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Abstract

The social interactions that take place in science museums, whether between family members or with mediators, are recognized as essential to visitors' experience. However, there is still little empirical research in the Brazilian context on how families interact and converse on visits to science museums – and even less on the role of the mediator in the museum experience. In this exploratory study, the authors analyze the social interactions of families in an interactive exhibition on biodiversity: “Forest of the Senses”, at the Museum Science and Life (Brazil), characterized by having one of the lowest human well-being indicators in the country. In particular, the authors analyzed the ways in which the presence of human mediation influenced the experience of family visits to the exhibit. Video and audio of ten low-income families' visits were recorded and analyzed using a protocol based on social interactions that take place in museums. Results show that human mediation did not influence the amount or types of visitor-exhibit interactions or the amount of time spent at the exhibit, but increased the amount of conversation time among the groups, including the amount of time discussing science content, thus providing insights into mediator training and qualification.

Introduction

Science museums provide a space for complex experiences and interactions among visitors, objects, and the exhibition environment (Ansbacher, 1999; Hennes, 2010). An important aspect of this environment is the potential for interaction with museum staff, paid or volunteer, and variously named mediators, explainers, educators, docents, or guides (Massarani et al., 2021), whose main functions often include welcoming, facilitating, interacting with visitors, and encouraging visitors to actively engage in activities (Massarani et al., 2008; Richard, 2010). In this article, the authors employ the term “mediators” to refer to professionals who work at the interface between science and the public in science museums. Although not every visitor to a science museum interacts with a mediator during a given visit or experience, the mediator role is practically ubiquitous in science museums of all sizes. While exact numbers are impossible to identify, a 2015 study found that, of 209 scientific and cultural institutions listed in the guide of Centros e Museus de Ciência no Brasil (Science Centres and Museums in Brazil)

(Almeida et al., 2015), 200 had mediators as part of their staff. As enablers of experiences with exhibits in science museums, mediators represent a potentially key element in interactivity and learning. Nonetheless, the role and impact of mediators on visitor experiences has not received the same amount of attention as family interaction itself or object mediation of experience.

Family Visits to Interactive Science Museums

The social interactions of family groups in science museums include discussions triggered by discoveries made in the exhibit, as well as observation of objects and reading of labels and other texts. Such social interactions also include conversations and actions between family members and other museum visitors or professionals. These conversations may include content (e.g., Ash, 2003; Tenenbaum & Callanan, 2008; Kopczak, 2012) related to the exhibit or theme, demonstrate scientific reasoning or discourse practices (e.g., Van Schijndel & Raijmakers, 2016; Willard, et al., 2019; Gutwill et al., 2015), or concern larger socioscientific themes such as conservation (e.g., Archer et al., 2012; Kopczak, 2012; Rowe, 2018). Leinhardt et al. (2002), however, argue that visitors should not be expected to converse in a deep and meaningful way about the museum's content at all times since museums are places of leisure where discussions about visit logistics, rules, and family arrangements also comprise part of the interactive process.

Studies on family learning in museum spaces have revealed that interactions between adults and children result in rich and meaningful experiences even without the support of a mediator. Crowley et al. (2001) and Van Schijndel and Raijmakers (2016), for example, emphasize the role of adults in encouraging children to investigate and in promoting learning conversations. Other studies have shown that the explanations provided by adults during visits contribute to a better understanding of the content of exhibitions (Callanan, et al., 2017; Fender & Crowley, 2007; Eberbach & Crowley, 2005; Fender & Crowley, 2007; Haden et al., 2014). These studies demonstrate that even simple, short, and potentially incomplete explanations given by parents can help children to learn since they occur within a contextualized situation of shared attention. Zimmerman et al. (2010), who examined how families create meaning from biological exhibitions, found that, when parents recall earlier shared experiences and provide their children with support and guidance while interacting with exhibitions, they contribute to a deeper understanding of science and nature. Similarly, Benjamin et al. (2010) and Jant et al. (2014) state that, when parents make associations with prior knowledge in conversations, there is more evidence of children's learning. A study conducted at the National Museum of Natural History in Paris, France, finds that it is common for the father to present himself as a "mediator-demonstrator," providing an interface between the child and the exhibition and building knowledge through conversation. However, an inverse educational relationship also sometimes occurs, in which the children are more knowledgeable about the topic than their fathers due to prior participation in a school visit or personal interest in the subject. In such a situation, the children assume the role of mediator while the father accepts this inversion (Jonchery & Van Praet, 2014).

Gaskins (2016) and Gelman et al. (1991), however, point out that parents also have their limitations, be it with regard to the content presented or to familiarity with the museum location itself, hindering the use of available resources. In addition, other factors may affect the way in which families interact and talk about science at

museums, such as their level of education, socioeconomic status, previous experience in visiting museums, and their science, social, and cultural capital (Gaskins, 2016; Archer et al., 2012, 2015; Aschbacher et al., 2010). Archer et al. (2012), for example, used concepts coined by French sociologist Pierre Bourdieu to examine how and why families influence the development of children's aspirations in relation to family habitus and science capital. Based on interviews with 160 parents of 10 to 11-year-old children, the authors argue that social class is an important factor in facilitating or restricting children's scientific aspirations and identifications. Their findings indicate that middle-class families are more likely to promote and capitalize on their children's interest in science than are working-class families – which tend not to have the same level and quality of science-related economic capital to support their children. However, their findings also reveal that the family habitus is not deterministic and that, in some cases, children “escape” from this pattern, choosing or resisting science and diverging from the family's expectations. In the museum context, Dawson (2014), who examines the expectations and practices of four families from low-income ethnic minority backgrounds visiting three English science museums, argues that, notwithstanding their potential, museums are not yet inclusive spaces. Factors such as the dominant language in the museum, scientific terms and concepts, available financial resources, “free” time, and familiarity with the institutions were investigated and were cited by the participating families as limitations to visits and use of museum spaces. Hence, families with lower social status may not feel welcome in science museums; many do not frequent these spaces, resulting in unequal opportunities for science learning and audience engagement. In corroboration, it has been found that, the higher the social class of the family, the sooner they attend these cultural spaces (Bourdieu, 1966).

Studies of family groups' social interactions and learning experiences have made meaningful contributions to the field over the past 30 years (see, for instance, Jonchery & Van Praet, 2014; Ellenbogen et al., 2004; Falk & Dierking, 1992; McManus, 1987). However, interactions between families and museum professionals have yet to be examined in depth. Studies seeking to understand how the relationship of families with museum professionals influences learning experiences – which can provide supporting evidence to improve museum practices – have only begun to gain momentum in the last ten years (Gutwill & Allen, 2010; Schwan et al., 2014). Pattison and Dierking (2013) argue that, although these professionals have gained increased recognition in enhancing visitors' learning experiences, studies that examine how they act and whether their mediation strategies are effective are still limited, and Good (2013) points out that most existing studies of mediators' impacts on visits occur in art rather than science museums.

The Role of Mediators during Family Visits

Studies have shown that the social interactions provided by mediators can improve visitors' experiences (Ash et al., 2012) by using strategies that facilitate learning (Kamolpattana et al., 2015; Kopczak, 2012; Patisson & Dierking, 2018; Shaby, Ben-Zvi & Tal, 2018). Foremost among the strategies used by mediators is the adaptation of content to visitors (Astor-Jack et al., 2007) in ways that engage them in scientific investigation, including activities such as observing, questioning, describing what they see, and arguing based on evidence (Allen & Gutwill, 2009; King, 2009; Rowe & Kisiel, 2012), and contextualize the exhibition's theme with experiences in their own lives (King, 2009). Furthermore, studies suggest that mediators encourage visitors to extend their

interactions with modular exhibits (Falk & Dierking, 2000; Pattison & Dierking, 2012, 2013), making the visit more satisfactory (Pattison & Dierking, 2018), particularly when they enable the physical manipulation of exhibit elements and the emotional engagement of visitors (Shaby, Ben-Zvi & Tal, 2018).

Other empirical research has sought to understand how interaction with mediators has influenced families' experiences in museums. Pattison et al. (2017), for instance, examined how qualified mediators influenced families' visits to the Oregon Museum of Science and Industry (Oregon, USA). A total of 263 families participated in the survey, 171 of which had their visits mediated by mediators trained by the REVEAL program (see Pattison et al., 2017), while 92 families served as a control group, with mediators only verbally greeting them without mediating the interactions during the visit. The conversations that took place between family members – with or without mediation – were analyzed with respect to evidence of visitor satisfaction, enjoyment of mathematics, mathematical awareness, mathematical reasoning, and intergenerational communication, as well as real-time engagement. The authors' findings indicated that team facilitation had a positive effect on engagement time, mathematical reasoning, and family satisfaction.

Franse et al. (2021) analyzed how the guidance of mediators influenced the learning experiences of families in an exhibition about physical properties (mass, acceleration, etc.). The study, which involved 112 families visiting the NEMO Science Museum (Amsterdam, Netherlands) presented three types of situations: i) *Describing evidence*, in which the mediator pointed out or offered relevant observations about the process or result of the task to be performed by the families; ii) *Offering explanations*, when the mediators described the causal relationship of the experiment or provided explanations to the families pertinent to their scientific investigation of the experiment; and iii) *Control group*, without guidance from an mediator. As a result, the authors present evidence that both guidance strategies provided by mediators, *Describing evidence* and *Offering explanations*, had positive effects on the reasoning in the families' conversations, reducing misinterpretations in their conclusions. Moreover, the strategies did not change the families' interactive behavior with the apparatuses. However, the authors emphasize that families that received less input from the mediator had more learning opportunities.

Schauble et al. (2002), in turn, interviewed 32 parents visiting the exhibits *The Creek* and *The Construction Zone* at the Children's Museum of Indianapolis (IN, USA), as well as 16 mediators at these exhibits, in order to discover what they thought about learning in museums, including the role of adults in this process. Most of the parents (17 respondents) stated that learning through the exhibits came by means of active experimentation and play, and that the role of adults should be minimal, leaving children to act on their own. The mediators' opinions about if and how learning took place in the exhibition were ambivalent, particularly with respect to the relationship between play and learning. Although the mediators recognized the potential of the exhibitions for play, self-discovery, and exploration, 9 of the 16 respondents questioned whether play actually facilitated learning. As for the role of adults, the mediators highlighted the importance of being actively involved in activities and playing together (12 respondents), talking to children or explaining how things work (10 respondents), or asking instigating questions (6 respondents).

Some studies have also found negative aspects in the interaction of mediators with visitors, for example, in cases

where they do not respect the public's desire to visit an exhibition by themselves (Kopczak, 2012; Pattison & Dierking, 2012, 2013), and in situations where, because they are eager to give explanations, they overload visitors with content – which is often the case with children (Alfonsi, 2005). Some authors also criticize the use of ready-made scripts during school children's visits, as this promotes adopting a didactic or narrative style, or using a plethora of scientific jargon or explanations that do not include comprehensive ideas or concepts and may be unrelated to visitors' previous experiences and knowledge (Cox-Peterson et al., 2003; Tal & Morag, 2007). In an analysis of children's experiences in museums, Jensen (1994) found that they prefer to visit museums in the company of family or friends rather than in a school group because with the family they are free to inspect the modules they find most interesting, giving them greater control over the pace of the visit and enabling them to share their activities and observations with their parents.

Studies on mediators in science museums in Brazil, the context of this study, are still scant, but several research lines stand out: Carlétti and Massarani (2015) and Massarani et al. (2021) have sought to map the profile of these professionals around the country; Norberto Rocha and Marandino (2020) and Marandino (2008) discuss their role in interfacing with the public; Costa (2019), Contier (2018), Giglio (2016) and Gomes and Cazelli (2015) have explored the continuing professional education of mediators; and Massarani, Reznik et al. (2019c) and Bizerra (2009) have examined the actions of mediators during museum visits. For example, in an analysis of how adolescents interact and what they talk about during a visit to an exhibition at the Museum of Life (Rio de Janeiro, Brazil), Massarani, Reznik et al. (2019c) found that the presence of the mediator was a factor that favored more in-depth conversations about the theme and the active construction of meaning.

Theoretical Framework

A sociocultural approach was taken (Vygotsky, 1978; Wertsch, 1998; Scribner, 1988, Scribner & Cole, 2014) to interactivity in museums in this study that focuses on both the unique and individual components of the experience, as well as the repeatable, shared, and goal-oriented nature of such activity. Within the sociocultural perspective, agency and cognition are seen as distributed, comprising both mediation through artifacts – objects, signs, and elements (Vygotsky, 1978; Wertsch, 1998) – and other agents – parents/guardians, mediators, etc. (Rogoff, 1990; Lave & Wenger, 1991). In this study, the authors focus on the human mediation of both parents and mediators rather than the object mediation of museum components.

In line with this general approach, the authors draw on Allard and Boucher (1998), who propose a theoretical model to investigate how interactions between individual (visitors), object (theme) and agent (mediator) develop in a museum setting from an educational perspective. The model specifically aligns with the theory of intent participation (Rogoff et al., 2003) and activity theory (Scribner & Cole, 2014; Leont'ev, 1978) conceptualizing the museum visit as an activity system, part of the goal of which is to support the visitors in taking ownership of content, practices, and ways of thinking during their interactive experience, gradually becoming more autonomous in choice of both the objective and how to achieve it. Allard's model is useful for the study of conversations and interactions that occur in the relationships of (i) *appropriation* between visitor and object, (ii) *transposition* between object and mediator, and (iii) *support* between mediator and visitor (or among visitors).

Finally, family talk is conceptualized in this study as a special type of discourse, where talk and action (gestures, touching, eye gaze, etc) shape each other over the course of an activity and must, therefore, be treated as co-constitutive (Gee, 2014; Rowe, 2005). As one result of this approach, the process employed in this study – described in more detail below – involves the application of coding directly to video segments rather than separating talk and action for coding on transcripts. Codes are applied not to words, sentences in the transcript, or transitions from one speaker to another - as in much discourse and conversation analysis - but rather to stretches of activity that have a clear beginning, middle, and end, what the authors refer to as, in accordance with Ash (2003) and Ash et al. (2012), significant events. From a theoretical perspective, this assists in the realization of one of the primary goals of a sociocultural approach: the analysis of cognition from both the individual psychological aspects of activity and the shared, social dimensions (Wertsch, 1998).

Method

The goal of this qualitative and quantitative exploratory study was to analyze the social interactions that occur during family visits to an interactive touring exhibition on biodiversity. In particular, the authors sought to determine to what extent the presence of human mediation influenced the experience of family visits to the exhibition. This study was carried out within the scope of National Institute of Public Communication of Science (INCT-CPCT) with the aim of understanding learning in science spaces and the meanings created by different audiences around the informal education activities offered in these scientific-cultural spaces (Massarani, Fazio et al. 2019a; Massarani, Poenaru et al., 2019b; Massarani, Reznik et al., 2019c).

The Exhibition

The exhibition under analysis, “Forest of the Senses,” (Floresta dos Sentidos) was produced by the Museum of Life, an interactive museum linked to the Casa de Oswaldo Cruz/Fiocruz, and by the Federal University of Rio de Janeiro (UFRJ), with support from the Rio de Janeiro Research Foundation (FAPERJ). During this study’s data collection period, the exhibition was on display at the Museum Science and Life (MCV), linked to the CECIERJ Foundation (Center for Science and Distance Learning in Higher Education of the State of Rio de Janeiro). Opened to the public in 2010, the Museum Science and Life – MCV – is an interactive museum located in the central region of the city of Duque de Caxias, which has a high population density, intense commercial activity, and a well-developed public transport network. Its floor space of approximately 5,000 square meters houses short and long-term exhibitions, a planetarium, an auditorium, and rooms for workshops. The MCV is the only science museum in Duque de Caxias, which has a population of almost one million. The region, which follows an urban-industrial model, faces serious problems of infrastructure, public health, and education, as well as an unequal income distribution. In fact, the metropolitan region of the state of Rio de Janeiro has one of the lowest Human Wellbeing Indices (IBEU) among the country’s metropolitan areas (Observatório das Metrópoles, 2010, 2013). The IBEU measures the level of urban conditions needed to live in cities, especially in Brazil’s large urban centers, considering urban mobility; urban environmental conditions; urban housing conditions; urban public services, and urban infrastructure.

Created for children, the exhibition aims to raise awareness of current issues in biodiversity, such as the dispute for resources between native and invasive species, species conservation, animal trafficking, and biopiracy. Brazil, with its high biodiversity, is home to 15 to 20% of the world's known animal species, the largest number of endemic species in the world (CDB, 2016; Lewinsohn & Prado, 2005), and two of the 19 global biodiversity hotspots: the Atlantic Forest and the Cerrado biome. However, due to the country's size and the fact that 87% of Brazilians live in urban areas (Statista, 2021), not everyone has the opportunity to visit and experience the countryside, forests, and environmental reserves that allow for contact with wildlife. Thus, environmental education efforts, including traveling exhibits, are important strategies to bring children closer to the natural environment in order to foster and encourage pro-environmental behavior, specifically their engaged participation in mitigation actions and changes in attitudes to ensure a more sustainable future.



Figure 1. A) Computer with Instructions; B and C) Children Performing Activities, and D) One of the Areas of the “forest.” Credit: Peter Iliciev

The exhibition uses a game-like language and situation definition (Rowe, 2005), engaging children and their families in looking for clues, as in a “treasure hunt,” that will help them progress. The exhibition entrance is Area 1, containing 2 tree-shaped “islands,” each with a touchscreen computer, which mark the beginning of the activity. A sloth, the game’s mascot, narrates and instructs visitors on how to play and challenges them to discover clues hidden in the scene (Figure 1A). Families are also given a kit with inexpensive objects such as magnifying glasses, flashlights, clothespins, and shells to be used during the visit. Following the mascot’s instructions, visitors enter

a 42 square meter nanoforest composed of printed images, objects, materials of different textures, sound effects, and scenic lighting, which serve to give visitors the impression of being immersed in a forest (Figure 1B, 1C and 1D). The forest is subdivided into four areas in which the clues that make up the game are “hidden.” In summary, the dynamics of the exhibition consist of 1) activating the computer and obtaining instructions in the form of clues; 2) entering the forest and performing the activity within the stipulated time of 180 seconds for each clue, and 3) returning to the computer to answer the question and get a new clue.

Procedures

Data were collected on Saturdays, the day of the week with the largest number of family group visits, from March to July 2015. Families were approached by researchers at the museum entrance. The study’s purpose and procedures were described in informal conversations, during which the researchers determined if the families met the research criteria, which were that the groups should be comprised of at least one adult and one child between 5 and 8 years old, with a maximum of six members, and live in low-income and/or disadvantaged urban areas (Observatório das Metrôpoles, 2010, 2013). Children of this age group were chosen because they were the target audience of the exhibition. In this study, families were defined as a closely related group, whether or not their relationship was biological (Briseño-Garzón & Anderson, 2012).

The study was submitted to and approved by the Research Ethics Committee at the Joaquim Venâncio Polytechnic School of Health (EPSJV/Fiocruz) under regulation No. 466/2012 and under Operational Standard No. 001/2013 of the CNS/MS (National Health Council/Ministry of Health). Families who accepted the invitation to participate filled out an Informed Consent Form (ICF) and a Video Consent and Release Form. To ensure anonymity, family groups participating in the study are indicated by codes (e.g., G1) and adults and children by letters, as follows: “A” for adult visitor and “C” for child visitor, “M” for mediator and “R” for researcher. Before beginning the visit, the adults answered a brief questionnaire about the family’s educational and socioeconomic background.

The families’ visit experiences were recorded using the point-of-view camera method (Burriss, 2017; Glaveanu & Lahlou, 2012; Massarani, Fazio et al. 2019a; Massarani, Poenaru, et al. 2019b; Massarani, Reznik et al. 2019c), which, in this case, consisted of video and audio recording with a *Looxcie* wearable camera attached to helmets worn by participants to document their interactions with the exhibit and with other people. One adult and one child from each family group used the wearable camera, but the data analyzed in this study are from the child’s point of view. With the cameras properly positioned, the families continued their visits, half of which were mediated and the other half of which took place without the help of mediators. For mediated visits, the only instructions the mediators received were to act/explain as they normally did. When the families wanted to end their visit, they notified the researcher – who kept his/her distance to avoid interfering in the family dynamics.

Characteristics of the Participating Families

A total of ten family groups composed of 14 adults (10 women and 4 men), 12 children (9 boys and 3 girls) and one adolescent girl participated in this study (see Table 1).

Table 1. Information on Family Groups

Groups	Adult Relationship	Child Gender (Age)	Duration of visit	Type of visit
G1 (n = 2)	Mother	1 ♀ (7)	6'43''	Free
G2 (n = 2)	Mother	1 ♂ (8)	11'38''	Free
G3 (n = 3)	Mother	2 ♂ (7, 7)	24'22''	Free
G4 (n = 3)	Grandmother and mother	1 ♂ (8)	17'08''	Free
G5 (n = 3)	Mother	2 ♀ (7, 4)	24'30''	Free
G6 (n = 3)	Father and mother	1 ♂ (5)	12'21''	Mediated
G7 (n = 3)	Father	2 ♂ (6) and (11)*	12'43''	Mediated
G8 (n = 4)	Father and mother	1 ♂ (7) and ♀ (15)	24'02''	Mediated
G9 (n = 3)	Father and mother	1 ♀ (7)	19'23''	Mediated
G10 (n = 2)	Grandmother	1 ♀ (6)	21'14''	Mediated

* Nephew. Source: the authors

The participating families were residents of different neighborhoods in the city of Duque de Caxias, some living up to 30 kilometers away from the Museum Science and Life, with few available public transport options. All these families belong to class D, with monthly incomes varying from two to four times Brazil's minimum wage (IBGE, 2021), which is equal to approximately US\$ 420.00 to US\$ 840.00 - Calculated based on the PTAX rate on August 2021, which was US\$1.00 = R\$5,23 according to the Central Bank of Brazil (Banco Central do Brasil). Admission to the museum is free for these families, but the cost of transport and a meal is one of the main aspects that make the visit difficult (Almeida et al., 2018).

Nevertheless, of the 10 groups had already visited the Museum on two to four occasions. Two of the children were already familiar with the "Forest of the Senses" exhibition on the day the data were collected, but this was their parents' first visit. With regard to their level of education, 4 of the participating adults had an elementary education, 7 were high school graduates, and 3 were university graduates. As for the children, 2 were attending pre-school at the time, 9 were in elementary school, 1 was in middle school, and the teenager was attending high school.

Data Analysis

To analyze the families' museum experiences, the videos recorded during the visits were uploaded to Dedoose 8.0.23 and coded using a protocol validated by the research group to which the authors belong (described in detail by Massarani, Reznik et al., 2019c). In brief, the protocol, which is based on the relationships proposed by Allard and Boucher (1998), includes three elements of the visit: (i) the visitors themselves, (ii) the museum mediators, and (iii) the exhibition components (see Massarani, Fazio et al. 2019a; Massarani, Poenaru et al. 2019b; Massarani, Reznik, et al. 2019c; Massarani et al., 2020) and is composed of five dimensions and their corresponding categories. This article discusses two of the five dimensions, namely, *Types of Interaction* and *Conversations*, given that they pertain to the objectives of the investigation and occurred the most frequently. The videos were viewed in full to identify the corresponding categories at specific points or excerpts, in order to consider the duration of the activity and experience and to determine the number of occurrences of each interaction type. Table 2 lists the definitions of categories and subcategories and their occurrences.

Table 2. Definitions and Occurrences of the Analyzed Categories

Categories	Definition	Occurrences
		n
Type of Interaction		
<i>Visitor-visitor</i>	Visitors talk among themselves, regardless of conversation content.	257
<i>Visitor-mediator</i>	Visitors listen to the mediator's comments and information or talk with them, regardless of the content of the conversation.	88
<i>Visitor-exhibit interactive activity</i>	Interaction that takes place through immersion, experimentation, and physical interaction.	25
Conversations		
<i>Conversations about science topics</i>	Conversations about ideas, data or scientific content, etc. These may include ethical and moral dilemmas in science, social impacts of scientific activities, etc.	81
<i>Conversations about the exhibition (its operation, design, and the museum experience)</i>	Conversations triggered by visitor interaction with the exhibition about its operation, design, and/or museum experience.	227

Source: Adapted from Massarani, Reznik et al. (2019c).

Results

The total combined duration of the families' visits to the exhibition was 188 minutes, with free visits and mediated visits lasting for approximately the same time, i.e., 16 min and 17 min, respectively. Video was not subdivided into equal time segments for coding; rather, codes were applied whether a given activity or conversation lasted less than 1 minute or several minutes. In the analysis of the audiovisual material, 678 occurrences of the target categories were identified. In the *Types of Interaction* dimension, the most recorded analytical categories in the video excerpts analyzed here were *Visitor-visitor* (257 times) and *Visitor-mediator* (88 times). In the *Conversations* dimension, the category *Conversations about the exhibition – its operations, design, and museum experience* – were recorded 227 times; in addition, 81 conversation clips were recorded in *Conversations about science topics*. Fewer occurrences (25) were recorded in the *Visitor-exhibit interactive activity* category (*Types of interaction* dimension) (see Table 2).

Due to the fact that the codes were applied to video instances of unequal length, a weighted average was generated in order to identify patterns of familial interaction at the exhibition during free visits (Families: G1, G2, G3, G4 and G5) and mediated visits (Families: G6, G7, G8, G9 and G10). This average took into account the relative amount of time each coded episode lasted by multiplying the occurrence of each category of analysis by the total amount of time it represented in the video.

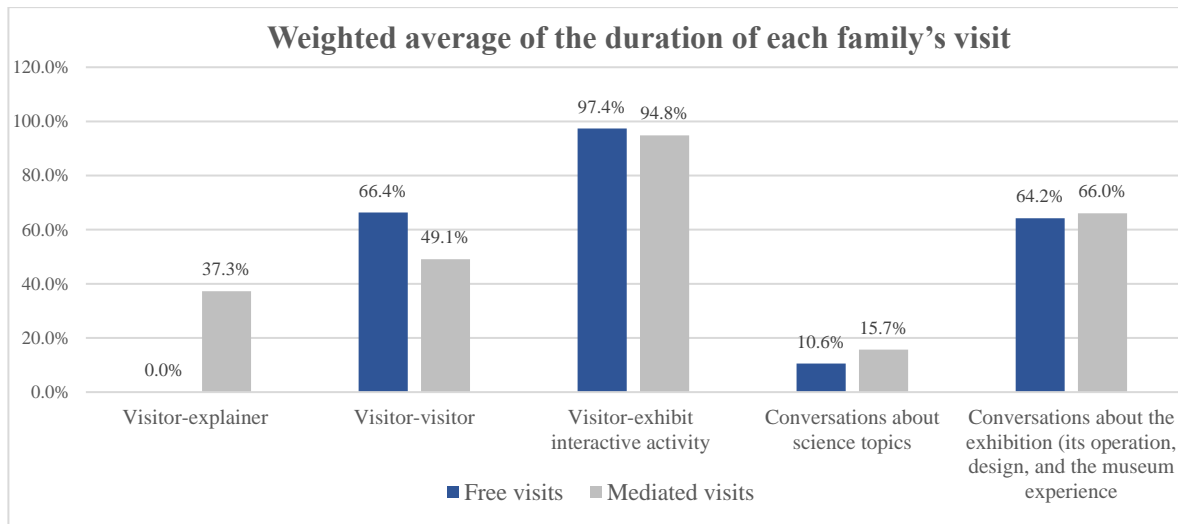


Figure 2. Weighted Average of The Duration of Each Family's Visit

The circumstances in which each category occurred were summarized based on these data. Throughout the exhibition visits, family members interacted with each other for a large portion of the total visit, during both free (66.4% of the time) and mediated visits (49.1% of the time). Interactions with mediators occupied 37.3% of the time spent at the exhibit by visitors in the mediated visits group. Despite the absence of professionals during free visits, four of the five families in this group were given explanations about the operations and dynamics of the exhibition by researchers who were collecting data, representing 8% of the visit time (22 occurrences in the video clips). In terms of *Visitor-exhibit* interaction, the data indicate no real difference in the amount of *Interactive*

Activity between group types (97.4% of the visit duration for free visits and 94.8% of the visit duration for mediated visits). Although *Interactive activity* code only occurred 25 times, each occurrence (i.e., each significant event) lasted for a long period of time, thus resulting in a higher total weighted average.

This weighted analysis of the content of family conversations indicates that, in the category of *Conversations about the exhibition (its operation, design, and the museum experience)*, there were no appreciable differences between the types of visits. These data suggest that, for these two categories (*Visitor-exhibit interactive activity* and *Conversations about the exhibition (its operation, design, and the museum experience)*), mediators do not interfere with *Visitor-exhibit* interactions. On the other hand, in *Conversations about science topics*, the data indicate a higher frequency of this category during mediated visits (15.7%) than in free visits (10.6%). To better place these findings in context, the authors turn to a qualitative description of particular episodes that illustrate what the dimensions of *Types of interaction* and *Conversations* looked like among participating families in both mediated and free experiences.

Family Interactions and Conversations during Free Visits

An analysis of conversations and interactions revealed a variety of mechanisms employed by families to interact with each other and explore the exhibition. With regard to interactions within the family group (*Visitor-visitor*), which occurred during 66.4% of the visit duration, it was found that adults and children demonstrated collaborative behavior. To a greater or lesser extent, the adults engaged in performing activities with their children, which will be discussed in the "What do free family visits reveal?" section. Families generally remained together, and when they separated in search of clues, they soon came together again to share their findings. Parents/guardians encouraged children to use multimedia resources and to answer the questions posed by the sloth. They also helped children look for clues in the forest, as indicated in the examples listed below.

Example 1 – Interaction of G5 on the computer concerning the flowers shown in the exhibition

V1: Which flower did you see there on the wall? Was it this, that, or the other one?

C2: I don't know.

V1: Look properly, press here. Now.

C1: Ahhh! [Happy to have got it right]

V1: Let's continue.

Example 2 – Interaction of G3 looking for the clue about fireflies

V1: Oh, the firefly lights [eager]. Let's go.

C1: Look, there's a bat!

V1: Settle down. Let's go see the fireflies, come on.

C1: Is it in the cave?

V1: Where's C2, huh? This is where the fireflies are, remember I told you? The fireflies. Here look, here are the fireflies, let's follow them.

C1: Here, here!

V1: Come on, turn it on (the flashlight) so we can follow them. Guys, where's C2?

C1: Did you find them (the fireflies)? Here?

V1: Come along!

C1: Or should it (the flashlight) be turned off?

V1: Did you find them? [asking excitedly, while they continue their visit]

In Example 1, the father encourages the child to answer the question; the child says he doesn't remember, but V1 encourages him: "*look properly*" and even advises the child to activate the selected option "*press here. Now*", explaining how to interact. In Example 2, the mother tells the child to look for fireflies. When the child draws the mother's attention to something else, a bat, she asks the child to settle down and focus, continuing the search, modeling her sense of organization and commitment to finding the clues. A recurrent behavior in different episodes, which was identified 35 times in the families' speech, was parents/guardians seeking to stimulate their children's memory, helping them remember what they saw in the forest in order to answer the multimedia questions. To demonstrate: "*V1: Which flower did you see there on the wall?*" (Example 1, G5), or what they needed to look for in the forest, such as, "*V1: This is where the fireflies are, remember I told you?*" (Example 2, G3). As for children's role in family dynamics, some episodes indicate that they encouraged the adults to engage in the game, had the freedom to initiate conversations, and guided their families to play the game correctly. This is exemplified below (Example 3), when the children of G3 seek to discover the clue, telling their mother how to do it properly.

Example 3 – Interaction of G3 in the search for the clue about bees

C1: See? You have to follow the bees to find the flowers. They're near the tapir, near the tapir. Let's go!

V1: Come.

C1: Near the tapir!

V1: Where's the tapir? Is this the tapir?

C1: Flowers

V1: Come on.

C2: Here!!! (excited)

V1: Find it?

C2: Here!! (here), right here.

In this type of interaction in which the child takes the lead, the authors highlight an episode from G4, in which C1 guides his grandmother, who had difficulties in understanding the dynamics of the game. After listening to the sloth's instructions, the child's grandmother (V1) is confused and does not understand that it is her turn to go to the forest. C1 explains that it's her turn and directs her to the forest, "*C1: It's you, V1. It's you, go, go.*" V1 is happy because it's her turn, but, when she reaches the forest, she wonders where to find the clue, "*V1: Where am I going to find this here?*" – a behavior that is discussed below.

In family interactions with exhibition modules, it appears that the nature of the exhibition favored *Interactive Activity*, which was recorded in 97.4% of the total visit duration. In general, families interacted with the game and

handled the multimedia or expographic elements present in the exhibition (e.g., magnifying glasses, flashlights, etc.), expressed in the examples above in phrases such as, “V1: *Close to flowers, they like flowers. Look, look here, use the magnifying glass, C1.*” / C1: “*Look, look! [excitedly]. We found it!*” / V1: “*Now hurry, press it.*” (G5).

In search of clues, two families (G2 and G5) showed concern regarding the time spent performing the activities, since it was timed. Phrases that illustrate this aspect are highlighted below, “V1: *Wait a minute, we’ve got to count the time. Come on, you’ve got to count the time, there’s the waterfall*” (G2), and, “V1: *Look, you’ve got to keep the challenge in mind. Come here, remember how that sloth asked us to look at the trunk? If it takes too long our time may run out, you have to see where the spider is.*” (G5). Another aspect observed frequently (31 times) during family conversations was that of difficulty experienced by adults interacting with the game, not knowing how to guide their children or answer questions on the computer, as illustrated by the following examples.

Example 4 – G1 talking about the clues

V1: Start looking, dear.

C1: Is this it?

V1: I don’t know, I didn’t get it, dear [...] listen, think, what color was the creature?

Example 5 – G5 looking for the snake

C1: At the top of the tree? [listening to the choices on the computer]

V1: Maybe? Go look, daughter. Oh, then it wasn’t this creature. Wasn’t it this animal, dear?

C2: No, it doesn’t have legs.

V1: Then we were looking for the wrong animal.

Example 6 – G2 interacting with the multimedia computer

V1: I saw that there. I saw it.

C1: Is it the lion?

V1: I saw the chameleon; you can go on the chameleon, kid. It’s the chameleon, go ahead, I saw it.

C1: Chameleon? [They press the key and find they were wrong]

V1: Then it’s the toad [correct answer]

V1: I didn’t see it there. Did you?

C1: No.

Utterances such as, “V1: *I don’t know, I didn’t get it, dear*” (Example 4), “V1: *Then we were looking for the wrong animal*” (Example 5) and in the phrases indicating doubt in G2 (Example 6) identifying the right animal, “C1: *Is it the lion?*” / “V1: *I saw the chameleon; you can go to the chameleon kid...*” and, “V1: *Then it’s the toad*” reinforce the parents/guardians' difficulties in understanding the dynamics of the game.

Some families asked the researcher for help upon encountering difficulty. The guidelines the researcher gave upon welcoming visitors and explaining the dynamics of the game were occasionally complemented during the visit at

these times. Specifically, family G5 requested the researcher's help more than once while interacting with the game, as illustrated in the example below.

Example 7 – G5 asks the researcher for help

V1: Are these the fruits?

R1: Do you want a clue?

V1: Are these the fruits?

R1: They were in the bamboo, weren't they?

V1: Yes.

R1: That's the bamboo right there. Just take a look at the seeds; we've got to pay attention in order to answer.

V1: Look, the bamboo seed.

C1: Bamboo seed.

The mother's request is direct in example 7. She does not want the researcher to provide a clue; she wants to know if she has the right answer and can continue playing. In the dimension of *Conversations*, the conversations held during the families' interactions focused more frequently on how to use the computer and directions in the Forest space to search for clues, as seen in *Conversations about the exhibition (its operation, design, and the museum experience)*, which occurred during 64.2% of the total visit duration. In general, these directions are given directly by adults to children, aiming to succeed at the game, as indicated by the following examples.

Example 8 – G3 solving the jackfruit puzzle

V1: No, no, let me, you're just jumping around

C1: You can do it here...

V1: Hold on, wait. Let's go

C1: Come on. It's here, come on, come here. I've played this before

V1: Ah [surprised]; no, but what's this? It's a jackfruit.

C1: The name of the tree is gonna appear.

V1: It's a jackfruit. Come here.

C1: The name of the tree is gonna appear, and we have to press [the button on the screen].

V1: Oh, really?

C1: Yeah.

Example 9 – G2 looking for an animal in the forest

V1: Where? [listening to the instructions on the computer] Lighter, lighter, come on.

C1: I know what it is.

V1: No, it gets mixed up with the thing.

C1: Macaw, it's a macaw.

V1: What? The photo?

C1: Yes.

V1: No, it gets mixed up with the color of the wood.

C1: What is it?

V1: I think it's here, look. It blends in with the color of the wood. What animal blends in with the color of wood?

These examples (8 and 9) demonstrate that *Conversations about the exhibition (its operation, design, and the museum experience)* occurred spontaneously and that the families seek ways to discover the information they need through trial and error. *Conversations about science topics* took place during 10.6% of the total visit duration. These conversations between parents/guardians and children generally focused on identifying animals and/or plants, although some of the conversations were about habits and behaviors. In examples 10 and 11, families try to guess which animal is nocturnal, and in example 12, which animal is diurnal.

Example 10 – G1 discussing the habits of fireflies

V1: When does this creature prefer to be awake? [reading] Right, hold on. What time do fireflies prefer (to be awake)?

C1: At night.

V1: In the nighttime.

C1: (should I press) here?

V1: Yes! [after seeing C1 pressed the wrong button] No? What's the answer?

Example 11 – G3 discussing the habits of owls

C1: Owl? I think it's an owl

V1: When is it [the owl] awake, in the daytime or the nighttime?

C1: At night

V1: At night? Then write that down, at night, can you believe that? It likes to stay awake.

Example 12 – G2 looking for a clue about an animal in the forest

C1: I think I've identified it; I think it's a spider.

V1: There's a butterfly, a butterfly. It likes light places, right? Or dark?

C1: Light

V1: In the lighter places.

C1: Toucan?

V1: I don't know. Let's go.

C1: I think it's a hummingbird.

V1: Did you see any hummingbirds? No, love. Did you see it? Ah, it's a giraffe.

Note that these conversations do not delve deeply into content and discussions about science; instead, 81% (n = 27) of them focus on identifying animals by their common names or consist of brief statements. Another comment that illustrates this finding occurred in G4, "*V1: Where are the parrots? Were they taken away? They've gone, disappeared. I can't see one measly parrot. Did it fly away? Is it gone? Put it there, put it there, I couldn't find it.*"

Interactions and Conversations of Families during Mediated Visits

In mediated visits, *Visitor-mediator* interactions corresponded to 37.3% of the families' interaction time. In these groups, families appear to be more intent on carrying out the proposed activities, thereby demonstrating that they take better advantage of the game throughout their visit thanks to the mediators' presence and actions. At the entrance to the exhibition, the mediators introduced themselves, described the dynamics of the game, and continued to help the families use the computer and discover clues. The nature of the exhibition, along with the families' receptivity to the mediators, favored a recurrent behavior in this type of visit in which mediators were integrated into the family group, helping as an active member of the group. Some examples that illustrate this behavior are shown here:

Example 13 – G8 during the presentation of the exhibition by the mediator

M2: Was it? Did you look properly, did you really get to see it?

V1: We did. Hey, son. Come over here.

M2: So, what happens [looking at C1]? C1, the sloth will talk about an animal or a plant that's endangered, or that isn't part of our fauna or flora, that isn't from Brazil, that came from somewhere else. And that's bad; you'll understand why, OK? So, we're going to play [the game] and you'll have to solve this challenge. What animal or plant is this; let's pay close attention. Just a moment.

V1: Ahh [explanation of the dynamics of the game to the visitors continues]

Example 14 – Mediator telling G9 what items are to be found in the forest

M1: Check out where we have to look, see? [speaks directly to the child] In the trunks, in the trunks, in the hole near the cicada. We're going into the forest, let's go look.

V1: Let's, let's go into the forest.

M1: We're going into the forest [...] remember the clue? You have to look for the trunks, where are the trunks? Ah, and there should be a picture of what? Did you see the little creature?

V1: It was a little fly, wasn't it?

M1: It was a cicada.

V1: A cicada.

M1: Right near the little hole, there should be a cicada.

C1: Here!

M1: Ah, here it is, you're going to put your hand in there and feel it.

C1: But is it real?

M1: No, I'll put it here for you to see.

V2: It's make believe.

M1: There isn't any little creature, it's just for you to feel what it's like.

V1: Yeah, as if it were there.

C1: It's a rug.

M1: Oh, what do you mean? Does it feel like a rug? Is it soft?

C1: Yeah.

M1: So, this little creature, we still don't know what it is, it's like that, it's very soft. Shall we go find out?

Example 15 – Mediator and G10 in search of the invader's food

M1: Let's go.

V1: The invader's food. What food is it?

M2: The animal was eating something. What color was the stuff it was eating?

C1: Something green.

M2: Right.

V1: It was green.

M2: It was something green. Look, I'll give you a clue. We found the photo here, right? This is where we'll find what the creature was eating, it's on the ground. You're going to see something; what color is it?

V1: Green.

M2: Green, and there's a little piece missing, which it just ate. Let's take a closer look.

V1: Is it a leaf?

M2: Where can it be? Can you see something green on the floor?

C1: No.

M2: No? Isn't there anything green?

V1: There's nothing green?

M2: What?

V1: Over there, isn't there? Is there really not anything?

M2: Look, I can see it from here. What is it?

V1: Over there, look, look. Here, right?

C1: I can't see it.

M2: No? Don't you see anything green on the ground?

V1: Leaves, they're leaves. Ohhhhh [surprised]!

M2: Where's the piece the little creature ate?

V1: Green leaves.

M2: Wow, it bit off a really large piece, right? Let's continue, shall we? So what does it eat?

C1: It eats green leaves.

M2: It eats green leaves, very good.

In Examples 13, 14 and 15 above, it can be observed that the mediators' speeches are long and detailed, explaining step by step what families need to do. The mediator, having specific knowledge about the exhibition, assumes the position of group leader, guiding the families through the space and fostering the families' engagement with the game. The mediator's guidance was given both directly, such as in, "*M1: Right near the little hole, there should be a cicada*" (Example 14), and indirectly, "*M2: It was something green. Look, I'll give you a clue. We found the photo here, right? This is where we'll find what the creature was eating, it's on the ground. You're going to see something; what color is it?*" (Example 15). A common thread in these examples is that they reinforce the mediator's interaction strategies, which include helping the family from the beginning to the end of the discovery of each clue.

The episodes above also indicate a behavior that was recurrent in the mediator's interactions with families. On 35 occasions it was observed that mediators in conversation with families focused their explanations on children, sometimes excluding adults from the conversation – in body language or verbally – and placing them in the role of observers. In episode 13, for example, when the families return from their initial visit to the exhibition, for exploration and acclimation, the mediator continues her speech, directly addressing the child in the group. The same applies to example 14, but, unlike the preceding episode, the mother intervenes and begins a conversation with the mediator.

Families whose visits were mediated interacted with the game during 94.8% of the visit duration (*Interactive Activity*), demonstrating an active behavior of handling and experimentation. In this type of interaction, the highest number of conversations fell under the category of *Conversations about the exhibition (its operation, design, and the museum experience)* in the *Conversations* dimension, as was the case for families visiting without a mediator. As this initial section of the results suggests, the presence of the mediator does not influence this type of conversation. However, our analysis revealed that a distinguishing feature of the mediator's role is the kind of experience it provides to families, explaining in detail how to use the equipment (Example 16) and directing the families' attention to become involved in activities and find clues (Example 17).

Example 16 – Mediator telling G9 how the interactive video works

M1: Let's begin? It works like a cell phone [she addresses C1 directly], you know that cell phone you use like that with your little finger? Got it, then you'll click here so we can get started. OK?

V1: Go on, click it.

V2: Go on, my dear.

M1: Is she shy?

C1: Here?

M1: Right.

Example 17 – G9 with the mediator, looking for the nest with eggs

M1: Here's where the little creature lays its eggs. Does it go over the top like that? I'll give you a hint, she [referring to the sloth] said close to the roots. Are roots at the top or the bottom?

C1: At the top?

M1: What?

V1: At the bottom, close to the ground.

M1: Here at the bottom, right? Roots, right? Closer to the ground

C1: It's spiky.

M1: Spiky? I'll give you a hint. Over there you're colder.

V1: Closer. Good, shine your flashlight down. Further, further, further down.

M1: That's it, come closer over here, then you'll see everything.

V2: Look over here, look.

V1: That's it, here. See the little egg there.

M1: Look! [excited], is there just one little egg or are there many? Look carefully.

C1: There's a bunch.

M1: There's a bunch, right? So this little creature lays lots of eggs.

V1: Let's go give the answer.

In example 16, the mediator shows G9 how the multimedia program works and what it does, using an analogy to help the child understand how it works. To a greater extent, it was the conversations about the operations of the exhibition, as shown in example 17, in which the mediators guided the activity, using phrases such as “*M1: Here at the bottom, right? Roots, right? Closer to the ground,*” indicating that their participation can potentially influence the engagement of families in the exhibition. Families also talked about science (*Conversations about science topics*) with the mediator during 15.7% of the total visit duration. This represents a 48% increase compared to free visits (10.6%). In these conversations, the mediators' speeches and strategies indicate their educational intentions, aimed at informing families about relevant scientific content, which is considered consistent with current scientific thinking. Described below are some examples used by mediators in this category.

Example 18 – Mediator talks to G10 about the reproduction of the animal to be found

M2: Let's go into the forest to find out how baby animals are born. How many babies did she (the sloth) say that (the animal to be identified) has at a time? About two hundred, right? Do they come from her belly?

C1: No

M2: No, they don't, right? That would be too many in her belly, right?

V1: Yes.

M2: So what does she do to have so many babies? Does she maybe lay something?

C1: I think it eats a lot.

M2: What?

C1: I think it eats a lot.

M2: It eats a lot? To have so many babies, it has to eat a lot, right? Look, two hundred is a lot. Look, the creature was around here, right? It ate its little leaf, walked a bit and laid something here. What do you think this is? Take a close look, what is this here?

V1: A little egg.

C1: Egg.

M2: It's a little egg, so is that how its babies are born? From the....ah, you've just said it. From the eggs, right? Look how many the creature lays, that's a lot at a time. Can you imagine how many babies are going to be born there? A lot, right?

V1: Many, many, many.

Example 19 – Mediator discusses frogs and species conservation with G8

V1: That's it (upon hearing the choice of chameleon on the interactive video), it's the chameleon.

M2: Do you want the clue?

V1: No.

M2: What is it?

V1: A chameleon, chameleon,[' oh my God, my God in heaven!

C2: Dang, mom!

C1: It was a frog.

M2: Was it a frog, are you sure? Based on all this that you've seen (points at the screen).

V1: Oh, that's why I didn't see it, without my [...] glasses.

C2: A frog, right Mom?

M2: So, the frog is one of the most endangered animals, as it is hunted [...] and used for making medicine, so this is for you to learn.

V1: That's why, when they made the ring road, which was it, now I get it. They were making the ring road, the one that goes to Itaguaí.

M2: I know.

V1: But they ended up inside a reserve that had a lot of frogs, so people are joking that all construction has stopped because of a frog!

M2: Yes, it makes all the difference.

V1: I didn't know.

M2: This frog eats other animals, it is food for other animals, so if it's gone, what will other animals eat? Get it? It's a chain reaction.

V1: Oh [...]

M2: It [referring to the frog] is highly endangered and is at risk of extinction.

V1: Ohhh.

M2: So we need to learn about this issue, to preserve the environment.

Example 20 – G8 asks the mediator about an animal

V1: Is that a sloth?

M2: No, it's a tapir.

V1: Or is it the one that eats ants, what's it called again?

M2: Anteater?

V1: Anteater!

V1: It's a tapir. Now let's go.

Examples such as the above (18, 19 and 20) indicate that the mediators employ open-ended questions as a strategy, as shown here: "*M2: Was it a frog, are you sure?*" (G8); as well as questions to encourage visitors to try to make discoveries for themselves, such as, "*M2: What do you think this is? Take a close look, what is this here?*" (G10) and, "*M1: Look! [excited], is there just one little egg or are there many? Look carefully*" (G9). They also employed more direct interventions, e.g., answering or correcting some information, such as, "*V1: Is that a sloth? / M2: No, it's a tapir*" (G8).

Discussion

The purpose of this study was to analyze the social interactions of families visiting an interactive touring exhibition on biodiversity and to determine the extent to which the presence of mediators affected this experience. To this

end, the data from five families who made free visits (without the influence of the mediator) and five families who made mediated visits (in which the mediators accompanied the visit) were analyzed. While presence of a mediator did not appear to impact the amount of time families spent interacting with exhibit components or the amount of time spent talking about how to interact with or use the exhibit, groups with mediators spent more time discussing the content and themes of the exhibit than families who visited without a mediator.

What Do Free Family Visits Reveal?

Various studies investigating social interactions between parents/guardians and children in science museums have shown that children display a higher level of engagement and learning when they receive support from and become involved in activities together with their parents/guardians (see Crowley et al., 2001; Eberbach & Crowley, 2005; Fender & Crowley, 2007; Haden et al., 2014; Zimmerman et al., 2010). In this regard, our data are aligned with similar studies carried out in North American and European contexts. Our analysis shows evidence that, in the process of social interaction in the family group, parents do play an important role in guiding, supporting, and encouraging children in their interaction with the game. However, parents/guardians seem to have played a lesser role in helping children in the learning process of the content covered in the exhibition, as discussed later concerning *Conversations about science topics*.

In some *Visitor-visitor* episodes, parents did not always know how to be useful in the exhibition and expressed discomfort with this situation, as seen in, “V1: *I don’t know, I didn’t get it, dear [...]*” (A1 in G1). Archer et al. (2016) report that families unfamiliar with museum spaces, especially low-income families, may not interact with exhibits in the same ways as families with greater cultural and economic capital, who, according to the authors, may be more acquainted with the “rules of the game” – that is, they know what to do and how to act in a cultural institution like a museum. This also suggests that the way parents/guardians become involved in the activity and make sense of the exhibition by taking on a role as learning partners of their children may differ, depending on how confident or familiar they are with the space and content of the exhibition (Gaskins, 2016). In a study carried out at the Museum of Science and Life, Almeida et al. (2018) point out that parents recognize the importance of taking their children to a science museum as a complement to their children’s education and training. However, parents also say that their own lower educational level and/or lack of scientific training may interfere in their interaction with their children, causing them to feel some level of embarrassment in participating actively.

As for learning experiences, analysis of conversations shows that some parents/guardians had difficulty in finding the clues, since this depended on basic knowledge about science to help the children arrive at the correct answers. Examples of this are found in episodes 10, 11 and 12 – *Conversations about science topics*, in which families find it difficult to pinpoint animals’ daytime and nighttime habits, “V1: *There’s a butterfly, a butterfly. It likes light places, right? Or dark?* / C1: *Light.* / V1: *In the lighter places.* / C1: *Toucan?* / V1: *I don’t know. Let’s go*” (G2). In this regard, Gelman et al. (1991) point out that parents do not always have the knowledge necessary to help their children, indicating that the content of the exhibition makes a difference in the level of parental involvement. Nevertheless, parents stated in post-visit interviews that they think it is important for their children to visit these spaces in order to enable them to acquire cultural and science capital, to which they often have no access to in

their formal education. This is in line with the findings of other studies, such as that of Almeida et al. (2018).

The analysis of the dialogues in the category of *Conversations about science topics* also shows that parents/guardians generally used a pattern of short and perfunctory conversations focusing on the identification of the common names of animals and plants, as seen in the snippets, “*C1: Near the tapir!*” (Example 3, G3) and, “*V1: It’s a jackfruit. Come here*” (Example 6, G3), for instance. This finding is in line with those of other studies, such as Leinhardt et al. (2002), Tenenbaum and Callanan (2008), Tunnicliffe (1993), and Patrick and Tunnicliffe (2013). On the other hand, Ash (2003) and Leinhardt et al. (2002) argue that, in their conversations, the observations of visitors may show a gradual evolution – starting from simple identifications and developing into explanations of organized ideas. In contrast to this statement and to similar studies (see Crowley et al, 2001; Fender & Crowley, 2007 for more details), family conversations in the free-visit modality of this study remain at a more perfunctory level, without further in-depth conversations, questions, explanations, or discussions about the content of the exhibition.

Part of this may be attributed to the adults’ individual knowledge about the subject. Kopczak (2012) points out that the depth of knowledge in conversations is considered an indication of familiarity with the topic addressed in the exhibition and that this, in turn, informs the complexity of the discourse in which participants are able to engage. Thus, many parents/guardians may have felt embarrassed upon asking children questions to which they themselves would not know the answers or starting a conversation about content with which they are unfamiliar. Allied to this observation is the science capital of these families – understanding, knowledge, attitudes, activities, and social contact pertaining to science (Archer et al., 2015). Our data reflect how low-income Brazilian families delve into a specific reality – families who may not be accustomed to visiting museums and whose economic, social, cultural, and scientific resources are scant. Archer et al. (2012, p.898) suggest that “even where working-class children develop a personal science-related interest/aspiration, the resources and family ‘cultural infrastructure’ (family habitus) available to them are poorly equipped to enable the child to build/capitalize on their nascent interest.” Hence, this reality is a factor that may have affected the meaning making of these families in museums. In this regard, this study reinforces the importance of strategies that can better support disadvantaged families in science museums, aiming to help them occupy the space (Dawson, 2014).

Other aspects that may have contributed to sparser conversations about science include the families’ schedules (e.g., visit planning, the amount of time the family can spend or wants to spend at the exhibition and in the MCV), and the game itself, which was designed to be played with a specific time limit (180s) for the groups to discover clues and identify the proposal and topic addressed. These aspects may have contributed to the family dynamics being more focused on an effort to solve the puzzles correctly and quickly, which, in turn, may have led to the absence of reflections and/or more dialogic conversations. Archer et al. (2016), who analyzed the experiences of socially disadvantaged families in scientific-cultural spaces, argue that exhibitions must first attract the visitors’ attention and then involve them in the exhibition for long enough to enable them to learn. In this regard, it should be kept in mind that the time and sociocultural context of those involved may have contributed to this result.

It is worth highlighting in the families’ interactions in this study that children played an important role in family

dynamics. Few studies have discussed and analyzed family interactions from the child's perspective, describing their contributions to interactions and conversations in the family group (see Doley & Welch, 2014; Ayudhya & Vavoula, 2017 for further details). Doley and Welch (2014), for example, showed that, during a visit to a children's museum, children are as likely as their parents to lead interactions, actively showing, telling, questioning, and asking for explanations. The authors emphasize that, in this analysis, children on free visits played a leading role within their family context and encouraged their families to participate more fully. In some episodes, the children encouraged conversations through shared attention, directing the adults to look at what aroused their own interest, as seen in the excerpt, "*See? You have to follow the bees to find the flowers. They're near the tapir, near the tapir. Let's go!*" (C1 of G3).

As for the most common type of communication during family visits, *Conversations about the exhibition (its operation, design, and the museum experience)*, our analysis indicates that, when parents/guardians employed strategies of guidance and engagement that kept the family connected and in active exploration, free to control their experiences, there was a positive relationship with the children's level of exploratory behavior. This is illustrated by the following snippets: "*Which flower did you see there on the wall?*" (V1 from G5) and, "*I think it's here, look. It blends in with the color of the wood. What animal blends in with the color of wood?*" (V1 of G2). Van Schijndel and Raijmakers (2016) reported similar findings, and Rowe (2005) describes how the employment of such strategies by either children or adults in family interactions with exhibits create "hybrid spaces" which promote deeper and more equitable interactions.

How Do Mediators Influence Family Visits?

The analysis of the audio-visual material of the five families whose visits were mediated suggests that the assistance offered by the mediators was well-planned, thoughtful, explanatory, and led the families to have more conversation involving scientific content and thus aligned to the exhibit's educational intentions. This finding indicates, therefore, a positive aspect of the mediator's influence on family visits.

In addition, different episodes reinforce the finding that mediators join the visiting group as an additional member with an active attitude, at times acting as a leader in taking the initiative about what, when, and how to do something. For example, in G9, sentences such as, "*M1: Check out where we have to look, see?*" "*M1: Let's go look,*" and in G10, "*M2: Let's go into the forest to find out how baby animals are born.*" and, "*M2: It was something green. Look, I'll give you a clue. We found the photo here, right? This is where we'll find what the creature was eating, it's on the ground. You're going to see something; what color is it?*" reinforce this behavior. This intricate interaction between families and mediators gives rise to a question: To what extent can this behavior benefit or interfere with the learning experiences of families?

Schauble et al. (2002), who interviewed mediators and parents regarding their perception of learning in a children's museum, provide an interesting counterpoint to the discussion about this relationship. While mediators think that one of the most effective ways to provide learning for families is for adults to actively engage in the activities and play together with children, parents report having a more focused view of the child's independent

participation, with less adult interference in the process, allowing them to experiment on their own. Indeed, studies indicate that autonomy is an important motivating aspect of learning experiences (Pekrun & Linnenbrink-Garcia, 2010; Falk & Dierking, 2000).

In this regard, our data suggest that, when the mediator becomes a significant participant, both the parents/guardians and the children assume a more passive attitude, following the mediator's rules and guidelines, which, in our view, is a negative aspect of the interaction between families and mediators. In line with this statement, Pattison and Dierking (2018) point out that the presence of mediators can sometimes inhibit interactions between parents/guardians and children. Thus, in this study, the authors observed that, although mediation increased the discovery of clues and correct answers to questions, it also led to a notable decrease in the family's attitude of autonomous investigation.

Another aspect observed in mediated interactions is the mediators' attitude of focusing their attention on the children when explaining the game and helping them solve the puzzles, often leaving the parent/guardian in a passive role. Mediators adapted their voice and speech, speaking childishly when addressing children (e.g., using diminutives). This intervention, in our view, may have influenced family dynamics. The lack of "space" for adults may have created an environment in which parents/guardians felt they should not intervene, as the mediator had assumed the role of group leader and was familiar with the theme and exhibition, thereby inhibiting the children's interactions with their family members. If the family portrays an active and confident attitude, it can manage this interference to whatever degree it so desires. An example of this can be seen in a clip in which the mother of G8 refuses the mediator's help, "M2: *Do you want the clue?* / V1: *No.*" However, other parents/guardians welcome the mediator's attitude, perhaps because it removes the need for their own active involvement in the game. For example, in G9, when the parents displayed very passive behavior, the mediator guided and had more conversations with the child than with the adults.

With regard to visitors' interactions with the exhibit components, our findings are similar to those reported by Franse et al. (2021), who found that the mediator's approach in conversations with families, whether giving evidence or explaining phenomena, did not change the way in which the families interacted with the module. In this study, the groups showed no difference in their behavior while interacting with the exhibition (*Interactive Activity*) in the presence of the mediator. As for the duration of engagement – a variable that has been identified in different studies as an indicator of interest and attention – its stand-alone analysis in this study did not suffice to differentiate the family experience with respect to human mediation.

An analysis of the conversations revealed that the category *Conversations about exhibition themes (operations, design, museum experience)* occurred during 66% of the visit duration while *Conversations about science topics* during 15.7%. As mentioned in the results, a good deal of the speech comprising *Conversations about exhibits themes* was centered on giving or seeking assistance, especially in regard to how to help children operate and engage with the exhibit. Such conversations did not appear to cause significant differences in how visitors interacted with the exhibit. What stands out in the data analysis is that the category of *Conversations about science topics* increased by 48% during mediated visits. Allen and Gutwill (2009), in their discussion of the "Juicy

Questions” game, found similar dramatic increases in the amount of scientific content present in family conversations when mediated by a museum-produced interactive routine in the form of a game for families to engage with at exhibits.

In this regard, the dialogue analysis shows that the mediators used a variety of strategies to elicit responses from families and stimulate the learning process. For example, they played an important role in correcting misperceptions and rephrasing visitors’ sentences with scientific vocabulary, encouraging visitors to observe and describe specimens, bringing up some scientific questions that enriched these conversations and thus went beyond the dynamics of solving the questions posed by the game. Pattison and Dierking (2018) and Kopczak (2012) reported similar findings regarding the role played by mediators in the use of strategies that facilitate interaction. These authors found an improvement in the science content and quality of conversations of the families whose visits were mediated.

In contrast to the study by Pattison and Dierking (2018), who identified an increase in reasoning conversations, our data indicate that much of the families’ conversation pertaining to scientific content remained at a superficial level in both mediated and unmediated visits. There are few episodes in which mediators were able to actively engage the entire family in a conversation about scientific themes, offering information about the species in question or its preservation. In a counterexample, in G8, the mediator talks about frogs, stating, “*M2: So, the frog is one of the most endangered animals that, as it is hunted [...] and used for making medicines, so this is for you to learn*”. This gives V1 an insight into why a major public works project in Rio de Janeiro was halted. The remark V1 used to hear, “*Because of a frog, all construction stopped!*” suddenly made sense after the mediator’s comments. In the words of “*V1: I didn’t know.*” This event may be associated, as mentioned in the discussion of families on free visits, with the personal and sociocultural context of the families participating in this study. Rowe and Kissiel (2012) also found that many of the conversations of family visitors to interactive aquariums were perfunctory but could be deepened through simple “debrief” activities. In their study of 40 families interacting with touch tanks, deeper family engagement with scientific content and reasoning was made possible when perfunctory statements or actions were followed by a related question, comment, or description that, in turn, led to further investigation. These interactions were equally likely to be initiated by family members or by mediators.

Conclusion

The authors’ analysis of the social interactions of the families in this study indicates that the mediators affected the quality of the interactions of participants visiting the “Forest of the senses” exhibition both positively and negatively, depending on the aspect analyzed. During the analysis process, several patterns were identified upon comparison of the free family visits to the mediated visits. The data reinforce various previous findings, but also provide new input for future studies and practices.

Pattison and Dierking (2012) argue that one of a mediator’s roles is to enable interactions that enhance what adult visitors are already providing to children. This point is important because parents (or other responsible adults) play a prominent role in the interaction with and mediation of content for children. In this regard, mediators believe

that understanding the process of social interaction and learning experiences of families – a challenging group for museum mediators (Pattison & Dierking, 2013) – is potentially useful. While remaining mindful of the needs of families, mediators can improve their own interaction strategies, thereby rendering the mediation process more meaningful and contributing positively to visitors' experiences.

In this study, it was observed that one of the challenges families faced was that of maintaining their role in the proposed activity when the visit was mediated. The mediators, in turn, found it difficult to encourage active involvement, enabling families to perform the interactive activities independently, with greater cognitive and reflective engagement during their interactions with the content addressed by the exhibition. By assuming a leadership role in family groups, mediators influenced families' participation and learning experiences, leaving parents and even children in a more passive and less autonomous role. Therefore, although mediation has been shown in other studies to encourage the involvement of the entire family in the museum experience, this was not the case in this study.

Conversely, a positive aspect of mediator interaction was the increase in *Conversations about science topics*. Strategies such as challenging questions and support in the identification of animal and plant species contributed to this increase. The mediators were also available to clarify questions expressed by the families. Although the conversations were not deep, and the content regarding science themes was fairly superficial, the authors believe that such conversations can help families engage in more complex topics on future occasions. Thus, this finding suggests that mediation can stimulate more *Conversations about science topics* and opportunities for reflection.

The mediator's role requires knowledge in order to discuss scientific subjects and confidence in order to expose ideas that challenge, motivate, and question visitors. In fact, the parents/guardians found it difficult to perform this role as mediators of their children's experiences. Despite the positive aspect of encouraging the children's investigations and enthusiastic participation, some families demonstrated difficulties in engaging in the dynamics of the activity, be it with regard to spatial orientation or content. The authors suggest that this finding may reflect the profile of the families involved in this study – low-income families with rather lower cultural and scientific capital than families who frequent museums, which are usually the object of studies in research in this field – although more studies are certainly needed to gain a deeper understanding of this relationship. Moreover, this study demonstrates the importance of this type of space in socially fragile areas, as well as its potential to promote the social capital of families.

This study thus not only reinforces the important social role of the mediator in science museums, but also highlights the need for systematic efforts to train and qualify them to enable their greater involvement in providing support to parents/guardians wishing to encourage family experiences in these cultural and scientific spaces. In particular, our study sheds light on the museum experience in contexts of greater social vulnerability. Like other countries in Latin America, Brazil is characterized by high levels of social inequality, poverty, and restricted access to scientific and cultural capital. Mediators need to be trained to demonstrate awareness of different family dynamics and to be sensitive to intrafamily, economic, and social issues.

Lastly, it is important to keep in mind that the findings described herein reflect the reality of ten families living in the city of Duque de Caxias in the state of Rio de Janeiro, Brazil, and refer to a specific visitation context— an interactive exhibition in a game format. As such, neither the results nor the methodology may necessarily be generalized. However, the authors hope this study will encourage other museums to conduct similar investigations, seeking to better understand the relationship between mediators and visiting families, and also underpin training content so that these professionals can contribute even more to learning in science museums and to helping make the visit a memorable experience.

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