															
		Kneeling															
		Hiding															
		Watching															
		Clapping															
		Dancing															
		Pointing															
		Babies: using wall pieces to pull themselves up															
		Reading															
LOWER NET STRUCTURE		Playing in net holes															
		Playing with net swings															
		Hitting net swings															
		Swinging on net swings															
		Running into net swings															
		Touching/feeling texture rug															
		Playing on baby bumps															
		Playing on seats															
		Climbing on the outside of the net entrance															
		Grabbing the outside of the net structure entrance															

Item 111: Lower Net Behavior Checklist

			15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s
INTERACTIONS		SELF															
		PARENTS															
		CHILDREN															
		Playing with															
		Copying															
		Listening															
		Sharing															
		Showing the exhibit to															
		Refusing to play with															
BEHAVIORS	FACIAL	Smiling															
		Frowning															
		Scared Expressions															
		Excited Expressions															
		Focus, intense stares															
	VOCAL	Laughing															
		Excited Screaming															
		Crying															
		Scared Screaming															
		Calling for carer															
		Calling for friend															
		Asking Questions															
		Talking about exhibit															
	BODY	Standing															
		Sitting															
		Laying down															
		Running															
		Walking															
		Crawling															
		Jumping															
		Climbing															
		Kneeling															
		Hiding															
		Watching															
		Clapping															
		Dancing															
		Pointing															
		Babies: using wall pieces to pull themselves up															
		Reading															
LIGHT TORCH BEHAVIORS		Pointing torch randomly															
		Aiming torch at animals															
		Aiming torch at the ground															
		Aiming torch at other people															
		Reacting to noises															
		Reading animal names out loud															
		Looking at animal showcases															
		Touching animal showcases															

Item 12: Light Torch Behavior Checklist

			15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s
INTERACTIONS		SELF																					
		PARENTS																					
		CHILDREN																					
		Playing with																					
		Copying																					
		Listening																					
		Sharing																					
		Showing the exhibit to																					
		Refusing to play with																					
BEHAVIORS	FACIAL	Smiling																					
		Frowning																					
		Scared Expressions																					
		Excited Expressions																					
		Focus, intense stares																					
	VOCAL	Laughing																					
		Excited Screaming																					
		Crying																					
		Scared Screaming																					
		Calling for carer																					
		Calling for friend																					
		Asking Questions																					
		Talking about exhibit																					
	BODY	Standing																					
		Sitting																					
		Laying down																					
		Running																					
		Walking																					
		Crawling																					
		Jumping																					
		Climbing																					
		Kneeling																					
		Hiding																					
		Watching																					
		Clapping																					
		Dancing																					
		Pointing																					
		Babies: using wall pieces to pull themselves up																					
		Reading																					
BURROW BEHAVIORS		Looking at lower showcase																					
		Spinning magnifying glass on lower showcase																					
		Looking through magnifying glass - lower showcase																					
		Looking at upper showcase																					
		Spinning upper showcase																					
		Reading words on wall out loud																					
		Looking into showcases on the floor																					
		Climbing over peg wall																					
		Climbing under peg wall																					
		Avoiding peg wall																					
		Hanging upside-down from pegs																					
		Looking in mirrors																					
		Touching mirrors																					
		Feeling/playing with texture rug																					
		Jumping off seating																					
		Playing on cushioned ramp in burrow																					

Item 13: Burrows Behavior Checklist

			15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s
INTERACTIONS		SELF																
		PARENTS																
		CHILDREN																
		Playing with																
		Copying																
		Listening																
		Sharing																
		Showing the exhibit to																
		Refusing to play with																
BEHAVIORS	FACIAL	Smiling																
		Frowning																
		Scared Expressions																
		Excited Expressions																
		Focus, intense stares																
	VOCAL	Laughing																
		Excited Screaming																
		Crying																
		Scared Screaming																
		Calling for carer																
		Calling for friend																
		Asking Questions																
		Talking about exhibit																
	BODY	Standing																
		Sitting																
		Laying down																
		Running																
		Walking																
		Crawling																
		Jumping																
		Climbing																
		Kneeling																
		Hiding																
		Watching																
		Clapping																
		Dancing																
		Pointing																
		Babies: using wall pieces to pull themselves up																
		Reading																
BUTTERFLY HOLOGRAMS		Drawing on touchscreen																
		Looking at hologram																
		Focusing and concentrating on drawing																
		Drawing with a purpose (patterns)																
		Changing colors and experimenting with tools																
		Scribbling randomly on butterfly																
		Showing off drawing																
		Hits touchscreen with hands																
		Hits hologram with hands																

Item 134: Butterfly Hologram Behavior Checklist

			15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s	15s
INTERACTIONS	SELF															
	PARENTS															
	CHILDREN															
		Playing with														
		Copying														
		Listening														
		Sharing														
		Showing the exhibit to														
		Refusing to play with														
BEHAVIORS	FACIAL	Smiling														
		Frowning														
		Scared Expressions														
		Excited Expressions														
		Focus, intense stares														
	VOCAL	Laughing														
		Excited Screaming														
		Crying														
		Scared Screaming														
		Calling for carer														
		Calling for friend														
		Asking Questions														
		Talking about exhibit														
	BODY	Standing														
		Sitting														
		Laying down														
		Running														
		Walking														
		Crawling														
		Jumping														
		Climbing														
		Kneeling														
		Hiding														
		Watching														
		Clapping														
		Dancing														
		Pointing														
		Babies: using wall pieces to pull themselves up														
		Reading														
CAMOUFLAGE DISCO BEHAVIORS		Reacting to projections														
		Reacting to music														
		Looking at self in mirror														
		Pointing at mirror														
		Touching mirror														
		Reacting to animals														
		Making animal noises														
		Naming projections (ex: footprints)														
		Imaginative play														
		Follow expected pathway into disco														
		Skip showcase: interactive to disco														
		Skip interactive images: showcase to disco														
		Straight to disco														

Item 15: Camouflage Disco Behavior Checklist

Appendix C: Research Sign

Observation at Melbourne Museum

Melbourne Museum is keen to find out how people are experiencing our new Children's Gallery museum.

You may notice our researchers in the museum today. They will be observing people as they explore the gallery.

If you would rather not participate in our research please feel free to approach them and decline to be part of our research.

We hope you have a wonderful visit.

Further information on research at Melbourne Museum can be obtained from the Audience Insights Team on 8341 7758.

Appendix D: Interview Guide

Interviewer:
Note Taker:
Interviewee: Caregiver
Date:

Our names are [insert names here] and we are university students from the United States helping Melbourne Museum evaluate the newly renovated Children's Gallery. We are conducting interviews to gain an understanding of children's experiences at the Children's Gallery. Could we take 5 minutes of your time to ask you a few questions about your experiences today? Participation is voluntary and you do not have to answer any questions you do not want to. [Wait for answer. If yes:] Would you mind if we record the interview and take notes to aid in our analysis? All information collected will remain anonymous.

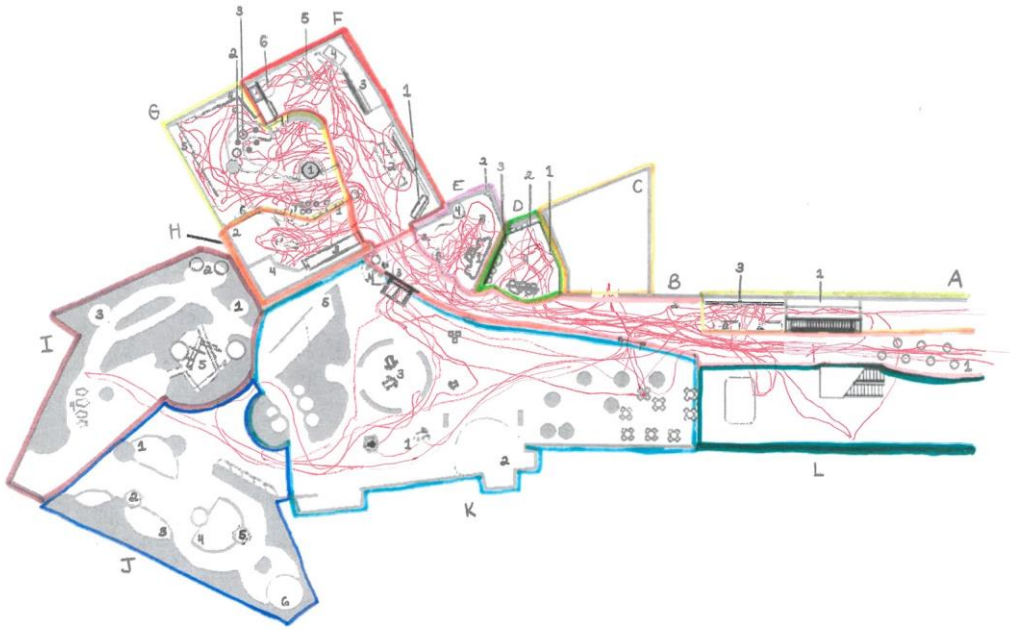
1. What brings you to the children's gallery today?

2. Which exhibit was your child/grandchild's favorite? Why?

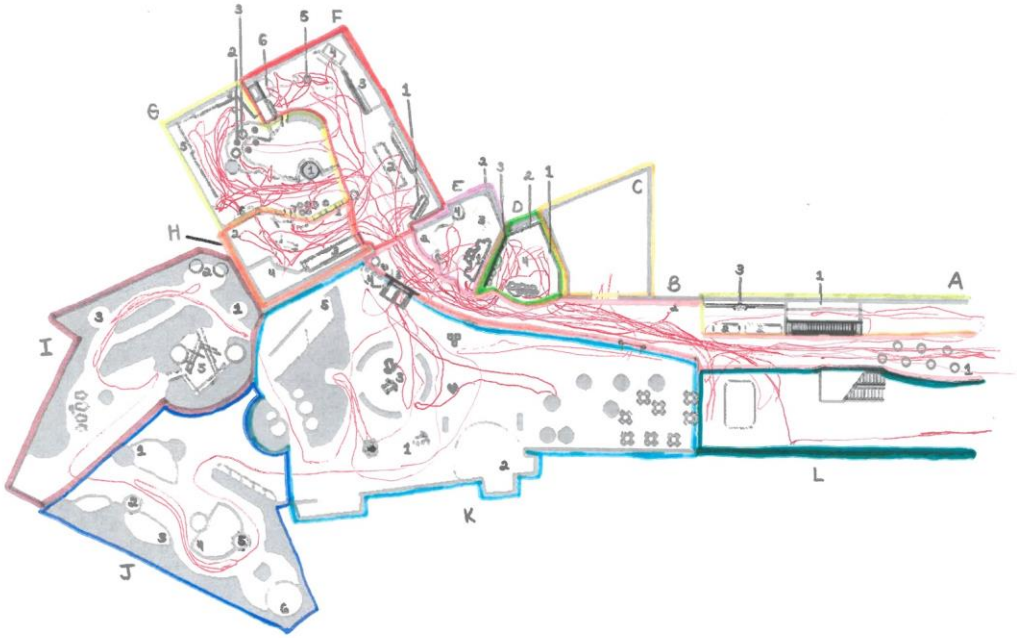
3. Do you feel that the exhibits were educational? In what ways?

4. Do you have any other comments about your visit or the gallery exhibits?

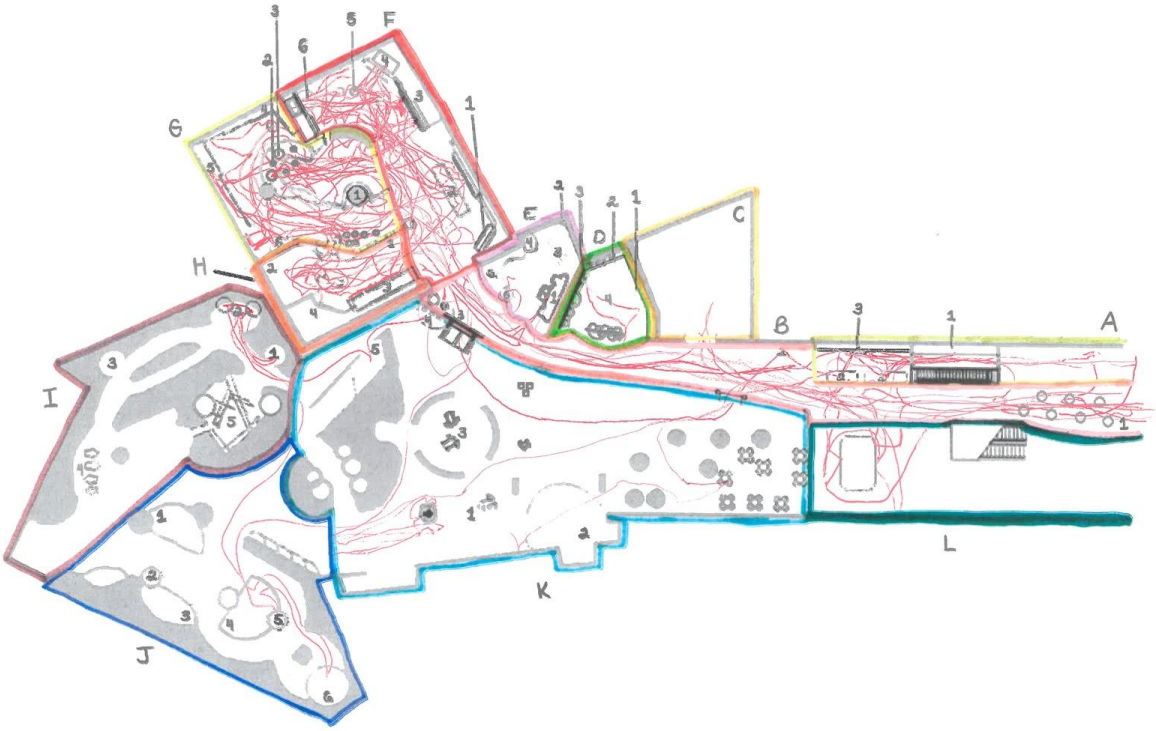
Appendix E: Tracking Study Overlays



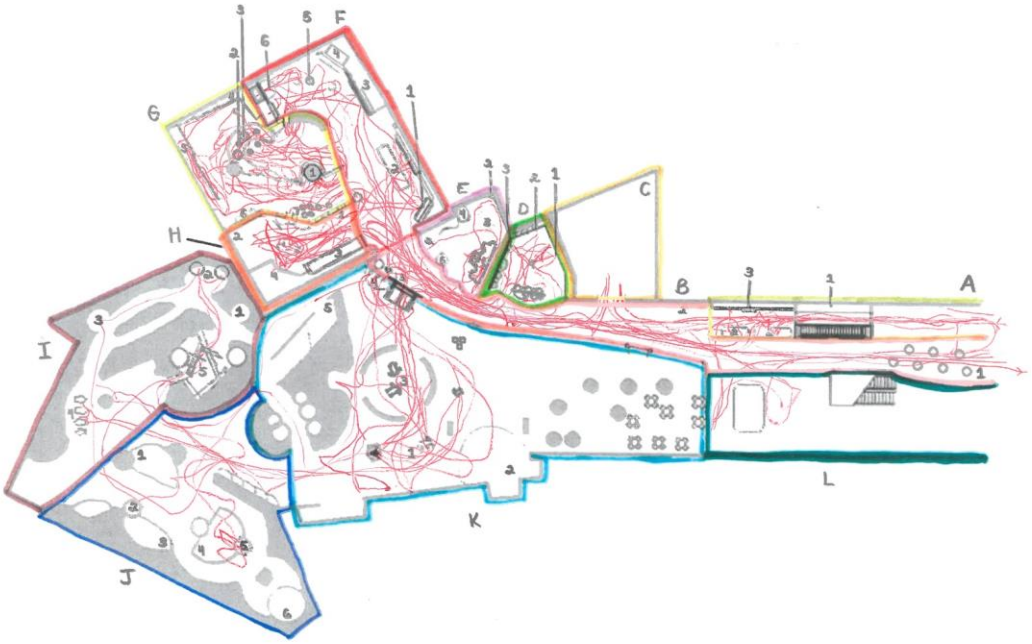
Item 16: Female Baby Overlay



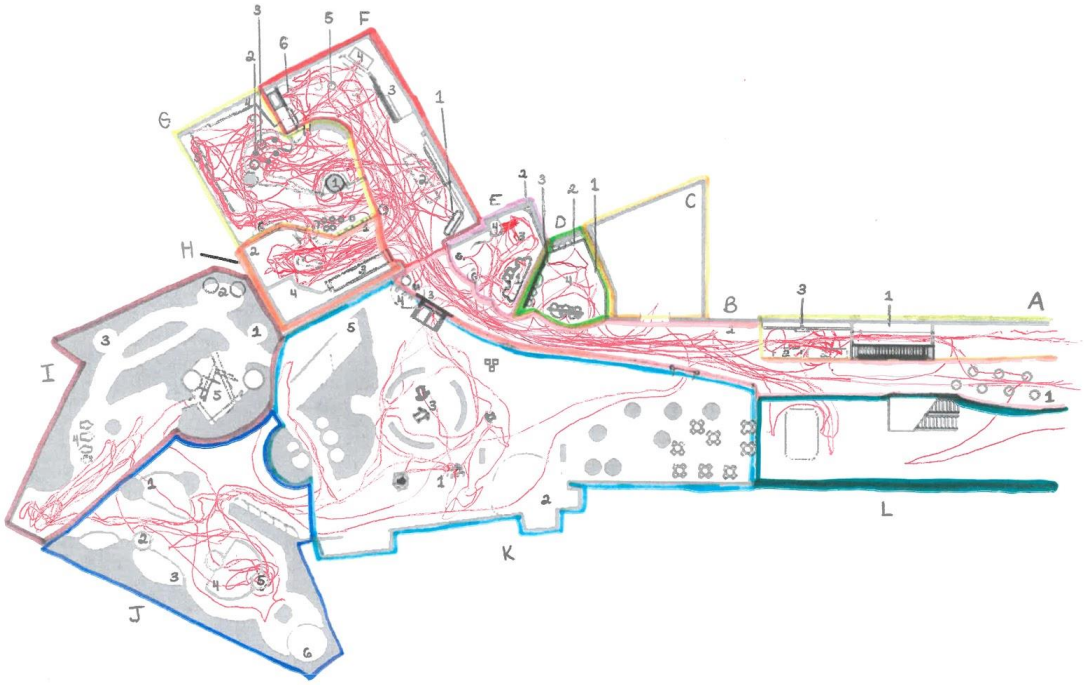
Item 1714: Male Baby Overlay



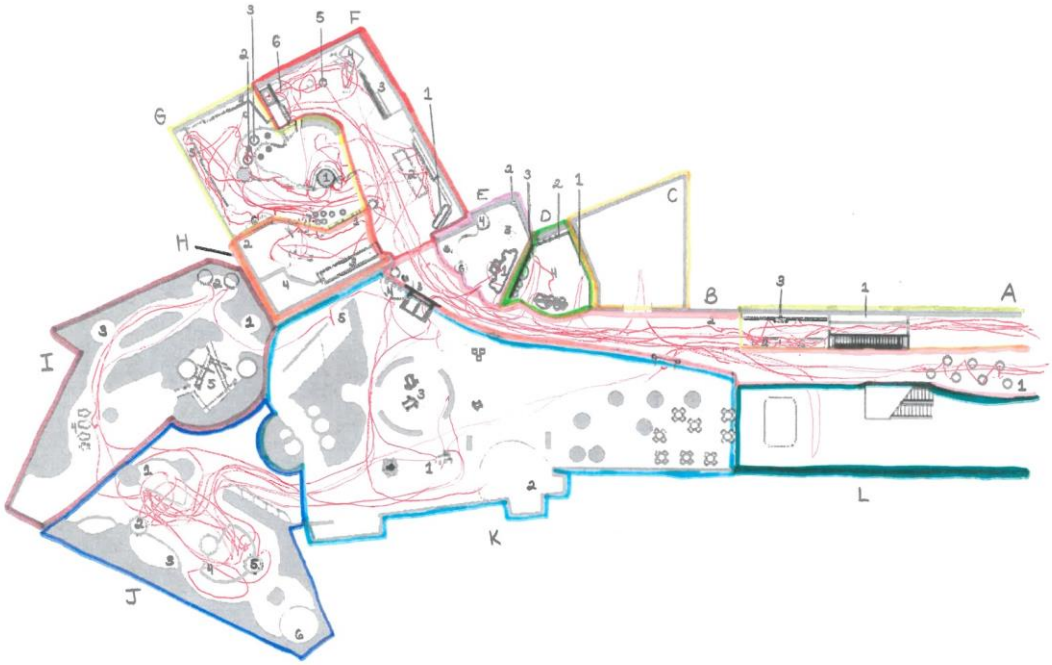
Item 18: Female Toddler Overlay



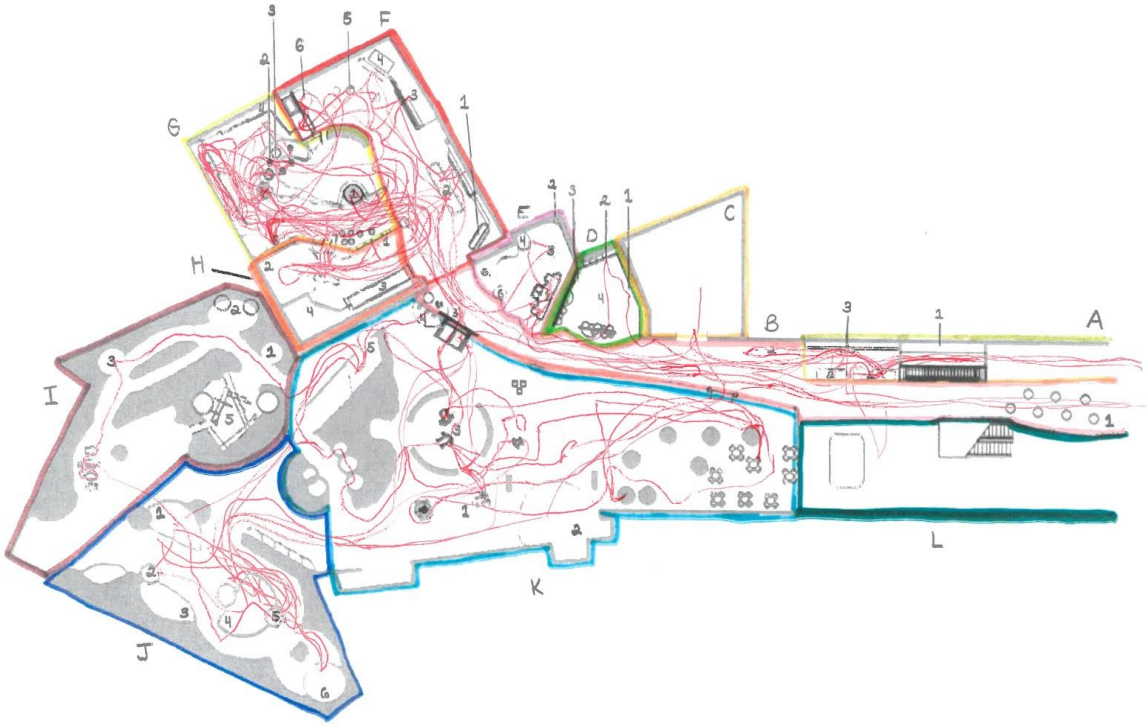
Item 15: Male Toddler Overlay



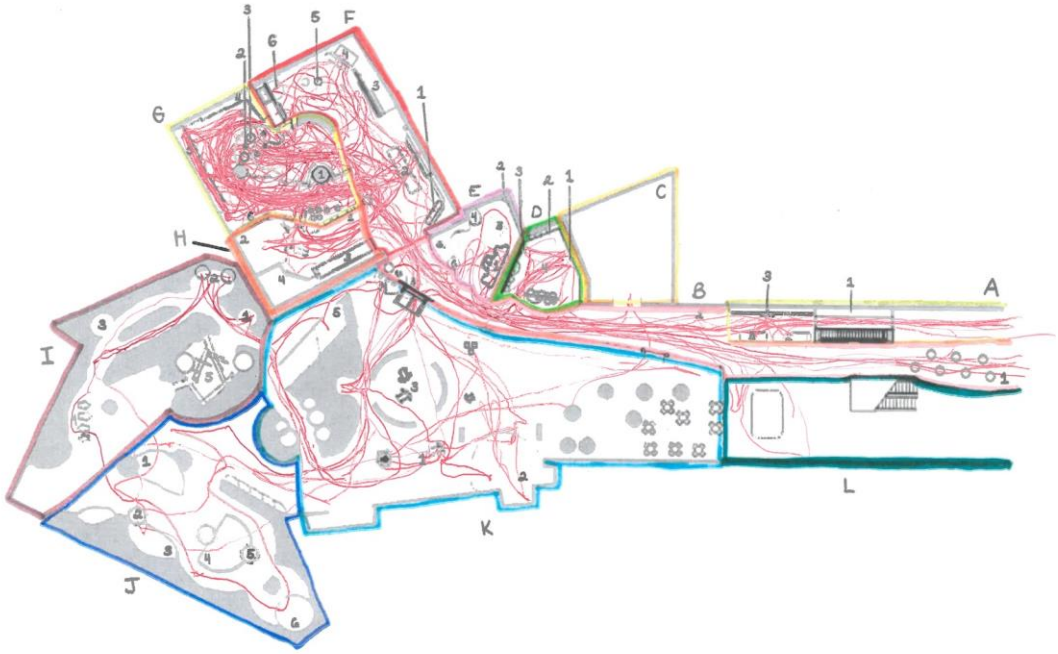
Item 160: Ages 3 to 4 Female Overlay



Item 171: Ages 3 to 4 Male Overlay

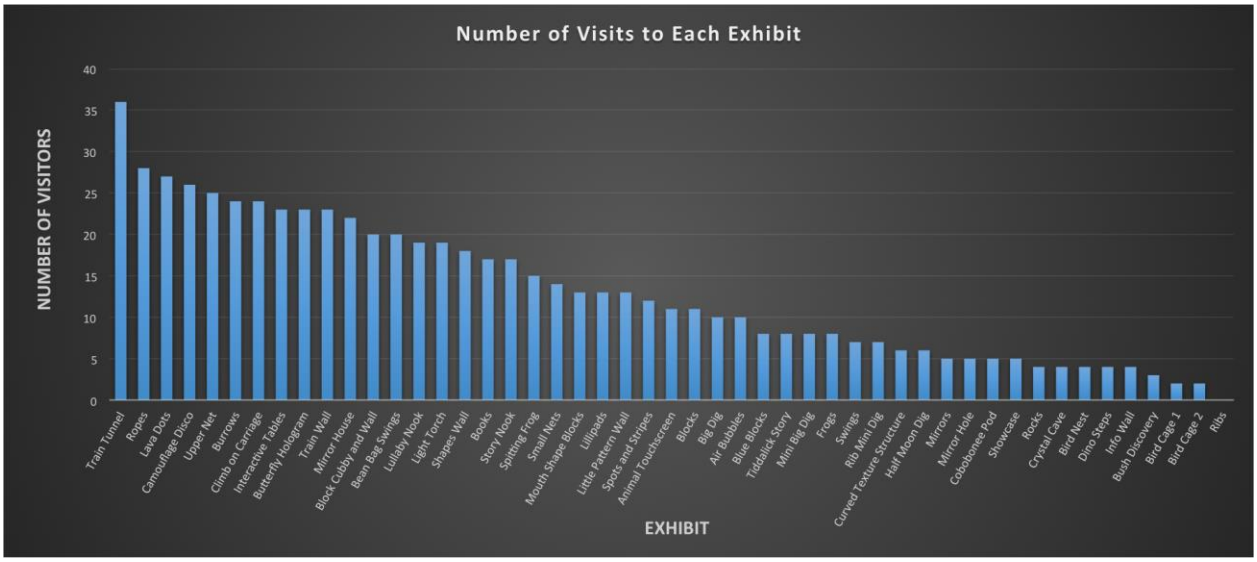


Item 182: Ages 4 to 5 Female Overlay

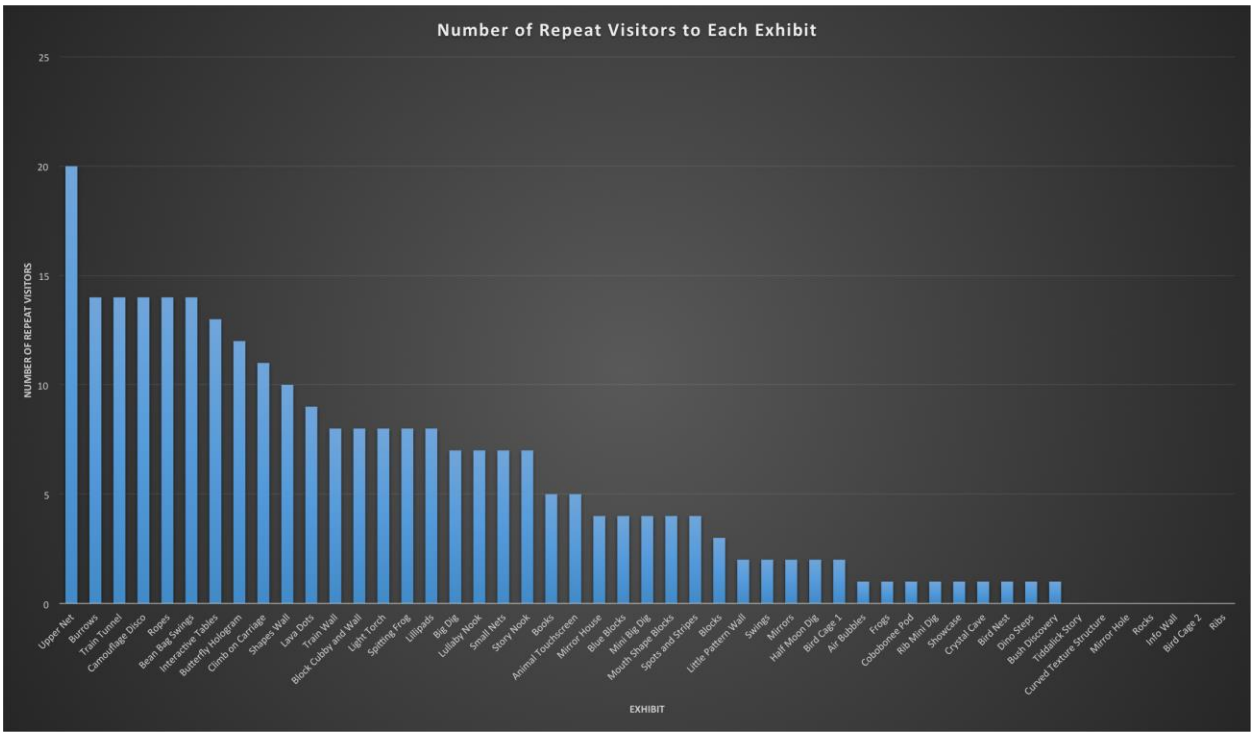


Item 193: Ages 4 to 5 Male Overlay

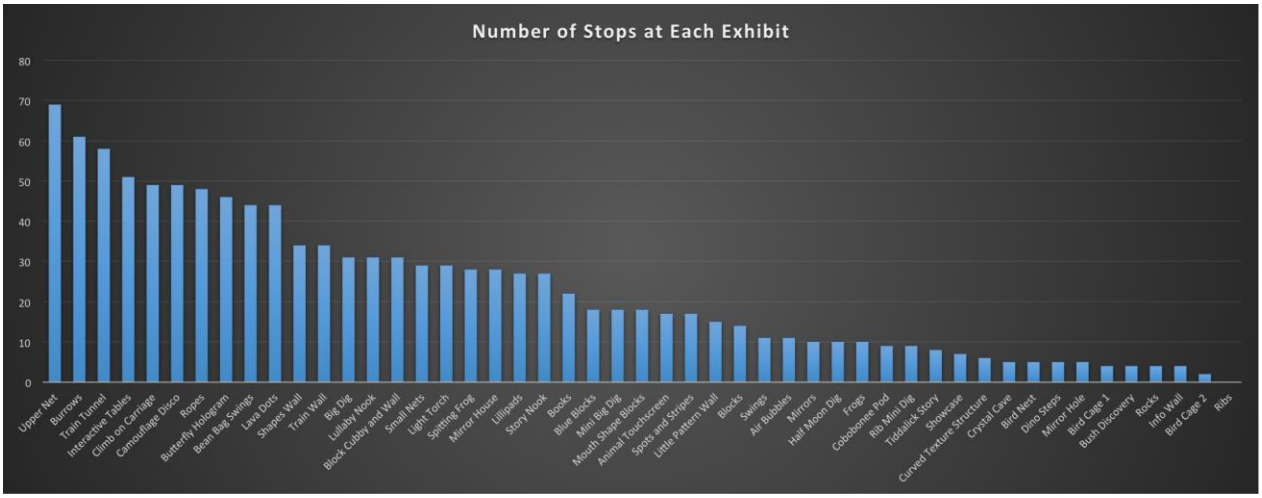
Appendix F: Timing and Visitation Data



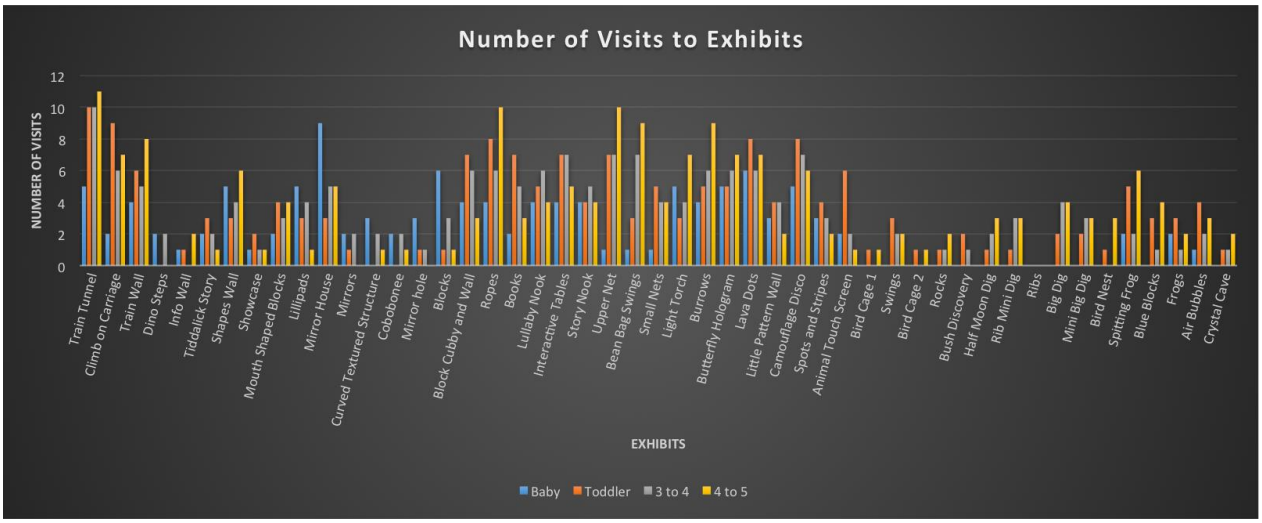
Item 204: Number of Visits to Each Exhibit



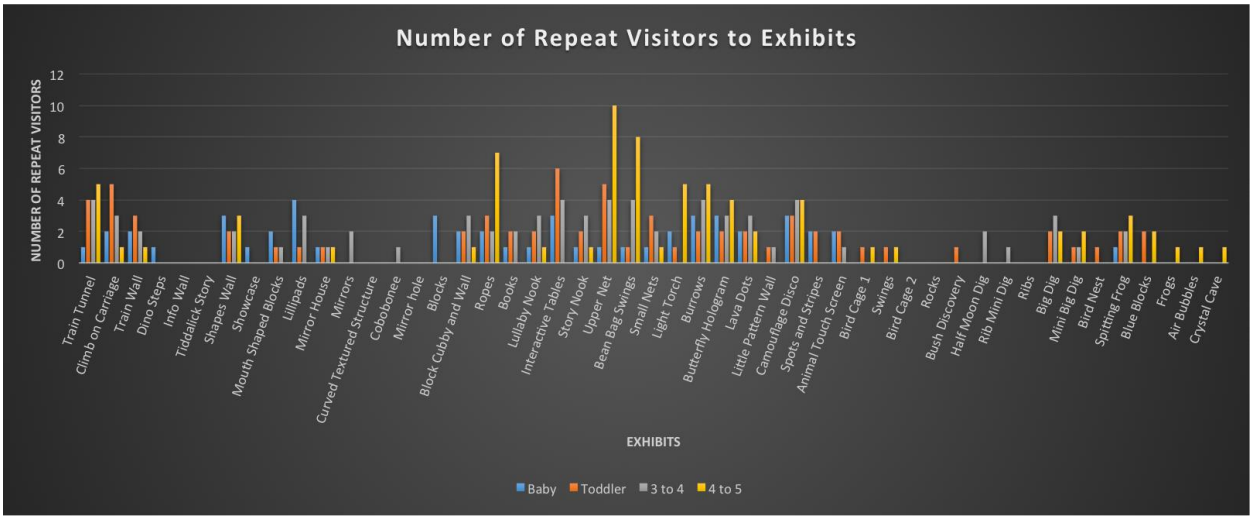
Item 215: Number of Repeat Visitors to Each Exhibit



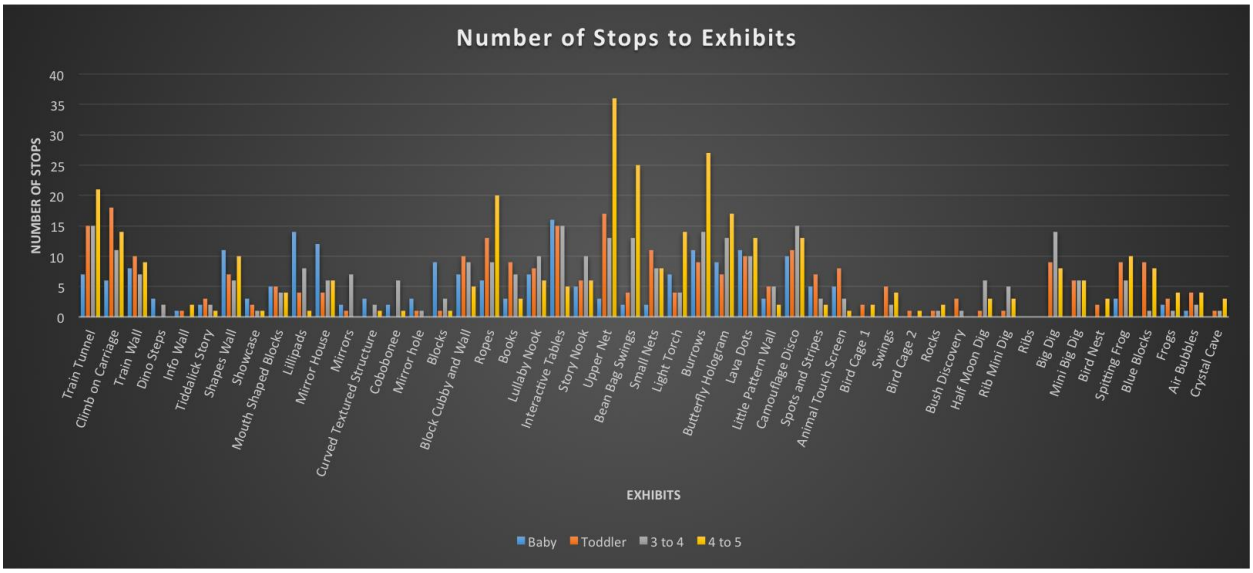
Item 226: Number of Stops at Each Exhibit



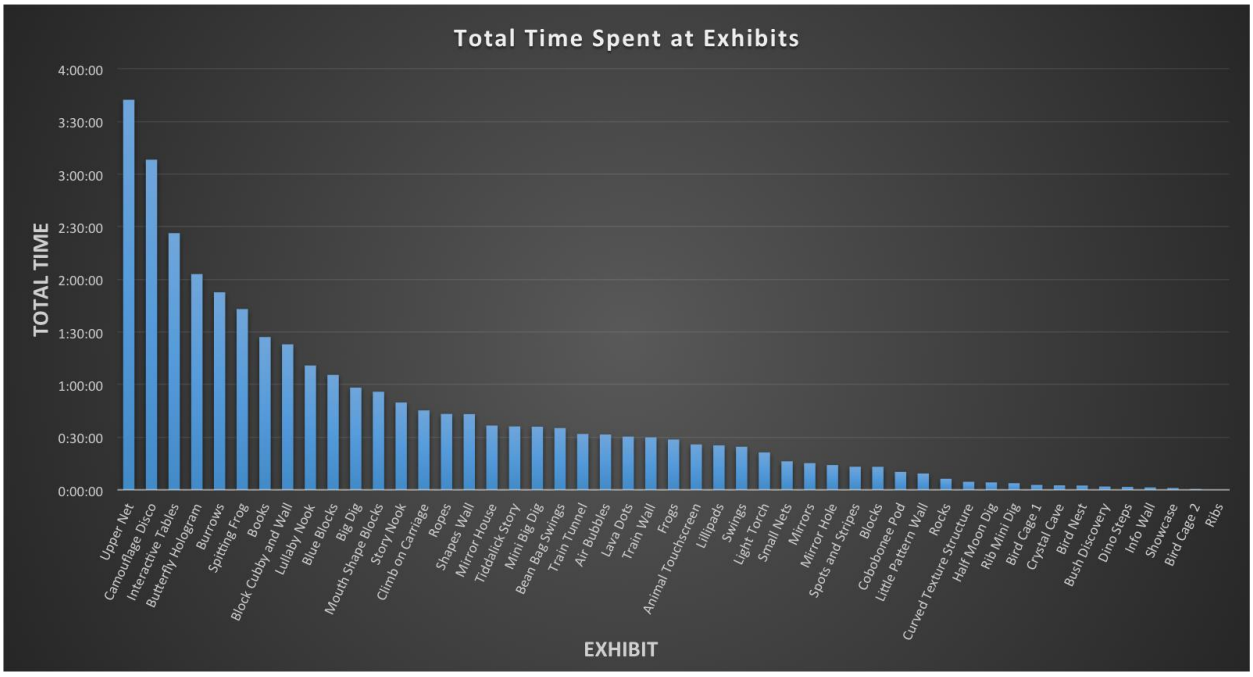
Item 237: Number of Visits to Exhibits by Age Group



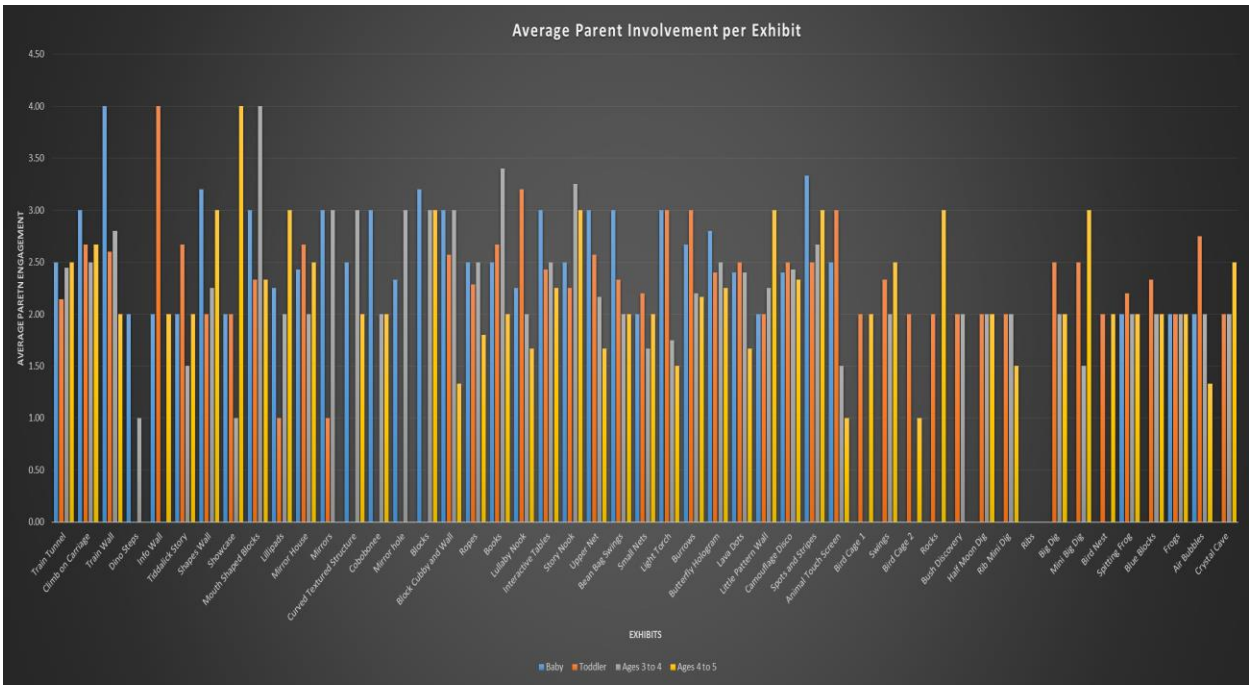
Item 28: Repeat Visitors to Exhibits by Age Group



Item 29: Number of Stops to Exhibits by Age Group

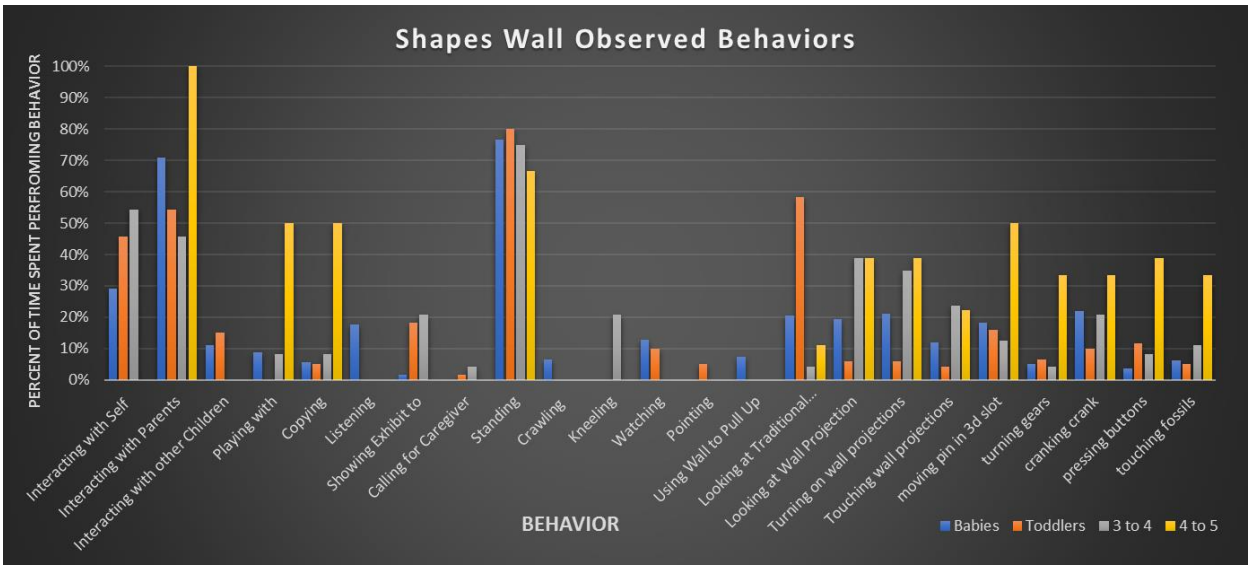


Item 240: Total Time Spent at Exhibits

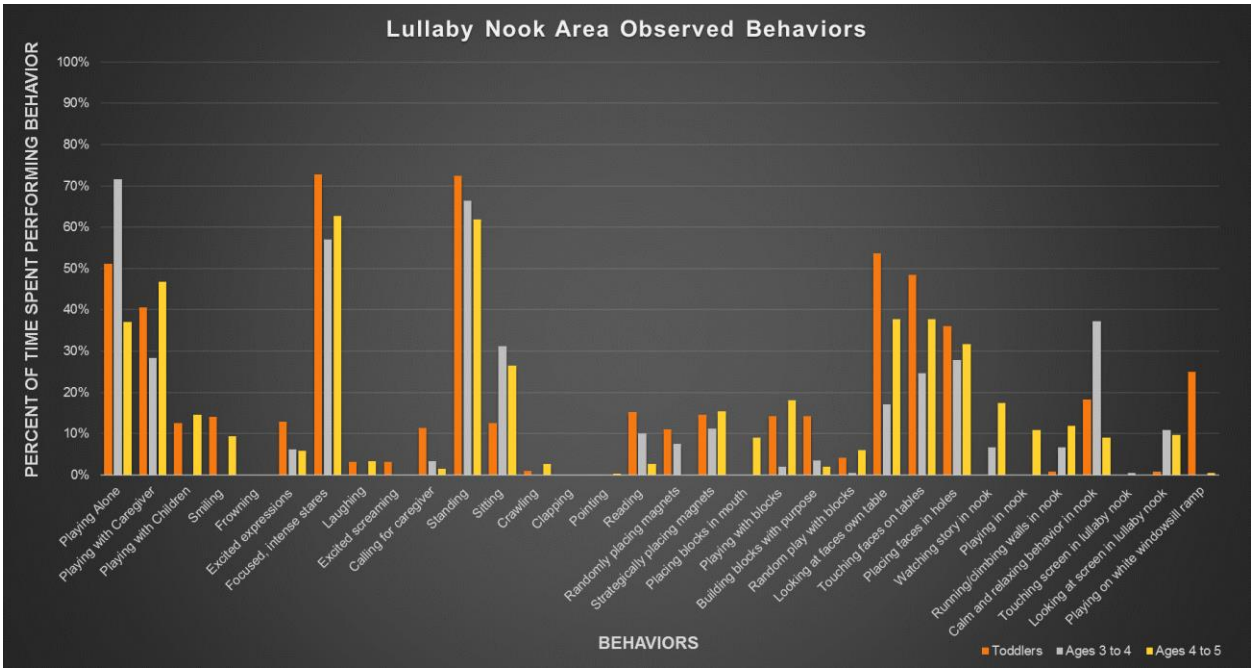


Item 251: Average Caregiver Interaction per Exhibit by Age Group

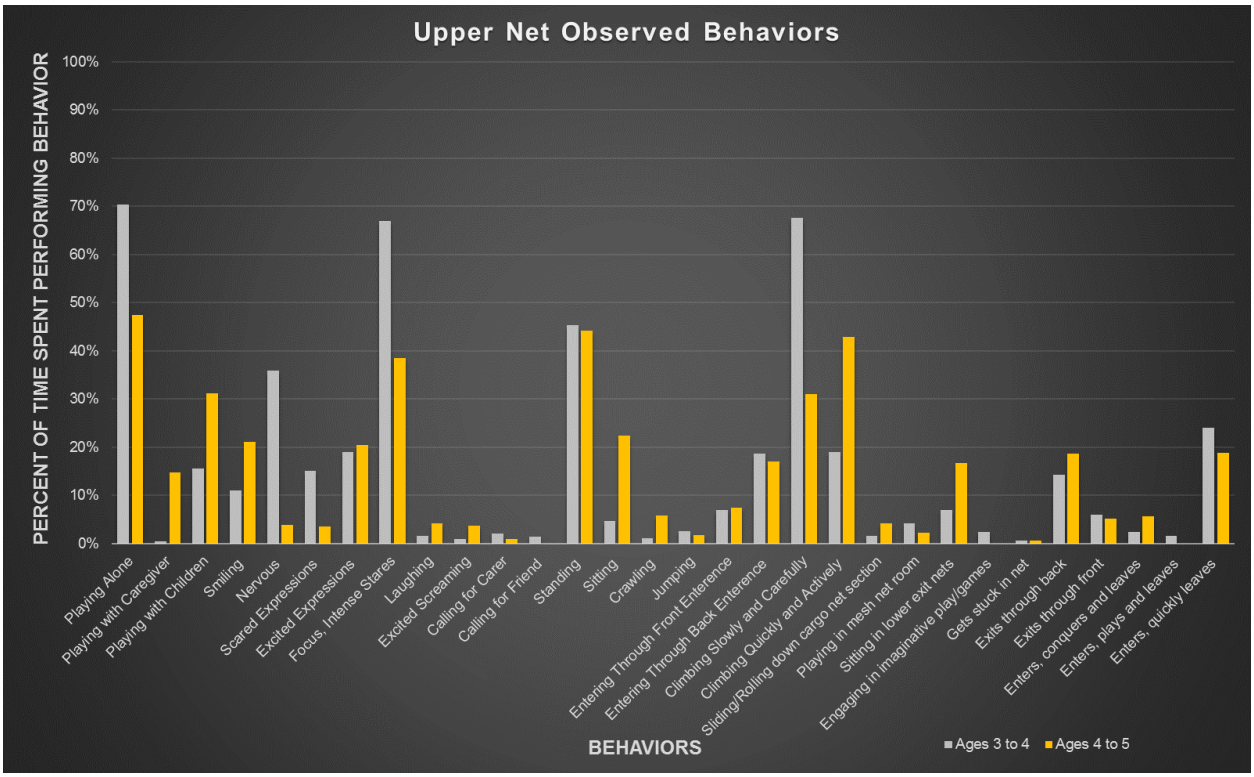
Appendix G: Observation Study Data



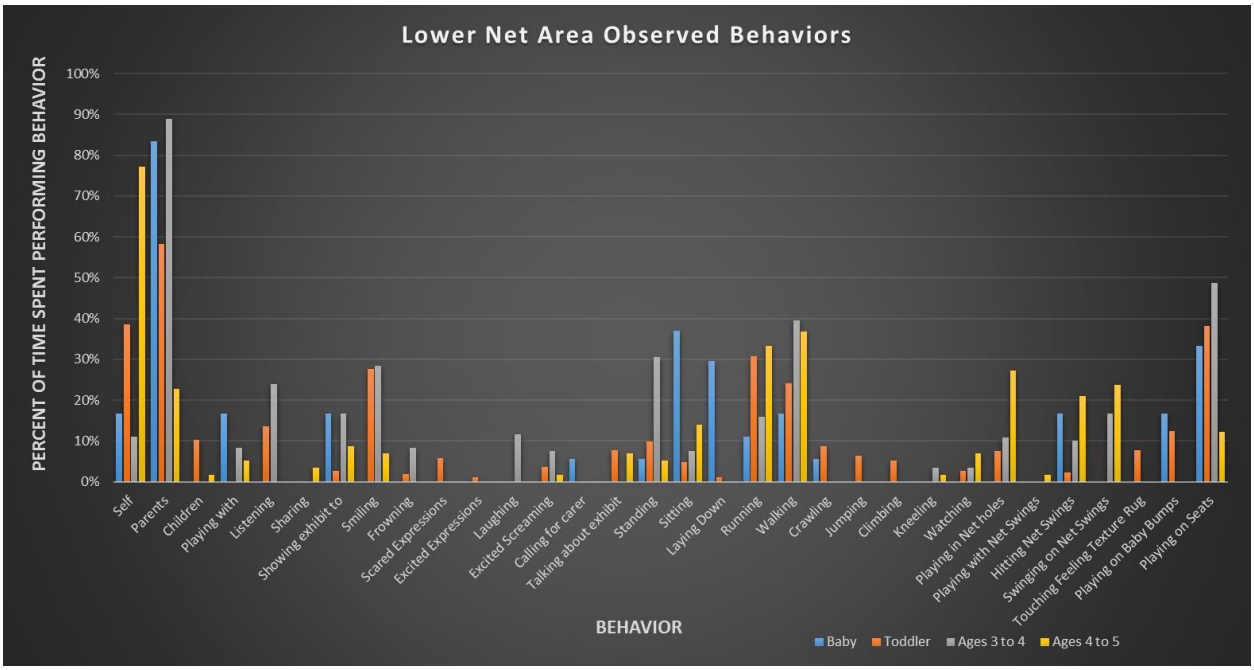
Item 262: Shapes Wall Observed Behaviors by Age Group



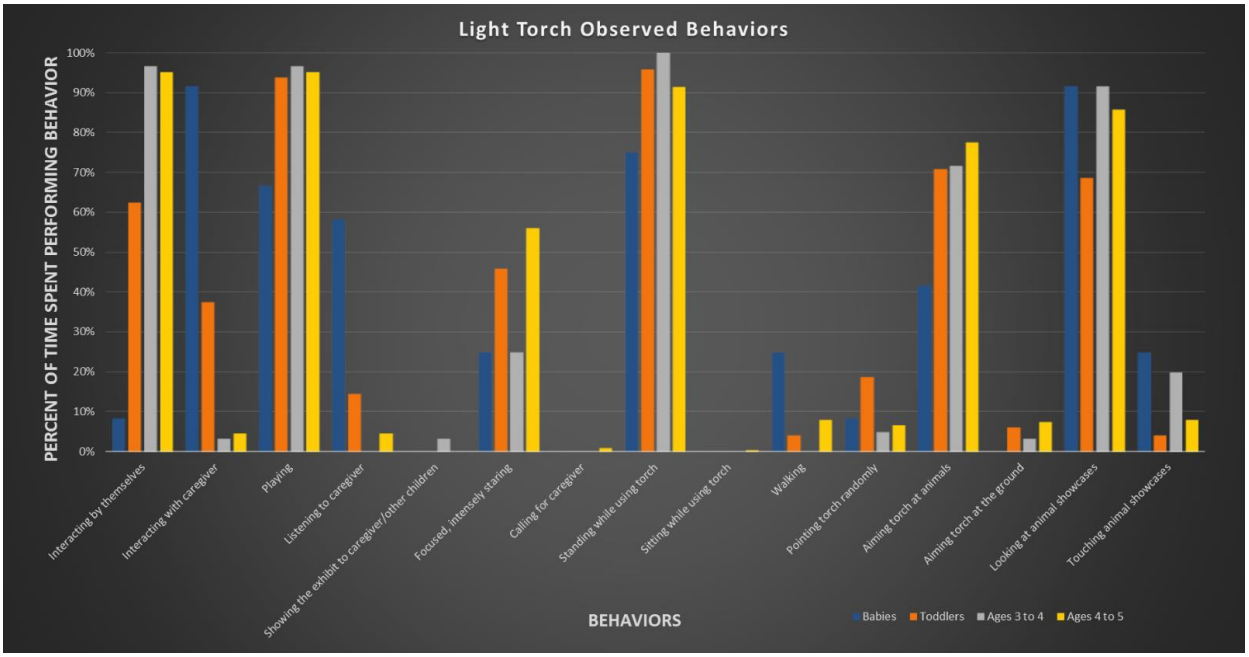
Item 273: Lullaby Nook Area Observed Behaviors by Age Group



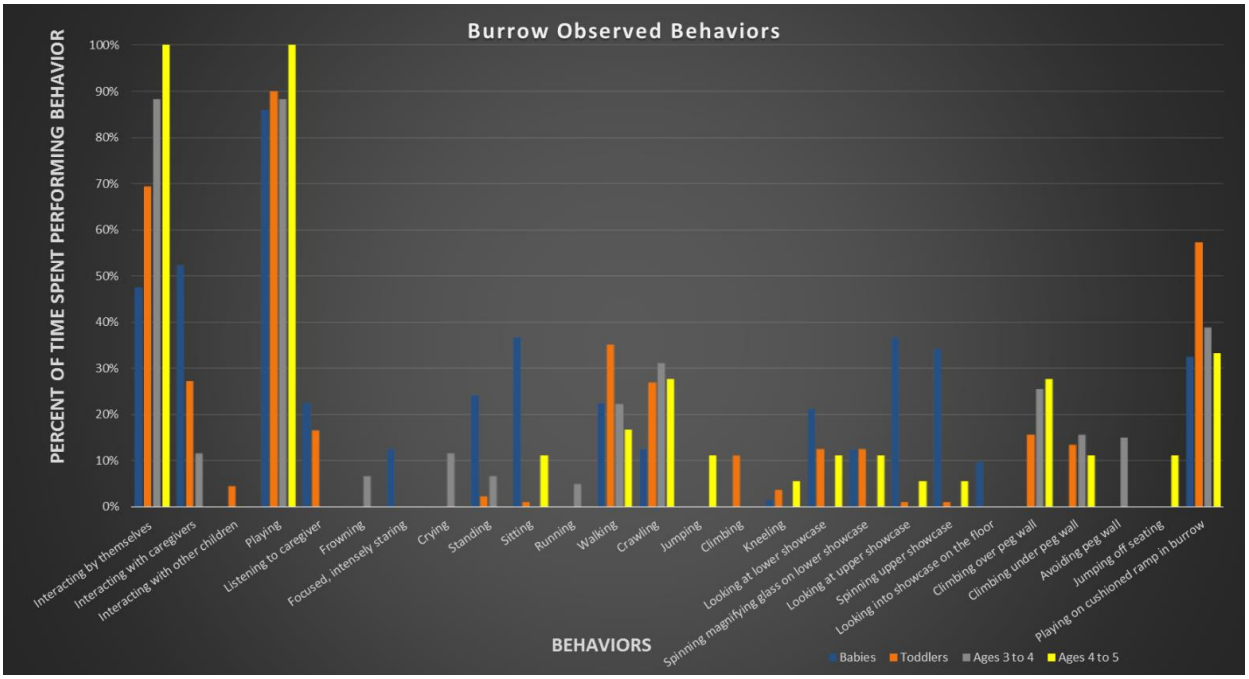
Item 284: Upper Net Observed Behaviors by Age Group



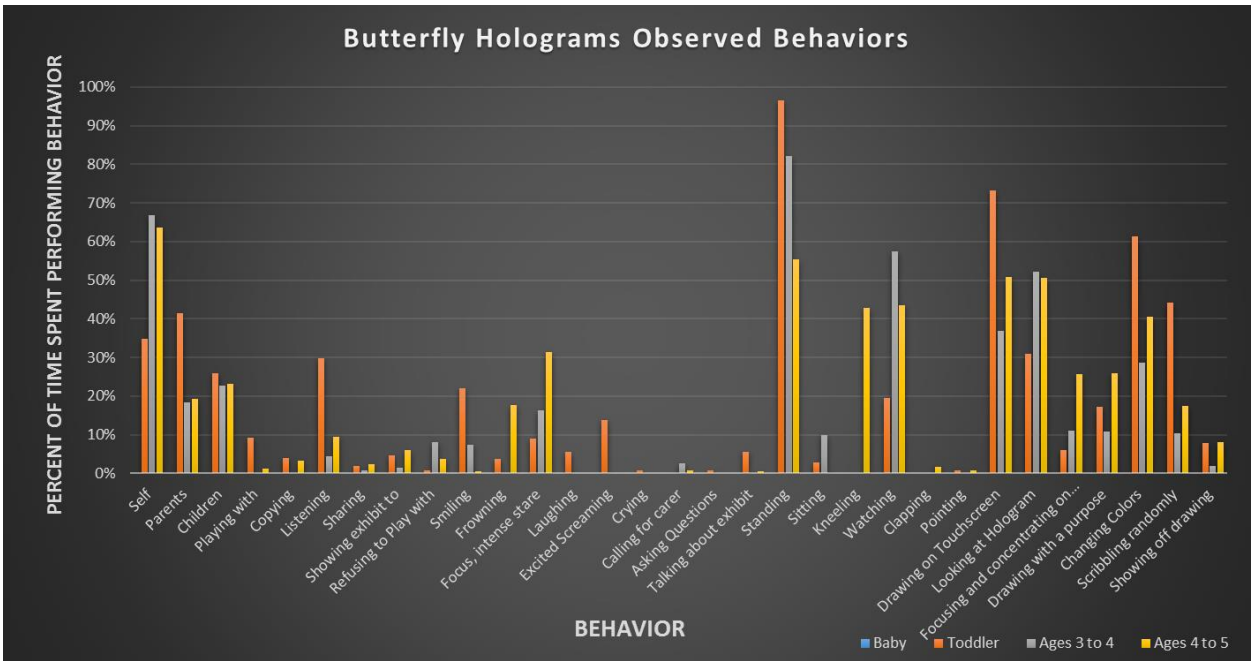
Item 295: Lower Net Area Observed Behaviors by Age Group



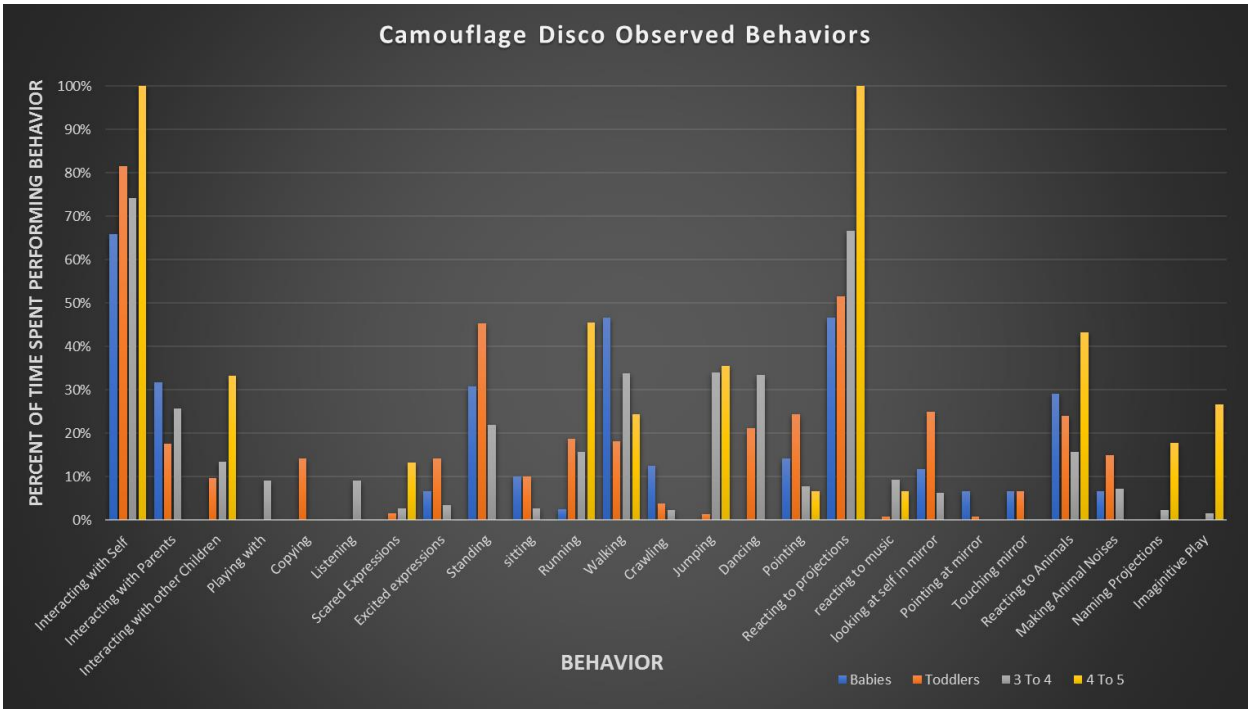
Item 306: Light Torch Observed Behaviors by Age Group



Item 37: Burrow Observed Behaviors by Age Group



Item 318: Butterfly Holograms Observed Behaviors by Age Group



Item 39: Camouflage Disco Observed Behaviors by Age Group