DESIGNING FOR FAMILY LEARNING IN MUSEUMS: HOW FRAMING, JOINT ATTENTION, CONVERSATION, AND TOGETHERNESS ARE AT PLAY

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Learning is social in nature and takes place across many contexts (e.g., Bandura & Walters, 1963; Lave & Wenger, 1991; Vygotsky, 1962, 1978). Informal learning environments, such as musuems, provide a venue to study such family learning. My dissertation acknowledges families as learning units and recognizes that thoughtful design informed by learning research can buttress their natural learning together.

Through a review of the museum-based, family learning literature, I identified three mechanisms—framing, joint attention, and conversation—that can serve to deepen and extend family learning. I then present two studies of simple interventions targeted at these mechanisms. In one study, families in a natural history museum explored dioramas in an experimental condition where they used flashlights to see into dioramas in a darkened room or in a control condition where they visited the dioramas in normal lighting conditions. Findings suggested the flashlights increased joint attention, which lead to learning conversations. In a second study, families visiting a children's museum exhibition were encouraged to adopt the interpretive frame of scientist or artist. Findings suggest that framing changed what the families focused on during their visit, how they interacted, and how they talked about the content. I propose that framing,

joint attention, and conversation are all aspects of a broader state of *togetherness*—which might serve as a useful concept to encourage research/practice collaboration for understanding and supporting families' informal learning.

In both studies, the goal was to utilize an exhibition's natural affordances and seamlessly integrate the design intervention into a typical parent-child museum experience. This contrasts with parent training programs or other interventions that might require additional time investment outside of the family museum experience. Rather, the challenge was to design "exhibit learning hacks," or employ simple tools that would impact parent-child learning talk in exhibit-aligned, playful ways. We found that families, as learning units, are malleable and design interventions can assist and shape their learning in low intervention but high impact ways.

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PREFACE

A wise friend once said, “Face every encounter with a smile on your face and a song in your heart.” While the PhD journey doesn’t always make that easy, I’m happy to submit this dissertation and hope the transcript excerpts, in particular, bring a smile to your face.

Thank you to my dissertation committee, Tom Akiva, Kevin Crowley, Mary Margaret Kerr, and Chris Schunn, for their time, advice, and interest in my studies, particularly Kevin Crowley, my advisor, who keenly identifies when it is time to stop the fountain of ideas and simply focus. I have learned much from the work and compassion of my colleagues and classmates, too numerous to list: it has been a pleasure to get to know each of you and your academic passions. Your edits, stats checks, lunch banter, and, yes, at times free babysitting have all added to my academic trajectory and sanity. Though the families who contributed to this work will likely never see its pages, I sincerely thank the parents and children who let me peer into their lives for a short time, and left me with hours of entertaining interactions to ponder. Thank you as well to the host institutions who kindly let me turn their halls into living laboratories.

With the deepest gratitude, I thank my family: my parents who have invested in my education, instilled in me the importance of persistence, and are ever-present to encourage and support me; my husband who relishes in my accomplishments and would campaign on my behalf; and my kids who have provided the smiles and laughter throughout the journey. I can now answer “yes,” to their nightly question, “Are you done with your paper yet?”

1.0 INTRODUCTION: DESIGNING FOR FAMILY LEARNING IN MUSEUMS

Approximately 850 million visits are made each year in the United States to museums (American Alliance of Museums). The learning that takes place in these educational institutions is complex-mediated by personal, sociocultural, and physical contexts (Falk & Dierking, 2000). While attention has been drawn to visitors' varied personal agendas and sociocultural perspectives, it is the physical context, primarily the exhibition, which has been the main focus of museum efforts for generations. After years of study, designing effective exhibitions is still a challenge. Recently, exhibit developers have begun to consider the visiting group rather than the individual as its user (Borun, 2008), and the field continues to encounter learning design questions when creating family experiences in museums. For example, competition for attention has been identified as "the single greatest constraint underlying exhibit design" (Allen, 2004, p. 2). Yet, at the same time, free choice among many potential experiences has been identified as one of the greatest strengths of museums as learning environments (Falk & Dierking, 2000). Such contrasting statements can stymie design. How then can learning sciences inform these design challenges so that the educational benefits of a free choice environment are accessible to families rather than obscured by exhibit overstimulation and competition for attention, and what other insights might learning sciences offer around designing for family learning in museums? The work presented here, is my contribution to pondering through the above question.

1.1 FAMILIES AS SOCICULTURAL LEARNING UNITS

Families come to museums to spend time together –learning and socializing. Museums have been described as a place of enculturation, a place for developing and affirming identity (as cited in Falk, Dierking, & Foutz, 2007, p.23), and as a tool for negotiating and building family identity (Ellenbogen, 2002). Museums are also a place to push, stretch, and test family learning as families encounter novel experiences, explore new information and ideas, and are encouraged to reflect and try out new roles. These nudges allow families to practice, grow, and develop within their typical habits and patterns of interaction. As social learning theories (e.g., Bandura & Walters, 1963; Lave & Wenger, 1991; Vygotsky, 1962, 1978) suggest that families take in not only information from exhibits but also learn through the exchange of information and reactions among group members as they make connections to past experiences and draw on prior knowledge. Therefore, families make their own meaning through the interpretation of the objects, interactions, and the conversations catalyzed by the exhibits and museum experience.

Families are complex in their multifaceted heterogeneity. In this work "family" is broadly defined as an intergenerational group composed of at least one adult and one child. While we refer to the adult in the group as "parent," we acknowledge that this significant adult in a child's life could be another relative, mentor, or caregiver. Given the range of family dynamics, the assorted intentions families bring with them, and the varied goals of museums, there is no one-way to measure family learning in museums. Instead, learning and success may look different and be uniquely defined across contexts and situations. For the most part, the field of informal learning has come to understand learning as a constellation of behaviors, processes, and outcomes: excitement, interest, and motivation; generating, understanding, and using concepts; exploring, predicting, and testing to make sense of the world; participating in learning practices

with others; and developing an identity as someone who values and knows how to learn (e.g., NRC 2009; 2015; Dorph, Schunn, & Crowley, in press). Some common means and measures to approximate family learning include using observation, audio recording, and interviews to calculate how long families stay at an exhibition, where they spend this time, and what they talk about (Leinhardt, Crowley, & Knutson, 2002; Sobel & Jipson, 2016).

Prior research has documented that families do learn together in museums but it takes effective negotiation to attend to and engage with museum exhibits (Falk & Dierking, 2000). Parents play an important role in this negotiation and ultimately mediate the exhibit experience for children through the directions, questions, and conversation they provide (Ash, 2004; Crowley, et al., 2001; Melber, 2007; Palmquist & Crowley, 2007; Rennie & McClafferty, 2002). It can be difficult, however, for families to move past narrating what they are seeing to engage in discussions that include sense making and deeper concepts (Ash, 2004; Melber, 2007; Mifsud, 2009; Tunnicliffe & Reiss, 2000). However, research has shown that museums can intervene to support this family learning (e.g., Allen & Gutwill, 2009; Benjamin, Haden, & Wilkerson, 2010; Tison-Povis & Crowley, 2015). Part of the need for these interventions stems from the recognition that museum experiences are sometimes designed more for child use, as opposed to structured for intergenerational groups (e.g., Gleason & Schauble, 2000; Schauble et al., 2002; Swartz & Crowley, 2004). The following chapters provide a deeper look into family learning in museums through a literature review of learning interventions, present two studies that seek to leverage the family relationship for learning, and make an argument for designing with the family learning unit in mind.

1.2 DETERMINING THE MECHANISMS OF TOGETHERNESS

Each of the three studies in this dissertation seeks to contribute to our understanding of how to design to support family learning in museums. I identify three mechanisms–framing, joint attention, and conversation–derived from the research literature that tie museum interventions to learning processes; I present two research studies that focus on implementing interventions based on these mechanisms; and I consider what designing with these mechanisms in mind and working to foster a state of "togetherness" could mean for museums, families, and learning in museums.

This work began in an empty, echoing hallway, with dust-covered dioramas and toolboxes filled with the educational loan collection of a natural history museum. I was conducting formative evaluation and collaborating with museum educators, exhibit designers, graphic designers, docents, and visitors to create a new 19,000 square foot, family-focused, hands-on, permanent exhibit with open collections for inquiry learning. A time-lapse video with an aerial perspective of the prototyping space revealed the "social accordion" of family learning in museums. In this video you can see families approaching an exhibit together, separating and exploring, then regrouping and sharing together. This movement of families being together, then apart, then coming back together again and again, is reminiscent of the movement of an accordion at play. Families covered the space of the exhibit at various distances from one another, but repeatedly came back together to share, highlighting the social nature of learning. Granted there was excitement and intrigue in isolation, but it was in the reciprocal moments of sharing interest, exchanging observations, and having conversations where Social Development Theory would argue the learning was first constructed (e.g., Vygotsky, 1962, 1978).

In evaluating this prototyping space, we wanted to capture this coming together that the exhibit seemed to promote and decided to include the gesture of pointing in our observations as an interest indicator. In coming to understand this prototyping space and the pointing indicator, I came across the term "joint attention." This concept, taken from developmental psychology and neuroscience, highlights the importance of two people knowingly attending to the same aspect of their shared environment (Tomasello, 1995). Joint attention is critical in social learning situations, particularly parent-child communications (Frischen & Tipper, 2004; Gleason & Schauble, 2000; Kim & Mundy, 2012; Moore & Dunham, 1995; Mundy & Newell, 2007; Striano, Reid, & Hoehl, 2006; Tomasello & Carpenter, 2007) and if it is not achieved, children are less likely to remember or learn (Tessler & Nelson, 1994).

Those dusty dioramas in the dark hallway now became an opportunity to test the effects of a joint attention exhibit design intervention. Despite the terminology of the word intervene, I did not want to interrupt the family experience; instead, I was focused on designing an integrated approach that would enhance learning within a fairly natural museum experience. Joint attention tells us that in order for families to successfully learn together, they must first be focused on the same thing. Working with the affordances of the exhibit –a set of seven darkened dioramas– we decided to use a flashlight as the simple tool to promote joint attention. By providing a single flashlight with which to explore the darkened dioramas, families were able to explore features of the recreated scenes through a restricted visual field, thus encouraging joint attention on those objects illuminated by the flashlight. This was in contrast to families who viewed the dioramas in a fully lit hallway condition. We found that families in the flashlight condition not only established joint attention more than those in the control condition, but that this joint attention led to more learning talk such as discussions of ecological relationships and form and function.

This study of joint attention, originally published in *Visitor Studies* (Tison-Povis & Crowley, 2015), is presented in full in Chapter 3. Note that the work presented in this dissertation is ordered to build conceptual understanding rather than arranged chronogoically.

Curious to understand other lines of intervention backed by learning theory, I conducted a literature review of studies of family learning in museums focused on exhibit interventions. Through this work, we identified three mechanisms–framing, joint attention, and conversation–which tie family museum interventions to learning processes. These mechanisms are discussed at length in Chapter 2 of this dissertation with examples from the literature. Perhaps the most nuanced, yet frequently employed, mechanism is that of conversation. Across family learning in museum literature, conversation is both manipulated directly as an intervention and is also used as a measure of learning. For example, many museum learning interventions involve conversational training (e.g., teaching parents to ask *wh*-questions); at the same time, parsing out the language used in parent-child discussions through conversational analysis is a common method in museum-based learning research. It is this duality of purpose, an aspect to be manipulated and an outcome to be measured, which makes this mechanism complex at times.

In my second study, presented in Chapter 4, I focus on the framing mechanism. Framing is a mental construct that determines a person's conception of a situation and influences perception, noticing, behavior, processing, and recall (Hammer, Elby, Scherr, and Redish, 2005). Again, I was interested in design interventions that manipulated the museum learning experience in exhibition-integrated ways and might seamlessly shape family interaction. Therefore, considering the affordances of the exhibition at hand–a children's museum exhibition focusing on the bug/nature-themed work of a prominent author/illustrator–I implemented an intervention that invited families to take a scientist or artist frame through donning a thematic costume. We

asked if framing, by suggesting a role through a themed costume, could extract different exhibit content though the context was held constant. Recall that joint attention is sharing both a mental and visual space and that the flashlight was used as a tool to hone the *visual space* shared by parent and child. In this framing intervention through costume, we worked to shift the *mental space* to see how such a shift can affect the visual and conversational aspects of family interactions in an exhibition. In both studies, I used conversation as a measurement tool rather than manipulate it directly. Again, we found that a simple, low-tech intervention can have significant impacts on the way families engage with a space and what they talk about with one another. The specifics of this study and the full discussion of findings can be found in Chapter 4.

The common aim of my work has been to understand and design for family learning in museums–to encourage families to look, think, and talk together. I conclude my dissertation musing over the concept of togetherness in museums–a concept that came about through this work and thinking about the importance of sociocultural learning in the museum context. How might we create and capitalize on the state of togetherness which, sociocultural theory leads us to believe, fosters learning? I hope that the contents of this dissertation may provide some insights and stimulate thinking and action around this question.

2.0 TOGETHERNESS: A COMMON LANGUAGE TO BRIDGE RESEARCH AND PRACTICE AROUND FAMILY LEARNING IN MUSEUMS

Under Review, Curator

2.1 ABSTRACT

We present a framework for bridging research and practice to support family learning in museums. Through a review of family museum learning literature, we identify three mechanisms—framing, attention, and conversation—that help explain parent-child engagement and learning in museums. These mechanisms, rooted in a broader literature on learning, can be used to identify practical strategies to support family learning in museums. The three are interdependent and, particularly from the standpoint of improving practice, we argue that it is most useful to see them as working together toward a larger concept of family "togetherness." We explore implications of this approach for the future of family museum learning.

2.2 INTRODUCTION

Families are an important audience for many museums, and designing exhibits that support family learning is a widely shared goal in the field. Over the last three decades, there have been many efforts to make exhibits more "family friendly," many evaluation studies of impact, and an increasing number of researchers exploring learning and development in the context of family museum experiences (e.g., Crowley, Pierroux, & Knutson, 2014). Yet, in the midst of this burgeoning field of study, we still see a conceptual gap between practice and research. On the one hand, practitioner-oriented conferences and newsletters are filled with examples, tips, and case studies that explain a wide variety of approaches, from the specific use of objects and interactivity, to mediation through signage or human facilitation, to incorporation of digital media, to use of narrative, open-ended questions, or cultural relevance. On the other hand, learning research conferences and journals are more likely to focus on studies that show how aspects of family learning in museums are linked to underlying learning processes (e.g., explanation, analogies, joint attention, and misconceptions, etc.) or to general frameworks for development and learning (e.g., sociocultural theory, information-processing, identity theory, constructionism, and constructivism, etc.). We have not yet achieved a common language where the problems of research and the problems of practice translate across boundaries and are immediately actionable. Although researchers and practitioners are both working to help families learn in museums, without a common language it becomes difficult for them to learn from one another.

In this paper, we extend a broader effort to establish stronger connections between research and practice around the topic of family museum learning (e.g., Dierking, 2014; Knutson & Crowley, 2005; Sobel & Jipson, 2016). Through a review of the literature, we identify three

learning mechanisms that impact family learning: framing, attention, and conversation. This review of the literature helps us answer two central questions: 1) What are the theoretical underpinnings and supporting learning mechanisms behind family learning intervention studies in museums? 2) What practitioner and researcher applications does this work suggest?

Studies of family learning in museums most often portray families as interdependent learning units, a position buttressed by sociocultural theory which recognizes the social component and processes by which conceptual change occurs through everyday interactions (e.g., Gauvain, 2001; Haden, 2010; Rogoff, 2003; Vygotsky, 1978). As direct parent-child interaction is often the goal of exhibitions designed to support family learning, the role of the parent or caregiver is critical in museums (Borun, Chambers, & Cleghorn, 1996; Crowley & Callanan, 1998; Diamond, 1986; Ellenbogen et al., 2004; Falk & Dierking, 2000; Martin, Brown, & Russell, 1991; Paris, 2002; Tunnicliffe & Reiss, 2000). Children have been found to stay longer at exhibits and learn more when a caregiver is actively involved (Puchner, Rapoport, & Gaskins, 2001). For example, Gleason and Schauble (2000) found that when parents participated, children at a science exhibit performed better experiments and made more powerful inferences. Conversely, when parents were passive rather than active participants, the learning potential of the visit was limited (Brown, 1995).

Parents can also facilitate museum experiences through talk (e.g., Borun, Chambers, & Cleghorn, 1996; Gutwill, 2002; Gutwill & Buennagel, 2003; Leinhardt, Crowley, & Knutson, 2002) and have been found to adjust the support they provide (i.e. making up attention getting games or changing their verbal scaffolding) based on how challenging and interesting they judge the context to be for their child (FLING, 2011; Melber, 2007; Palmquist & Crowley, 2007). When adults provide explanations, children develop more conceptual rather than procedural

understandings of a task (Fender & Crowley, 2007). Parents not only explain content, but communicate broader expectations and values as they frame the context of a visit (Dierking, 2014; Leichter, Hensel, & Larsen, 1989).

Though we know that parents play an important part in museum learning (e.g., Crowley et al., 2001; Crowley & Jacobs, 2002; Ellenbogen, 2002; Falk & Dierking, 2000; Rahm, 2002), many museums are not specifically designed to support this collaborative learning (e.g., Falk & Dierking, 2002; Schauble et al., 2002). Instead, museum experiences structured primarily for child use, as opposed to designed for intergenerational groups, can inadvertently hinder family learning (e.g., Gleason & Schauble, 2000; Schauble et al., 2002; Swartz & Crowley, 2004). Although parents may be adept at supporting their children's learning, it can be difficult for parents to know what role they play during a museum visit. Museums are complex environments with multiple experiences, exhibits, and objects competing for attention, raising the possibility that family members may have trouble negotiating a joint and sustained focus together. The role of parent is important; and while parents naturally support their children in many ways (Gutwill & Allen, 2010; Melber, 2007), families still benefit from interventions that provide supportive design and training to promote family learning (Boland, Haden, & Ornstein, 2003; Borun & Dritsas, 1997; Melber, 2007).

In this article, we review a body of research focused on intervention studies to support family learning at museum exhibitions. The studies describe a range of intervention strategies, from changing labels, to showing videos, to coaching parents, to providing additional information or supplies, and more. Our goal is to connect these interventions to underlying learning processes so that we can begin to understand not just THAT interventions are effective, but WHY interventions are effective. Many studies in the museum learning literature are not

explicit about the theory they draw upon and inform; so, much of our scholarship here was to trace the logic (implicit or explicit) for an intervention and then describe the underlying learning principles.

Our review suggested that most family learning interventions are founded in three core learning mechanisms: framing, attention, and conversation. We think these three core mechanism might be good candidates for a common language to guide future intervention work. We hope that by identifying these three principles, we can bridge the gap between learning theory and practical design considerations: providing researchers with a sense of how learning theory might be instantiated in design and providing practitioners with a sense of how designs can benefit from and potentially inform learning theory – all in support of family learning.

Before we begin, some comments about the scope of our review of family learning are needed. When we say "family," we are referring to an intergenerational group composed of at least one adult and one child. Throughout the paper we refer to the adult as "parent," but recognize that this could include any significant adult in a child's life—mentor, grandparent, child-care provider or other relative.[1] We are interested in the learning that happens between adult and child, how the museum experience can leverage this relationship for learning, and simultaneously strengthening this relationship. Now, what do we mean by "learning"? The field of informal learning has moved past traditional definitions that limited learning to the acquisition of facts, concepts, or skills. Instead, we most often adopt the view that learning includes a broader constellation of behaviors, processes, and outcomes: excitement, interest, and motivation; generating, understanding, and using concepts; exploring, predicting, and testing to

[1] Review boards for the protection of human subjects often require that legal guardians give consent for children to participate in research studies; thus, most (but not all) studies of family museum learning involve children and parents.

make sense of the world; participating in learning practices with others; and developing an identity as someone who values and knows how to learn (e.g., NRC 2009; 2015; Dorph, Schunn, & Crowley, in press). Thus, when we looked into the literature for studies of family learning in museums, we considered a wide range of learning outcomes for museum activity.

2.3 FRAMING

Framing is the way that people understand a situation—essentially the way a person might answer the question "What is going on here?" (Goffman, 1974). Framing involves expectations about a situation that will change what a person notices in the situation, what they value, and how they might respond to the physical or social environment (Hammer, Elby, Scherr, & Redish, 2005). Framing has direct impact on what people learn from an experience. The research behind framing suggests that an interpretive frame shapes the activities children engage in, the conceptual structures that are used during those activities (Klahr & Dunbar, 1989), and influences what information is attended to and remembered (Friedman, 1979; McClelland, 2013).

The idea of framing, which is often studied in the context of classrooms and schools, acknowledges that individuals can bring a wide range of personal frames to any given setting and that aligning frames, or at least recognizing that different frames are in play, can be important to facilitate learning. Often teachers are taught to state the objectives before a lesson, and doing so can introduce a frame to help set shared classroom expectations. For example, before watching a short video clip a teacher might tell students that they are watching for journalistic style not to acquire content knowledge. Stating this purpose acknowledges that students may have a (relaxed,

popcorn-eating) movie-watching frame and invites them to take up a new task oriented frame. Framing is also a concept studied in cognitive linguistics and has been applied to political contexts revealing the importance of messaging and the words selected to market issues, since language evokes frames (Lakoff, 2004). For example, the phrase "tax relief" draws upon an understanding of relief from pain or anguish, thereby making taxes the affliction by association. In the filed of journalism, Gamson & Modigliani (1987) discussed media frames as an organizing idea or storyline that provides meaning. Each of these applications is helpful for understanding how framing can channel sense making and relates back to Piaget's (1952) notion of schemas as a set of mental representations that influence how people understand and respond to situations.

How can these ideas of mental constructs be applied to family museum learning? Parents and children may come to the museum with similar or different personal interpretive frames, which may or may not be explicit to other family members. If different members of the family would answer the question "What is going on here?" in different ways, they are more likely to develop conflicting goals and behaviors. Take, for example, a family who enters an art museum. The mother's frame may include the notion that this is a place to be reflective, quiet, and appreciate art through looking. The child, having not been to an art museum before, may look around the cavernous gallery and see a place to run, play, and let her voice echo off the walls. These frames are clearly at odds. Museums, through additional environmental features, signage, activities, and staff, encourage framing by implicitly or explicitly communicating that particular behaviors and actions are encouraged. The family in the art museum, for example, may encounter very different framing messages from a museum as they move from the gallery floor

to a family room that encourages hands-on, child-directed exploration (Knutson & Crowley, 2010).

Framing works by contextualizing a new situation as something familiar, activating familiar schemas and creating expectations for what might happen and how a person might respond. Museum interventions that manipulate framing attempt to offer perspective, suggest roles, or convey content through a specific lens. Rather than leaving that basic question of "What is going on here?" wide open to any interpretation, framing interventions suggest a particular answer to that question, nudging families to adopt frames that the museum sees as particularly productive for a given exhibit. Take, for example, a study at the Denver Museum of Nature and Science of actors at dioramas portraying turn-of-the-century characters (Tinworth, 2009). These actors reframed static dioramas into first-person historical narratives, telling visitors how the landscape connected to the characters' lives and broader historical context. Visitors spent more time at the exhibits when enactors were present and looked more closely at the dioramas. Qualitative findings suggested that the visitor experience was powerful, educationally valuable, and meaningful. As one visitor said, "It was fun and unique. We learned some things we wouldn't have noticed on our own. [The enactor] was also good at interacting with young children."

Sometimes museums can unintentionally invoke potentially less-than desirable frames. This was the case in a study that set out to test exhibit labels and supplies at a heat camera exhibit that was supposed to illustrate how clothes insulate (Atkins, 2009). The intervention resulted in more talk about insulation, which was the goal of the designers. But the intervention also had an unintended effect: it appeared to change the nature of family talk from collaborative conversation to didactic instruction. In particular, signage may have unintentionally framed the

activity as more school-based, suggesting a schema where adults assumed the role of teaching their children and being concerned with correct answers over collaborative exploration. Similarly, in a botanical garden setting, Eberbach and Crowley (2005) discovered that botanical models triggered a more school-like interpretative frame in which family conversation focused on naming and recall. In contrast, when families were interacting with living plants, they were more likely to talk about personal nature-related connections and anecdotes.

Signage can reframe an exhibit by activating a discipline-specific schema, thereby altering exhibit behavior as well as impacting learning (Kim & Crowley, 2010). In an experiment conducted at an exhibit where visitors built and tested helicopters, families in one condition saw signage that framed the experience as an engineering problem ("How can we make a helicopter fly longer?") or as scientific inquiry ("What makes a difference in flying time?"). These simple nudges resulted in very different family behavior: parents in the engineering condition tended to stand back and let their children tinker by themselves, while parents in the science condition were more likely to co-design experiments and talk to their children about variables. With more parent support and more time spent doing controlled experiments, perhaps it is not surprising that children in the science condition also showed more learning about causal variables on the post-test. The tone and form of signage undoubtedly plays a part in whether and how frames are adopted. Although signage that is heavy on explanation and the museum's position of authority may encourage visitors to adopt more passive framing. Gutwill (2008) argues that signage that offers questions and suggestions can be an effective way of encouraging visitors to actively shape their own museum inquiry.

Games can be an effective intervention to frame museum learning. Allen and Gutwill (2009) taught families the "juicy question" game as a way to frame shared inquiry in a museum.

The game has prescribed rules around talk and exploration, which allowed each family member's voice to be heard and ideas to be jointly acted upon. As compared to control families, families taught the inquiry game improved their inquiry behaviors conducting more investigations, proposing questions, and interpreting results at museum exhibits. Perhaps the most impressive element of this short intervention was how families took up the concept and later reported using the game and inquiry skills in other contexts. The game frame had become part of their family script for "doing" museums.

It is important to remember that people bring into museum experiences their own frames, which dictate how they act within a context. In family learning, parents, in particular, often frame the experience in ways that impact their children's learning (Callanan & Jipson, 2001). A study investigating parent-child talk in Mexican-descent families with high and low levels of parent schooling emphasizes this point (Tenenbaum et al., 2002). In this study, family conversations were analyzed across two settings: 1) during a visit to the local children's museum and 2) at home after an agriculture-themed workshop. Results showed that families had different interaction styles depending on setting. Families in which the parent had more formal education ("high-schooling families") provided more causal explanations in the museum condition, but this difference was not evident in the workshop condition. This change in conversational behavior across settings could be attributed to framing. High-schooling families, who also had more familiarity with museums, would likely answer the framing question "What is going on here?" differently than those low-schooling families unfamiliar with the setting. Many of the families, regardless of education level, worked in agriculture, so their response to "What is going on here?" when approaching the agricultural workshop may have been much more similar. The frame these two family groups brought to the conditions could very well have affected the causal

explanations parents offered across these two contexts. This study also illustrates how interrelated the mechanisms are—in this case, framing and conversation—and the importance of attending to each. Had the above study only analyzed conversation within the museum context, a misconception about high and low schooling families may have been reported and a considerable finding would have been lost to research.

2.4 JOINT ATTENTION

Joint attention is a social learning mechanism involving two people knowingly attending to the same aspect of their shared environment (Tomasello, 1995). This phenomenon has considerable benefits in social learning situations and is studied across fields from developmental psychology to neuroscience. Joint attention can increase stay times and inquiry at exhibits, provide conversational opportunity, alter the depth of processing, and led to increased learning talk or memory outcomes (Frischen & Tipper, 2004; Gleason & Schauble, 2000; Kim & Mundy, 2012; Mundy & Newell, 2007; Striano, Reid, & Hoehl, 2006). It is such a critical skill for language development that joint attention is considered the basis for most parent-child communication (Carpenter, Nagell, & Tomasello, 1998; Moore & Dunham, 1995; Mundy & Newell, 2007; Striano, Chen, Cleveland, & Bradshaw, 2006; Tomasello, 1995; Tomasello & Carpenter, 2007). Children often learn what is important to pay attention to, to learn about, and to remember through joint attention with their parents. If joint attention is not achieved, children are less likely to remember or learn; an effect Tessler and Nelson (1994) call the "social-interactive effect on encoding."

Consider a parent and child at a train display as seen in many transportation or history exhibitions. This room-size, intricate scene is filled with figurines and miniature models of a community complete with agriculture, business, and a variety of goods and services. There is much to take in and a whole array of items on which to focus. Parent and child could easily attend to different aspects of this shared environment, visually exploring individually. In this particular exhibit, push buttons are also accessible on placards around the perimeter of this scene. When pressed, these buttons activate certain mechanical features of the display such as switching on lights, moving train cars, starting music, and turning the carousel. These visual changes work to shift attention to a particular feature within a busy scene. If used by the parent-child pair, these buttons could serve as a focusing technique to help the parent and child achieve joint attention and prompt the associated benefits.

As the example suggests, joint attention involves complex choreography between individuals' attention and the learning environment. Attention has perhaps been one of the most studied learning mechanisms in museums – in part because it is relatively easy to assess without disrupting a normal museum visit. For example, many studies have used timing and tracking methodologies to document the extent to which visitors attend to different elements within an exhibition (Yalowitz & Bronnenkant, 2009). Such studies have revealed a number of design elements that influence attention, including novelty and open-endedness (Sandifer, 2003), hands-on interaction (Koran, 1984), spatial layout of exhibitions (Gutwill & Hido, 2003), the use of authentic objects (Paris, 2002), and human facilitation (Boisvert & Seiz, 1995).

Studies of attention that involve tracking and timing methods produce high-level summaries of engagement. Although they are able to precisely document visitor flow, they often do not capture social dynamics or more precise measures such as whether or not visitors achieve

joint attention. However, findings are often interpreted to suggest that certain patterns of engagement foster social interaction and joint engagement (e.g., Choya, 2008; Paris, 2002).

Some studies have directly explored joint attention and its role in family museum learning. Tison-Povis and Crowley (2015) looked at how to promote joint attention at dioramas with static, taxidermy animals. Parent-child pairs used a flashlight to explore the dioramas that were otherwise too dark to see. The flashlight, which was held and directed by the child, focused the visual field on only the objects at which the child was looking. Families in this condition achieved significantly more joint attention compared to families who saw the dioramas under full light. Once joint attention was established around an object, families were more likely to engage in learning talk about that object. In a study of family learning at an aquarium, Rowe and Kisiel (2012) found that live animals provide a similar role in focusing attention, with parents and children engaging in conversational "debriefs" following joint attention to living collections in touch tanks.

Although these examples are "in the moment," joint attention could also be achieved through a social reconstruction of what occurred during a museum visit. Stevens (1997) asked visitors who had just engaged with an interactive tornado display to watch video footage of themselves at that exhibit. Reflecting on their recorded interactions supported post-hoc learning. The facilitator asked questions such as "What do you notice?" which encouraged groups to reflect and jointly attend to each other's actions and explanations.

2.5 CONVERSATION

Studies of human learning often show that conversation during an activity influences learning during the activity and recall afterwards (Fivush et al., 2006; Haden, Ornstein, Eckerman, & Didow, 2001; Hendrick, San Sousi, Haden, & Ornstein, 2009; Ornstein et al., 2004; Ornstein, Haden, & Hendrick, 2004; Tessler & Nelson, 1994). Guided by sociocultural theory (e.g., Vygotsky, 1962,1978), many researchers have explored the role of parent-child conversations as both a mechanism that supports learning, and as an outcome of learning itself (e.g., Ash, 2004; Callanan & Jipson, 2001; Haden, 2010; Leinhardt, Crowley, & Knutson, 2002). In other words, research generally suggests that talking during museum visits is associated with all sorts of family learning outcomes. At the same time, learning how to talk together, particularly about art, science, history, or some other disciplinary content, is also an outcome of some family museum visits.

We recently observed a family in a children's museum, visiting an exhibit that included a larger than life scale, woven rope spider web visitors could explore:

> Adult: Careful! You gonna climb the spider web? ….nice climbing.
> Child: {gasp} There's a spider!
> Adult: There's a sp- is that a spider?
> Child: No, it's not.
> Adult: No. It only has six legs, huh? There might be a spider though.
> Child: There is!
> Adult: Is that a spider? Nope, look, it has wings. Do spiders have wings?
> Child: Nope.
> Adult: Nope, but maybe- you know what these might be though? The spider's dinner. They're stuck in the web, huh?
> Child: Yeah.
> Adult: It's like our-
> Child: Come on, Mommy.
> Adult: Alright.
> Child: We have to get out.
> Adult: You wanna get out before we're spider dinner?

As shown in this example, parents can use conversation as a tool for focusing attention, determining child understandings, making connections, and sharing information (Ash, 2004; Braswell & Callanan, 2003; Crowley et al., 2001; Diamond, 1986; Dierking, 1989; Szechter & Carey, 2009). Parents often alter their verbal scaffolding depending on exhibit context (FLING, 2011; Melber, 2007). Some parents have particular conversational routines and question asking styles including quiz-like or open-ended question asking (Ash, 2004), which is thought to impact learning differently. Haas (1997) has argued that open-ended questions from a caregiver result in increased learning compared to no guidance or prescriptive guidance at exhibits. Similarly, it can enhance a child's learning when a parent provides associative talk that links current experience with past experiences and knowledge (Crowley & Jacobs, 2002).

As noted by Benjamin et al. (2010), it is important to explore how particular kinds of conversations promote particular kinds of museum engagement and learning. *Wh*-questions (such as asking who, what, where, when, why, or how, as opposed to as opposed to questions with a simple yes/no answer) are a key part of conversation-eliciting speech (Leech et. al., 2013). Parents have been shown to adopt *wh*-question strategies as a result of training both outside (Boland, Haden, & Ornstein, 2003; Hendrick, Haden & Ornstein, 2009) and inside the museum context (Benjamin, Haden, & Wilkerson, 2010; Eberbach & Crowley, 2016; Falk & Dierking, 2000; Leinhardt & Knutson, 2004). For example, Van Schijndel et al. (2010) showed parents a short video before they entered an exhibit with their child, which offered tips and examples of conversational strategies (i.e. scaffold investigations through question asking, provide explanations, connect to child's existing knowledge) to use at the exhibits in order to stimulate exploratory behavior. Parents demonstrated these strategies in the exhibit with the intended positive effects on preschool children's exploratory behavior.

In a study of family learning in an art museum, Knutson and Crowley (2010) observed that parents "need help deciding *what* it is they should be talking about, not just how they should be talking" (p. 200) This has also been found to be true in other object-based museums like natural history museums, where families similarly need help going beyond a surface level experience (Mifsud, 2009; Tunnicliffe & Reiss, 2000). This need has sometimes been approached as a knowledge-deficit problem, since encouraging parents without topical knowledge to simply talk about objects is not sufficient for stimulating good explanations and rich learning conversations (Kim & Crowley, 2010). Yet, having content knowledge does not, in and of itself, guarantee deeper, more elaborative exhibit conversations, which could contribute to information sharing and processing (Fender & Crowley, 2007).

Parent content knowledge, as well as what to talk about, were considered in a study by Eberbach and Crowley (2016) where parents were trained on conversational strategies and cued to talk about pollination in a botanical garden. Though parents with more content knowledge exhibited more disciplinary talk, training on conversational strategies effectively increased *wh*-questions, child-focused talk, and linking to past experiences. Moreover, the use of these strategies also increased disciplinary talk, which, in turn, was predictive of child learning. As opposed to measuring parent content knowledge, Benjamin, Haden, and Wilkerson (2010) provided content instruction (what makes for sturdy building design) and/or conversation instruction (use of elaborative *wh*-questions and associations) to families at a construction exhibit. Again, conversational instruction was found to increase parents' use of *wh*-questions and associations. Direct content instruction, as opposed to providing building models, was important for conveying content information that was then used in the exhibit and later recalled in memory tasks. Less prescriptively perhaps, Hohenstein and Tran (2007) also cued families about what to

talk about, but did so through exhibit labels which read, “Why is this here?” For some exhibits, this guiding question increased explanations and open-ended questions, but for others it did not. The authors take their exhibit-specific results to suggest that it is important to match the type of question with the complexity of the object on exhibit in order to stimulate conversation. In sum, parent-child talk can be influenced by conversational interventions and these parent-child conversations affect children’s understanding and learning, but we must be thoughtful in our designs.

Some of these conversation intervention studies begin to outline an important line of missing research – the togetherness of conversation. In Eberbach and Crowley (2016) one of the coded conversational categories was “child focus talk,” which is when parents are in tune with their child and able to converse around that which the child has already expressed interest, such as something the child is viewing, touching, or saying – much like joint attention. Although they found that training helped parents be more attentive in conversation and provide more child-focused talk, analysis did not delve into this fully. Instead, the categories were collapsed under “parent use of conversational strategies.” Similarly, Benjamin et al. (2010) found that conversational instruction increased “caregiver-child joint talk”—defined in this study as when a child responded with new information to a parent’s elaborative question. They hypothesized that *wh*-questions may work by “focusing attention on what is available to learn” and further conjectured that it might be the pairing of parent question followed by the child response that really matters for enhancing learning. Though these studies use different terminology, they both suggest there is more to investigate around the shared or joint aspect of conversation.

2.6 PUTTING IT ALL TOGETHER: FAMILY TOGETHERNESS AS A MEETING PLACE BETWEEN RESEARCH AND PRACTICE

So what is the usefulness of coming to understand these three mechanisms–framing, joint attention, and conversation? Consider the three individual mechanisms to each exist on a continuum. Framing, for example, is situated on a spectrum from misaligned to aligned. On one end of this spectrum, individual expectations are disparate; while on the other end, parent and child have mutual intentions and are more together in the moment. Attention falls along a socialness spectrum ranging from isolated and individually focused (little to no social interaction) to the more together state of shared observation and interaction (joint attention and joint engagement). At one end of the conversation spectrum would be no talk, or perhaps disconnected utterances without acknowledgement, while at the other would be mutual dialog with high-level exchanges between parent and child. When we visualize each mechanism as a spectrum, we see an important parallel state across all three mechanisms that we term *togetherness*

Togetherness is the shared state where parent and child feel connected, are co-participating, are mutually invested, and are attuned to one another's actions and thoughts. More specifically, togetherness is indicated by the degree to which parent and child are adopting aligned frames, are jointly attending to their shared environment, and are engaging in shared talk. The literature reviewed identifies specific strategies that can impact family engagement and learning, which may move families along the framing, attention, and conversation continuums toward a state of togetherness. We suggest that togetherness may also serve as a middle ground where both researchers and practitioners may think about their individual and collective work

from a shared stance. Our hope is that togetherness can help characterize a large body of research (without oversimplifying or distorting) in a way that inspires innovation and reflective practice.

From the standpoint of practice, togetherness is useful because it emphasizes the forest over the trees. Those who design museum experiences often have vast, first-hand knowledge of how families engage in their museum. They observe, consider, and design for the entire visit, not isolated moments of the interaction captured through the lens of researcher's video camera. Museum staff know that families are different from each other, and that sometimes even the same family can act very differently over the course of the visit. Not all ways of being together and learning as a family will necessarily look the same. Togetherness may look like mutual rapt attention, but it could also look like parallel play where, rather than jointly attending to the same object, parent and child might be jointly attending to like tasks and thereby engaging simultaneously if not collaboratively, which can create the space to have a rich verbal exchange around the shared experience.

However, amidst all of the variation, the research literature does show that certain patterns do matter for family learning, and that museums can make design choices that may hinder or support togetherness. We think it could be a useful tool, as practitioners engage with researchers and the family learning research literature, to keep asking whether the study they are learning about promotes togetherness, for what kinds of families, and through what kinds of design choices. Although the research literature is filled with very different frameworks, theoretical terms, and learning outcomes, most of the literature can be read as explorations of interventions that affect togetherness.

In some ways, we see togetherness as a sibling to recommendations Borun et al. (1997) derived for family friendly exhibits. In their study, across a wide range of exhibit types, families

appeared most engaged when using exhibits that were multi-sided, multi-user, accessible, multi-outcome, multi-modal, readable, and relevant. Togetherness could be thought of as an explanation for why such characteristics engage families.

We hope that by defining each mechanism and linking it to the larger concept of togetherness, we stimulate a new way of thinking about, talking about, and designing for family learning interventions. These three mechanisms might be used as a design tool to anchor exhibit ideas to research-based family learning theories by encouraging design-based researchers and practitioners to think about interventions not as a product provided to visitors, but as a prompt to engage in a learning process. For example, practitioners may consider how a proposed exhibit intervention fosters togetherness in order to bolster family learning. If researchers are inclined to isolate, identify, and measure things, while practitioners are accustomed to taking a holistic view, one communication barrier may relate to scale or an issue of grain-size. Individual studies often hone in on a particular nuance within an intervention mechanism, but introducing the notion of togetherness helps frame all three intervention mechanisms as all part of a single phenomenon which may help translate research to practice. In the future we hope both research and practice focus on this idea of togetherness, which can help us look more broadly at the whole museum experience and treat the family as a learning system.

Togetherness is a way to organize research and guide practice by encouraging the field to increase social interaction by giving families a perspective by which to consider the context (framing), a way to focus (attention), and a way to talk about what they are seeing (conversation). By identifying and naming these mechanisms—which have been shown to be successfully manipulated through design interventions—we hope to offer a tool to shape future research and bring social learning considerations further into design conversations. Instead of

thinking about the intervention and what will be delivered, we hope thought will also be given to how families will be prompted to look, talk, and think *together*. If we begin to bring togetherness into our lexicon, practitioners might engage in more systematic exploration of the three spectra as they explore implementing interventions with togetherness in mind. Researchers might stretch toward including more holistic measures – thinking about the family as a unit rather than as individual actors and considering not just their learning at an exhibit, but across the whole museum and multiple visits. Together practitioners and researchers can strengthen family learning in museums and strengthen families by creating spaces which foster *togetherness*.

3.0 FAMILY LEARNING IN OBJECT-BASED MUSEUMS: THE ROLE OF JOINT ATTENTION

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3.1 ABSTRACT

From an early age, joint attention serves as a basis for parent-child communication. This study explored how increased joint attention (two people knowingly focused on the same object) might lead to increased learning as 54 families explored dioramas in a natural history museum. Using a 2X2 factorial design, we tested two interventions intended to increase parent-child (5-8 years of age) joint attention to objects in the dioramas. In one intervention families used flashlights to explore darkened dioramas, thereby restricting the visual field, and in the other intervention families were provided with signage prompts intended to focus attention on particular diorama features. Results showed that families who explored dioramas with flashlights were significantly more likely to establish joint attention compared to controls. Furthermore, once families established joint attention around an object, they were more likely to engage in learning talk about that object, suggesting that relatively simple manipulations of joint attention might be an effective means of supporting family learning in object-based learning environments such as natural history museums.

3.2 INTRODUCTION

Joint attention is a social-cognitive phenomenon in which people know they are attending to the same aspect of their shared environment (Tomasello, 1995). Early in life, joint attention enables an infant to share a common point of reference with another person by following that individual's gaze—a critical skill that underlies early language learning and communication (Carpenter, Nagell, & Tomasello, 1998; Moore & Dunham, 1995; Mundy & Newell, 2007; Striano, Chen, Cleveland, & Bradshaw, 2006; Tomasello, 1995; Tomasello & Carpenter, 2007). Children seek joint attention by repeatedly showing objects to adults, sometimes coupled with gestures or verbalizations, until adults acknowledge and engage with children around the objects (Kidwell & Zimmerman, 2007). Coordinating joint attention is also considered an essential element of successful adult communication (Richardson, Dale, & Kirkham, 2007). Joint attention is more than sharing a line of sight, co-viewing, or simultaneous visual orientation; it also implies shared cognitive engagement around stimuli that are the focus of attention (Mundy & Newell, 2007; Takeuchi & Stevens, 2011). Joint attention supports enhanced information processing and retention (Tessler & Nelson, 1994). For example, once joint attention has been established around a visual target, people are less inclined to rapidly move on to the next target, thereby allowing more processing time, deeper processing of stimuli, and a conversational opportunity around a shared referent (Frischen & Tipper, 2004; Kim & Mundy, 2012; Mundy & Newell, 2007; Striano, Reid, & Hoehl, 2006).

In this study, we examined the role joint attention plays in parent-child learning in a natural history museum. Museums are complex learning environments with many stimuli competing for attention. Allen (2004) has identified this competition for attention as "the single greatest constraint underlying exhibit design" (p. 2); yet, it is precisely this free choice among

many potential experiences that is one of the greatest strengths of museums as learning environments (Falk & Dierking, 2000). For families to learn together in museums, they need to effectively negotiate how they attend to, engage with, and learn from museum exhibits (Falk & Dierking, 2000). Parents play a key role in that negotiation, often providing directions, asking questions, and prompting conversation (Ash, 2004; Crowley et al., 2001; Palmquist & Crowley, 2007; Melber, 2007; Rennie & McClafferty, 2002). Many of these behaviors imply that parents and children have achieved joint attention around objects, but no prior studies have independently assessed whether achieving joint attention is a necessary or sufficient condition for family learning talk in museums. Joint attention may be an important, previously missing, piece of the conversation on family learning in museums.

We are specifically interested in whether museum interventions directly targeted at increasing joint attention led to subsequent increases in family learning talk. Family learning talk refers to talk that goes beyond simple identification of objects on display: talk that makes comparisons and connections between exhibits, constructs explanations, or connects exhibits to prior family experience (Borun, Cleghorn, & Garfield, 1995; Dierking, 1989; Leinhardt, Crowley, & Knutson, 2002; Siegel, Easterly, Callanan, & Wright, 2007). Studies of museum visitors have focused on group conversations as a primary process and outcome of museum learning (e.g., Allen, 2002; Ash, 2002, 2003; Leinhardt & Knutson, 2004; Palmquist & Crowley, 2007). We know talk is a powerful mechanism for learning (Bransford, Brown, & Cocking, 2000; Halliday, 1993; Hohenstein, 2006; Sawyer, 2006) and prior knowledge, question asking, interest, and sign reading all appear to contribute to family learning talk (Ash, 2004; Eberbach & Crowley, 2009; Kim & Crowley, 2010; Knutson & Crowley, 2010; Siegel, Easterly, Callanan, & Wright, 2007). We believe that intervening to increase joint attention may be a relatively

straightforward way to encourage family learning in object-based museums, which place strong demands upon selective attention.

Dioramas, as dense displays of visual stimuli, are a prime location to test the benefits of joint attention. Dioramas trace their beginnings back at least as far as the early 19th century, when taxidermy was displayed to aid visual comparison between and among species (Morris, 2009). By the end of the 19th century, taxidermy and associated objects were often arranged in story-like associations meant to provide a narrative scene for the visitor (Marandino & Oliveira, 2009). This gave birth to the natural history dioramas we know today—recreated scenes, capturing a moment in time with soil, plant samples, and painted or photographed scenery. Realistic dioramas became a way to expose visitors to objects they would not otherwise have had an opportunity to see and to prompt conversation about those species and places they could not typically visit (Ash, 2004).

As dioramas are most often static displays behind glass, visitors interact with them primarily via observation, reading available signage, and, if visitors are not alone, conversation. Observing visitors at dioramas suggests that conversations at dioramas often progress in the following manner: label according to existing knowledge, identify features, relate objects to one another, and provide narratives (Tunnicliffe, 2009). When given time, children at dioramas will sometimes ask questions and offer hypotheses, or talk about fundamental characteristics of objects (Ash, 1995; Medin & Ortony, 1989; Tomkins & Tunnicliffe, 2001). But, more often than not, visitors, particularly children and their families, must work to advance beyond simple descriptions of what they are seeing (Melber, 2007; Mifsud, 2009; Tunnicliffe & Reiss, 2000). In summarizing learning around dioramas, Ash (2004) notes that it is difficult work for families to make sense of what they see, coordinate thinking, ask questions, and sustain talk that includes

deeper biological themes. We hypothesize that at least some of this difficulty stems from the challenge of coordinating joint attention around static, often unfamiliar objects in a busy scene behind glass, which likely impedes some of the attention focusing behaviors that families use in other settings, such as pointing (Bangerter, 2004; Kita, 2003) and body position (Marin, 2013).

In the current study, we explored the impact of two interventions on joint attention as families learn from natural history dioramas. In the first intervention, we attempted to directly intervene to increase joint attention by having half of the families explore dioramas in a dark room using a flashlight and the other half explore the same dioramas in a fully lit room without a flashlight. The flashlight, held by the child, was intended to restrict the visual field to single objects or small groups of objects within a diorama and thus make it clear to parents exactly what children were looking at and therefore easier for the parent and child to establish joint attention around specific objects. In the second intervention, we had half of the families explore the dioramas with signage prompts that encouraged exploration strategies focused on objects within the diorama as opposed to the standard descriptive text panel posted beside each diorama. Crossing these two conditions produced a 2 (self-illuminated with flashlight vs. fully-illuminated control) X 2 (signage prompts vs. no signage prompts controls) design.

We expected both interventions to increase family engagement with the dioramas: to increase time spent, to increase number of objects noticed, to increase the presence of joint attention, and to increase the presence of learning talk. We expected the group that received both interventions to be the highest performing group in the study. Specifically, we explored the following research questions: (a) Do self-illuminated and/or signage prompts affect the number of objects families *notice* and establish *joint attention* around in dioramas after controlling for

time spent? (b) Once joint attention is established around an object, do families then go on to engage in *learning talk* about the object?

3.3 METHOD

We recruited 54 parent-child dyads to participate in the study from the general museum visitor population in adjoining exhibit areas. Children were between 5 and 8 years old, an age range in which adult-child conversation is expected to be prominent during museum visits (Crowley, Pierroux, & Knutson, 2014), and also an age range of great interest to natural history museums encouraging family visitors (Crowley & Knutson, 2014). To control for prior experience with the exhibit, we excluded families who had visited the exhibit previously.

The setting for this study was a series of dioramas at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania. Seven dioramas from the early 1900s, each approximately eight feet wide and six feet high, were positioned as individual cases along a hallway-like exhibit space. Two of the dioramas presented fish and four featured birds, all within life-like environments. Each diorama was accompanied by a text panel identifying the species and describing the recreated scene. For example, the Blue Goose Diorama depicts geese along their fall migration. In the painted background, birds are seen in flight and standing along the mud flats at daybreak. Four juvenile geese and three adult geese (distinguished by their white necks) are positioned in the foreground, many feeding on marsh grasses. The text panel reads:

> BLUE GOOSE: Once thought to be a separate species, the "Blue" Goose is now known to be a color phase of the Lesser Snow Goose, the white birds seen in the painted background of this diorama. The genetics of these two color types has been extensively

studied. These geese nest on the arctic tundra from eastern Siberia to Hudson Bay; the proportion of blue to white is highest in the central part of the species' range. In fall migration, tremendous numbers congregate on mud flats at the head of James Bay to feed on marsh grasses and fatten up for their journey to their winter home on the Louisiana and Texas coasts. This diorama represents such a fall gathering, the dark-headed birds being the young of the year. A larger subspecies, the Greater Snow Goose, breeds in the eastern Canadian Arctic and in Greenland, and winters along the Atlantic coast, mostly from Chesapeake Bay to North Carolina. Blue individuals are very rare among these populations.

The exhibit space was partitioned off during the study so that only one participating parent-child dyad would be in the space during data collection. The researcher approached families that appeared to meet the subject selection criteria and asked if they would be willing to participate in a study that involved viewing an exhibit undergoing some redesign and answering a few interview questions. Prospective participants were then asked the age of the child, the family relationship between adult and child, and if they had been to this exhibit before. Since the study was restricted to one parent-child dyad at a time, larger family groups were asked to select one parent to participate along with one child of the appropriate age. Those dyads that were willing and able to participate were given wireless audio recording devices to wear during the study so their conversations could later be coded for analysis.

On the days we were collecting self-illuminated data, the normal, overhead lights in the diorama hallway were turned off. Children in dyads assigned to the self-illuminated condition were given a flashlight to illuminate the dioramas.

For the signage prompt condition, we placed a written prompt next to each diorama which suggested family exploration activities based on objects in the diorama. For example next to a diorama featuring fish, the exploration read: "Get low, how many perch do your sharp eyes show?" For safety reasons, even the self-illuminated condition was not entirely dark. There was enough ambient light so that it was easy to detect the presences of signs, although the text was difficult to read without shining the flashlight on the sign.

Due to the logistics of changing the hall to collect each cell in the 2x2 study design (installing signage prompts and taking out lighting), families were assigned to a condition based on the condition that was set up the day they happened to come to the museum. We set up conditions for each cell in sequence, collecting data for several days until the cell was filled. We then moved on to the next cell (Table 3.1).

Table 3.1: 2x2 Study Design with Number of Participants in Each Cell

Lighting Condition	Signage Condition	
	Prompt	No Prompt
Self-Illuminated	14 dyads	13 dyads
Fully-Illuminated	14 dyads	13 dyads

In case we had questions about the parent-child interaction while reviewing the audio tape, a researcher followed each dyad through the exhibit noting behaviors such as length of stay at each diorama, pointing, squatting, lifting a child up to see, touching the case, and reading the signs silently or aloud. Once each dyad indicated that they had finished viewing the exhibit, the researcher conducted a post-exhibit interview designed to rule out possible alternative

explanations for why families might engage differently at dioramas. We asked questions about shared family interest in birds and fish, museum-going frequency, and amount of time spent outdoors. We also asked for general reflections about the experience to detect whether families felt they were engaged, whether they valued the experience, and whether they had trouble interpreting the dioramas. Preliminary analysis suggested no differences in responses across condition, so we did not consider these further.

Recall that our research questions require us to measure (a) the extent to which families notice and establish joint attention around objects and (b) the extent to which they engage in learning talk about the objects. Thus, audio recordings of the visit conversation were coded for noticing, joint attention, and learning talk. Codes were developed iteratively in discussions among the research team. One researcher then coded the entire dataset while a second coded 50% of the data. Coders agreed on 95% of occurrences for noticing, 94% for joint attention, and 91% for learning talk.

We coded *noticing* a diorama object when a dyad first mentioned an object by name, descriptor, or exclamation. For example, the following three quotes would all be coded as noticing the owl: "Ooo, look at that owl," "Wow, that's a big bird," or "Ahh, scary!" While listening to the audio recordings for each family at least twice, the researcher tracked the initial instance each object was noticed and whether the adult or child noticed the object.

After each coded instance of noticing, we then coded separately for *joint attention*, which was defined as a reciprocal noticing of the same object by the other person in the dyad. This could include responding to noticing by mentioning an object by name, descriptor, or exclamation. If, for example, a child had noticed the owl, as described above, the following responses from the adult would all qualify as statements that establish joint attention: "He's

going to get the skunk," "It's a big owl," "Whoa, yeah!" This coding produced a count of how many objects each dyad jointly attended to in each diorama.

Following Leinhardt and Knutson (2005) and Palmquist and Crowley (2007), we counted an instance of *learning talk* when we heard participants referencing personal connections (e.g., "This looks like grandpa's pond."), using scientific terminology (e.g., "They are nocturnal."), making predictions (e.g., "I bet there is a nest in there."), comparing objects (e.g., "This one is bigger than that other one."), or stating or asking about high level (e.g., ecological) relations (e.g., "Do the lizards eat the eggs?"), behaviors (e.g., "Why do they build nests on the ground?") and functions (e.g., "They use their webbed feet to swim."). This coding scheme was applied at the conversational level with sentence strings around the same theme coded as one instance of learning talk.

3.4 RESULTS

Analyses focused on determining whether the two interventions, self-illuminated and object-based signage prompts, resulted in families noticing and establishing joint attention around objects more often and, thus, engaging in more learning talk. To provide depth and context to our quantitative findings, we conclude the results section by presenting examples of family joint attention and learning talk.

3.4.1 Noticing Objects & Establishing Joint Attention

Families in the self-illuminated group spent almost 50% more time (M=280 s) looking at the dioramas than the control group (M = 189 s), $F(1, 50) = 7.59$, $p < .01$.[2] Although self-illuminated families spent considerably more time viewing the dioramas, there was no significant difference in the number of objects families talked about (M = 27 for self-illuminated and M = 21 for control) as revealed through a two-way (self-illuminated verses fully-illuminated) ANOVA. Thus, families in the self-illuminated condition spent more time considering each object they observed. This finding supports the idea that lighting intervention helps slow people down, increasing the opportunity to engage with the dioramas.

However, even the self-illuminated families went fairly quickly through the exhibit, averaging just 40 seconds at each of the seven dioramas, and talking about an average of just 27 of the 145 objects in the cases. Visitors often spent little time interacting with dioramas and, although families using flashlights slowed down and observed more closely, they were still far from exhausting the exploratory capacity of the dioramas, noting just 19% of the total objects in the cases.

In contrast to the impact of illumination, a two-way ANOVA (signage prompts verses no prompts) indicated the signage prompts did not significantly influence time spent with dioramas (M = 249 s vs. M = 220 s for signage prompts vs. control, respectively) or the number of objects observed (M = 23 vs. M = 25 for signage prompts vs. control, respectively). The interactions

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[2] Preliminary analyses revealed no significant effects or systematic patterns due to gender or age of child; we did not include them in the ANOVAs.

between illuminated and signage prompt conditions were also not significant for either time spent or objects observed.

A two-way (self-illuminated vs. fully-illuminated) ANOVA indicated that families in the self-illuminated condition were more likely to establish joint attention around objects (M = 19 instances) (as evidenced by one person noticing an object and the other person affirming the co-viewing experience) than families in the control group (M = 14 instances), $F(1, 50) = 5.80$, $p < .05$. No significant differences were found for signage prompts (Ms = 17 and 16 for signage prompts and control, respectively) or the interaction between conditions.

Although group differences in the number of objects mentioned were not statistically significant, families in the self-illuminated condition did notice 6 more objects, on average, than families in the control condition. It is possible that the number of joint attention instances might be, in part, attributed to differences in the number of objects viewed; the more objects noted by one person, the more opportunities for the other person to jointly attend to said objects. We tested this possibility by asking: When an object was first mentioned by one member of the family, how likely was it that the other member responded and established joint attention around that object?

We calculated the percentage of object noticing counts that were followed by joint attention and found, through a two-way (self-illuminated vs. fully-illuminated) ANOVA, that families in the self-illuminated condition followed up on a greater percentage of object noticing with joint attention (M=76%) than families in the control group (M = 68%), $F(1,50) = 4.23$, $p < .05$. This analysis essentially adjusts for differences in the number of objects viewed by the two groups of families and confirms that, per object, families in the self-illuminated condition were more likely to establish joint attention than families in the control group.

Table 3.2: Means (and Standard Deviations) for Time Spent, Objects Noticed, Joint Attention, and Learning Talk Across Conditions

Lighting and Sign Type	Time in seconds	Noticing	Joint Attention	Learning Talk
Self-Illuminated				
Prompts	297 (156)	24 (10)	19 (8)	10 (7)
No Prompts	262 (110)	29 (13)	19 (9)	11 (8)
Fully-Illuminated				
Prompts	200 (113)	21 (11)	15 (8)	8 (6)
No Prompts	177 (97)	21 (11)	13 (7)	9 (5)

3.4.2 Engaging in Learning Talk

Once joint attention was established, did families go on to engage in learning talk? We identified every coded instance of learning talk in the transcripts and then checked to see whether the learning talk (a) followed a coded instance of joint attention to the same object, (b) preceded an instance of joint attention to the same object, or (c) did not co-occur with an instance of joint attention to the same object. We found that 71% of learning talk codes followed directly after a coded instance of joint attention, compared to 19% of learning talk codes that preceded joint attention, and 11% of learning talk codes that were unrelated to joint attention.

As joint attention and learning talk were found to be strongly associated, and families in the self-illuminated condition were more likely to establish joint attention, one might expect to find significantly more instances of learning talk among the self-illuminated families. The group means supported this expectation with self-illuminated families having more learning talk (M =

10.33, SD = 7.38) than control families (M = 8.15, SD = 5.27). However, a 2 (Condition 1: self-illuminated vs. fully-illuminated) X 2 (Condition 2: prompts versus no prompts) ANOVA determined that the difference was not significant, $F(1, 50) = 1.50$, $p > .05$. We note the high standard deviations in the data, which suggest that, although joint attention may be one factor that enables learning talk, it appears to be neither a necessary nor sufficient condition.

A final analysis allowed us to look more directly at the relation of joint attention and learning talk. Up to this point, our findings suggested that the self-illuminated intervention successfully increased joint attention and that about three fourths of observed learning talk about an object followed a moment of joint attention. This pair of findings suggests that successfully increasing family joint attention has the effect of increasing family learning talk. However, there might be alternative contributing factors produced by the manipulations that are in large or small part responsible for the observed increase in learning talk. For example, although the object-based exploratory prompts did not lead to an increase in joint attention, they may have introduced additional content knowledge that allowed parents to offer explanations that they might not otherwise be able to offer.

We explored the possibility of other contributing factors through two step-wise regressions. First we entered children's age, sex, illumination condition, and signage condition into a regression to find out the best combination of variables to predict instances of joint attention (Table 3.3). Step-wise regression revealed that the illumination condition contributed most to the prediction of joint attention $F(1,52) = 5.83$, $p < .05$). Once illumination condition is in the model, the addition of children's age ($t = .603$, $p > .05$), signage condition ($t = -.565$, $p > .05$), and sex ($t = .348$, $p > .05$) did not significantly contribute to the prediction of joint attention. Thus, only illumination condition ended up in the regression equation. Illumination

condition alone accounted for 10.1% of the variance in joint attention (R^2=.101). This analysis confirmed that the self-illuminated condition significantly increased joint attention to museum objects (β=.318, p < .05).

Table 3.3: Summary of Linear Stepwise Regression Analysis for Variables Predicting Joint Attention

Variable	*B*	*SEB*	*B*
Model 1			
Constant	24.296	3.394	
Illumination	5.185	2.147	.318*
R^2	.101		
F	5.835*		

Note. *B* = unstandardized regression coefficient; *SE* = standard error; β = standardized regression coefficient
*p <.05.

In a separate step-wise regression (Table 3.4), we entered children's age, sex, illumination condition, signage condition, and instances of joint attention to predict instances of learning talk ($R^2 = .39$, $F(1,52) = 33.23$, $p < .001$). Findings show that joint attention significantly predicated learning talk ($\beta = .624$, $p < .001$) and, importantly, once the presence of joint attention was accounted for, other variables did not add significant variance to the presence of learning talk. This increases our confidence in concluding that the self-illuminated condition was successful in increasing learning talk through the influence of joint attention. We still note that the final regression accounted for only 39% of the overall variance, which suggests there are many other factors at play (and thus many other potential intervention targets) when families engage in learning talk than simply the presence of joint attention.

Table 3.4: Summary of Linear Stepwise Regression Analysis for Variables Predicting Learning Talk

Variable	*B*	*SEB*	*B*
Model 1			
Constant	1.167	1.562	
Joint Attention	.489	.085	.624**
R^2	.390		
F	33.235**		

Note. *B* = unstandardized regression coefficient; *SE* = standard error; β = standardized regression coefficient
*p <.05, ***p<.001*.

3.4.3 Examples of Joint Attention and Learning Talk

To give some sense of what joint attention and learning talk sounded like in our data, we include excerpts from the audio transcripts of two family dyads in our study: Family 32, who viewed the dioramas with the signage prompts in the fully-illuminated control condition, and Family 20, who explored the dioramas with the signage prompts and a flashlight to illuminate the cases. Both dyads are composed of a 33-year-old parent and a five-year-old child visiting the museum together for the first time. Both families indicated that they did not come to the exhibit particularly interested in the specific animals in the dioramas, but found the exhibit to be educational. Though similar in profile, these two dyads provide divergent examples of talk within the diorama exhibit.

Our first example, Family 32, is a typical case of a dyad that stops briefly at each diorama, notices a few objects, sometimes establishes joint attention, but does not progress beyond listing the dioramas' contents to the deeper engagement of learning talk:

Child: Wow, fishes! Fishes. *(fish noticed)*

[Child moves to next diorama]

Adult: Where are you going? You see the fish? *(No JA because not co-viewing)*
Child: Mhm…Owl. *(owl noticed)*
[Adult joins child at diorama]

Adult: An owl. And a skunk. *(JA around owl) (skunk noticed)*
[Dyad moves to next diorama]

Child: The ducks…ducks. *(two geese noticed)*
Adult: Huh?
Child: Ducks.
Adult: Those are goose, geese. *(JA for two geese)*
Child: Goose.

In contrast, consider the example of Family 20, who is standing in front of a diorama featuring a skunk and a great horned owl:

Child: (gasps) Skunks! *(skunk noticed)*
Adult: Skunks! What are skunks doing in here? *(JA for skunk)*
Child: Owls *(owl noticed)*
Adult: The great horned owl [reading sign]
Child: Yes.
Adult: Point the flashlight on the owl. Let me see.
Wow, he's big. *(JA for owl)*
What do you think of him?
What do you think he's going to do?
What do – how do owls, um, get food?
Child: I can show you who's he's going to hunt. *(Learning Talk relation)*
Do you know who he's going to hunt?
Adult: Who is he- who is he going to hunt?
Child: [illuminates skunk with flashlight]
Adult: You think he's going to hunt this skunk?
Child: Mhm

Here, there is a clear focusing of their shared visual field as the mother asks the child to "Point the flashlight on the owl." With a shared visual field and acknowledged joint attention around the owl, the dyad transitions into learning talk together. The mother poses a series of

questions and the child then makes the predator-prey connection. Shifting their joint attention to each object in turn, he uses the flashlight to point out the skunk that the owl is going to hunt.

Adult: Well, he is a bird. How is he going to catch the skunk on the ground?	
Child: Well, if it sprays, he flies away quick. And then he grabs his face and then he--	*(Learning Talk behavior)*
Adult: Well, that's the skunk's defense, but what… how is the owl going to catch him?	*(Learning Talk terminology)*
Child: Maybe not.	
Adult: With his wings?	
Child: Maybe not. Yeah, maybe not.	
Adult: No, I bet you're right though. Look at his claws.	*(claws noticed)*
Child: [Moving on to next diorama] Ahh.	
Adult: Jack…	
Child: [Child returns to owl case]	
Adult: … look at his claws. Look at those- look at those fingernails. You think he can grab ahold of that skunk and pick him up?	*(Learning Talk function)*
Child: Maybe he can stick one of his claws in him so he's dead and then eat him!	*(JA for claws)* *(Learning Talk function)*
Adult: Yeah. I bet you're right. I bet you-he's pretty big. I didn't realize he was so big.	

The mother extends the learning conversation, encouraging the child to think about the mechanism of the attack. When the child's attention wanders, the mother cues the child to focus on the claws with her, which is followed by a form-function connection around the use of talons.

3.5 DISCUSSION

Prior work has established that family learning talk in museums is associated with deeper engagement, better understanding, and more retention (e.g., Ash, 2004; Fender & Crowley, 2007; Tessler & Nelson, 1994). This study provides a direct examination of one mechanism—

joint attention—that may establish conditions conducive to learning talk. We found that joint attention typically preceded learning talk and that viewing darkened dioramas with a flashlight was a direct way to increase family joint attention, and thus increase family learning talk.

We also attempted to manipulate joint attention by providing structured signage prompts. Although prior work suggested that such activities might effectively increase engagement (e.g., Atkins, Velez, Goudy, & Dunbar, 2009; Bitgood, 2000; Hohenstein & Tran, 2007), and the manipulation produced differences in the predicted direction, the differences were not significant. Why did signage prompts fail to increase joint attention? The signage prompts provided a goal for families to achieve together at each diorama such as counting the number of fish or discovering what feature distinguishes an adult bird from a juvenile. For families to effectively use these prompts, they had to notice the prompts, read the prompts, and then use the suggested exploration strategy. This may have been too high a burden, especially for families who already have an established way of engaging with objects and dioramas. In essence, the signage prompts may have required parents to take charge and repurpose the interaction, as opposed to noticing their child's interests and following their child's lead as encouraged by the self-illuminated condition.

In thinking about the differences between the two manipulations, we are struck by the simple and straightforward role of the restricted visual field. The flashlight may have made it easier for families to establish joint attention because they did not need to do as much explicit work to identify specific objects to which they were attending in the dioramas. It is a potentially powerful tool, because it could be used in a wide variety of object-based museums. Interactive museums, with their abundance of hands-on exhibits, offer less of a challenge in terms of joint attention than object-based exhibits. Families using an interactive physics exhibit, for example,

can touch, turn, and observe sequential effects in time. As described in Crowley et al. (2001), the pattern of effects produced by interactive exhibits often provides an external, explicit, and shared point of reference for descriptive and learning talk. In object-based museums, however, interaction occurs most often in the context of observation across a static collection, and joint attention may be more difficult to establish. The flashlight provided a simple means of making gaze external and explicit. One might imagine that laser pointers or other tools could be used to similar effect in more typical museum spaces (i.e., spaces that are fully lit as opposed to darkened).

While this study is limited in its sample size and could have been strengthened with some pre and post testing examining observation, perception, and memory measures, the results are promising. This study shows that joint attention is a productive part of parent child interaction that can be manipulated through simple exhibit design interventions. Restricting the visual field is one successful way to manipulate joint attention. This study prompts us to think about other ways to design support for parents to manage joint attention in productive ways to deepen and extend museum learning. Parent training has been effective for enhancing parent-child conversation (Eberbach & Crowley, in press); child-generated questions could be springboards for establishing joint attention and further developing learning conversations. Future research should test other potential parent-child focusing tools such as photo journaling, cooperative tasks, and goal-based challenges, and investigate the effectiveness of these tools for a variety of visitors including children on the autism spectrum—a population with particular difficulty establishing joint attention (Mundy, Sullivan, & Mastergeorge, 2009).

In summary, establishing joint attention appears to increase the likelihood a family will take the conversational leap to learning talk. Although joint attention around an object did not

always lead to learning talk incorporating that object, almost all instances of learning talk were preceded by joint attention. Therefore, if museums work to help visitors establish joint attention, they may increase opportunities for learning talk and increase depth of processing.

4.0 ARTIST OR SCIENTIST: HOW FRAMING EXTRACTS EXHIBIT CONTENT

4.1 ABSTRACT

The way people frame a situation–their mental construct that helps explain, "what is going on here?"–affects what they notice, how they act, how they respond socially, and ultimately what they learn in a given environment. This study applied the concept of framing to the museum experience to see how prompting a particular frame may impact family learning in a museum exhibition. Thirty-eight parent-child (4.5-7 years of age) pairs participated in this quasi-experimental design, which randomly assigned a simple persona-linked costume (scientist or artist) to children in the experimental groups as a means to prompt a mental frame and no costume to those children in the control group. Results showed that families in the costume conditions engaged in significantly more explanatory learning talk than those in the control condition. Moreover, there were also significant differences between the two costume conditions with scientist families engaging in more "science talk" (e.g., the form and function of a spider web) and artist families engaging in more "art talk" (e.g., art processes such as collage). These conversational differences indicate that relatively simple manipulations of framing may be a promising design strategy to encourage families to focus on particular themes within complex learning environments such as museums.

4.2 INTRODUCTION

The majority of our lifetime is spent out of school (Falk & Dierking, 2010), and for young children, in particular, much of this time is spent with family. Therefore, it is important for us to continue to work to understand family learning in out-of-school environments so that we can design robust family learning experiences. One out-of-school environment families frequent is museums. In fact, more than 30 million children and families visit children's museums each year (Association of Children's Museums). Research tells us that families learn in museums, but they need to effectively negotiate how they attend to and engage with museum exhibits in order to learn (Falk & Dierking, 2000). Parents facilitate this negotiation by providing directions, asking questions, and prompting conversation (Ash, 2004; Crowley, et al., 2001; Melber, 2007; Palmquist & Crowley, 2007; Rennie & McClafferty, 2002). Often visitors, specifically children and their families, struggle to advance beyond basic engagement in an exhibit and simple descriptions of what they are seeing to deeper sense making, question asking, and sustained talk around content themes (Ash, 2004; Melber, 2007; Mifsud, 2009; Tunnicliffe & Reiss, 2000).

Research has shown that museums can intervene to support family learning (e.g., Allen & Gutwill, 2009; Benjamin, Haden, & Wilkerson, 2010; Tison-Povis & Crowley, 2015). Through a previous review of the literature on family learning in museums, we identified three mechanisms–framing, joint attention, and conversation–which provide a way to explain how museum-based exhibit interventions are tied to learning processes (Tison-Povis & Crowley, under review). In this study, we build on this prior work to examine whether exhibit design can influence the frames visitors adopt and subsequently influence their interactions, activities, and conversations.

Framing is a mental construct that helps explain, "what is going on here?" (Goffman, 1974) through a remembered framework of a stereotyped situation (Minsky, 1975), similar to Piaget's (1952) notion of schemas. Framing affects what people notice, how they act, and how they respond to a situation (Hammer, Elby, Scherr, & Redish, 2005). Ultimately, interpretative frames impact what people learn from an experience by influencing the activities in which people engage (Klahr & Dunbar, 1989) and the information they attend to and remember (Friedman, 1979; McClelland, 2013). Given this breadth of impact, framing is an enticing area of study in a museum context.

The concept of interpretive framing suggests that if groups are provided contrasting frames, there should be differences in how those groups notice, behave, process, code, and later recall their experiences since a frame sanctions some observations, actions, and comments over others. Therefore, in this study, we established two different frames to set up a contrast. This approach allowed us to explore how framing can influence the behaviors and conversational aspects of family interactions in an exhibition. Given the topic and context of the exhibition for the study, we hoped to elicit a "scientist" frame or an "artist" frame through the use of simple costumes for child participants at a children's museum.

We hypothesized that if our costume interventions primed families to activate a "scientist" or "artist" frame, then the two groups would attend to different frame-aligned aspects of the exhibition and extract different frame-aligned exhibition content. The purpose of this study was to better understand family learning in museums and how framing might affect what they notice, how they behave, and the content of their conversations. In this article we hope to show how an exhibition intergraded design intervention can enhance family learning in museums.

4.2.1 Research Questions

In this intervention study on family learning, we prompted participating visitors by asking the child to wear a simple persona-linked costumes to frame their exhibition experience as either a scientist or an artist. We were particularly interested in how this intervention impacted parent-child frames, influenced exhibit use, and altered learning conversations across the two experimental groups (scientist and artist) and in comparison to the control (no costume) group. Specifically, we aimed to answer four related clusters of research questions:

1) Frame Adoption

   As an indication of if families adopted the frame, did parent and/or child refer to the role of a scientist or an artist either in a role-assumed way ("That's what I discovered as a scientist!"; "I'm an artist, I'm going to draw!") or in a role-prompting way ("Alright scientist, anything else we need to document?"; "I want to see what you think about it as an artist") or use the supplied notebook/sketchbook to document their experience? Did frame condition influence family's self-reported learning? For example, when asked in an open-ended question what they felt they learned in the exhibition, did families assigned to the scientist condition respond with science-related content (e.g., "He learned more about bugs.") and families assigned to the artist condition respond with art-based content (e.g., "We learned that his art is a collage.")?

2) Attention and Behavioral Practices

   How did the intervention affect attention and behavioral practices such as overall time spend and which exhibit areas were visited? For example, did families in the artist condition attend to the art studio portion of the exhibition space more than families in the scientist condition?

3) Learning Conversations

   Did having a shared frame promote learning talk such that families in the experimental costume conditions engage in more learning conversations than families in the control group? Did families align their conversations with the condition to which they were assigned, extracting frame-aligned concepts and content from the exhibition? For example, did scientist families discuss ecological relationships while artist families talked more about art processes or techniques?

4.2.2 Study Context: The Very Eric Carle Exhibit

The setting for this study was the debut of a traveling exhibition designed in-house at the Children's Museum of Pittsburgh in collaboration with The Eric Carle Museum of Picture Book Art. The Very Eric Carle Exhibit was based on five of Eric Carle's nature-themed stories. The exhibition was divided into five zones each highlighting one of the featured book characters: a caterpillar, click beetle, cricket, firefly, and spider. Exhibit activities included building a spider web to trap prey, journeying along a butterfly's life cycle, creating a nocturnal insect symphony, moving through a beetle habitat, and searching like a firefly in the night. These interactive and kinesthetic exhibits intended to spark imaginary play, were positioned around a central art studio in the middle of the 1,900 square foot exhibition space where families could get hands-on experience learning more about Eric Carle and his art techniques while surrounded by some of his original art and personal artifacts (Figure 4.1).

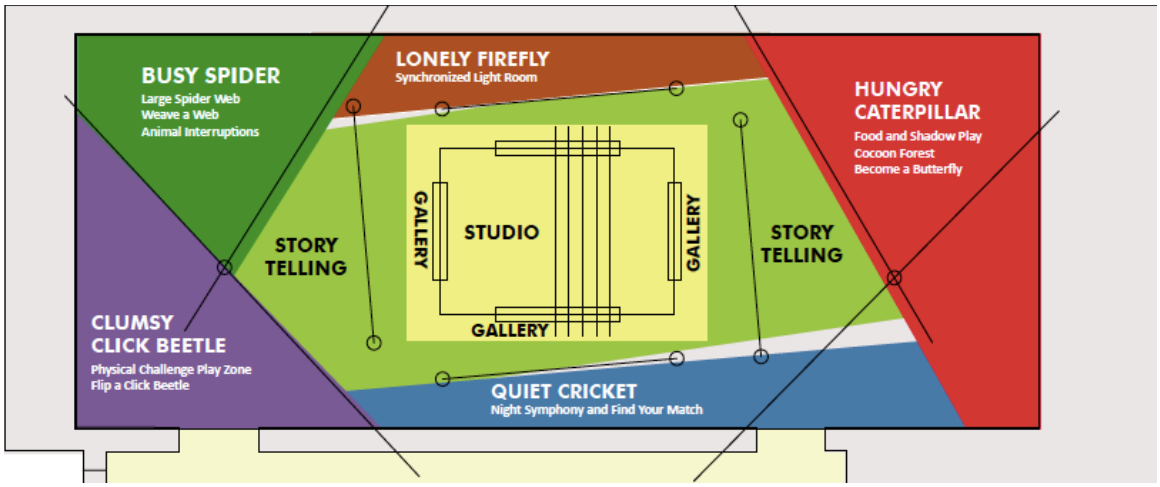

Figure 4.1: Exhibition Floor Plan

4.3 METHODS

In this study, we implemented an intervention aimed at altering the interpretive frame with which families viewed an exhibition in order to analyze the effects of framing on family learning in museums. Given that framing has been found to affect what people notice, what they value, and how they respond to a situation (Hammer, Elby, Scherr, & Redish, 2005) we expected to see both behavioral and conversational differences across conditions.

4.3.1 Participants

From the general population of museum visitors at nearby exhibits, we recruited 38 parent-child dyads to participate in the study. Participating children were between 4.5 and 7 years old, an age range in which parent-child conversation has been shown to be expected and ample during

museum visits (Crowley, Pierroux, & Knutson, 2014), and also a primary audience for children's museums and therefore of particular interest (Association of Children's Museums).

The exhibition space was open to all visitors during the study in keeping with the natural museum-going environment and was conducted on both weekdays and weekends. The researcher intercepted families who appeared to meet the subject selection criteria (parent with child age 4.5-7 years old) as they approached the exhibition and asked if the families would be willing to participate in a study that involved testing a new idea for the exhibit. Prospective participants were then asked the age of their child and if they had been to the exhibition before. Families who said they had visited the exhibition previously were excluded in an effort to control for prior experience with the exhibition. Family groups larger than one parent and one child were asked to select one adult to participate with the child of the appropriate age. After reading and providing consent, both parent and child received intervention supplies depending on condition. Fourteen parent-child dyads participated in each of the two experimental conditions. Due to unexpected exhibit changes that altered a large footprint of the exhibition toward the end of its run, ten rather than the intended fourteen families were included in the third condition, the control condition. Thus, the final dataset contains 38 parent-child dyads (Table 4.1).

Table 4.1: Count, Child Age, Gender, Parent Level of Education, Museum Membership, and Race of Subjects by Condition

Condition	Number Dyads	Child Avg. Age (in months)	Child Gender	Adult College Graduate	Family Museum Member	Adult Reported Race
Scientist	14	74.64 (10.03 SD)	6 girls 8 boys	12 (yes) 2 (no)	13 (yes) 1 (no)	12 Caucasian 2 non-Caucasian
Artists	14	68.43 (11.89 SD)	5 girls 6 boys	12 (yes) 2 (no)	11 (yes) 3 (no)	11 Caucasian 3 non-Caucasian
Control	10	72.70 (13.56 SD)	6 girls 4 boys	9 (yes) 1 (no)	9 (yes) 1 (no)	9 Caucasian 1 non-Caucasian
Totals	**38**	71.84 (11.72 SD)	20 girls 18 boys	33(yes) 5 (no)	33(yes) 5 (no)	32 Caucasian 6 non-Caucasian

4.3.2 Intervention Conditions

Adult and child participants in all three conditions wore an audio recorder to capture conversational data about exhibit use and family interaction. In addition to the audio recorder, children in the two intervention conditions also wore either a scientist vest with a field notebook in the pocket or an artist smock with a sketchbook in the pocket. These costumes were given out alternatingly to participants except when trying to balance for age and gender within each condition. In this manner, a maximum of two dyads participated at a time and never were two scientists or two artists in the exhibition simultaneously. After the costume conditions were filled, the control condition data were collected. Before entering the exhibition, participants in each condition heard a short introductory script to explain where they were going and to reinforce the intervention (see Appendix A).

4.3.3 Data Collected

Audio data from the microphone recorder worn by each participant captured conversational data about exhibit use and family interactions. When participants determined they had completed their visit, they returned to the researcher waiting in the adjoining hallway. While the parent took an iPad-based, online survey asking for a variety of demographic and interest information as well as their impressions of the exhibition (see Appendix B), the child shared with the researcher any pictures or notes documented in the notebook or sketchbook. After the researcher photographed these artifacts, she invited children to keep the pages. In this manner 38 participating parent-child dyads across the three conditions provided audio, survey, and artifact data.

4.3.4 Analysis

Each data collection method (audio recordings of conversation, post-exhibition survey, and notebook/sketchbook artifact documentation) contributed useful information to our analyses and ultimately informed how the framing intervention may have altered the exhibition experience. One of the first steps in analysis was to use the survey data to determine how well matched the conditions were across background characteristics. Although we worked to keep age and gender balanced across conditions, other family characteristics were known to us only after the random assignment to condition. The survey data provided by each parent in the dyad allowed us to know more about our sample (e.g., museum-going history, educational background, race/ethnicity) and therefore the population to which our results might generalize. Below we discuss our analysis methods, according to the research questions they inform–whether the frames were adopted and if this contributed to differences in exhibit use and conversational

content. The main variables for analysis include role enactment and parent reinforcement markers, use of the notebook/sketchbook, time spent in the exhibition, engagement with particular exhibit elements, and learning talk.

4.3.4.1 Frame Adoption

As an indicator of whether families adopted the costume-linked frame, we looked both at the artifact data and conversational markers to see if families referenced their assigned frame and/or used the supplies provide to reinforce the frame. The artifact data provided visual documentation for part of the exhibition experience and was a useful reference when listening to the audio data around the notebook/sketchbook use. Although all of the other exhibit components remained relatively standard, and therefore easy to identify in conversation, the conversational reference point of the notebook/sketchbook varied with each family's use. To quantify the documentation, we tabulated the number of entries made (for example, some subjects used a single page, but made three distinct observations at three different time points), and whether documentation took the form of text or pictures. We also tagged in the conversational data any direct mention of the scientist or artist frame, which we defined as the parent and/or child referring to the role of a scientist or an artist either in a role-prompting way (e.g., "Alright, scientist; anything else we need to document?") or in a role-assumed way (e.g., "I'm an artist. I'm going to draw!")? A third frame adoption measure came from an open-ended question on the survey, which asked parents "What do you feel your child learned in the Eric Carle exhibit today?" These self-reported statements of what was learned were easily coded into scientist-linked, artist-linked, or neither. The proportion of statements in each coding category provides a small insight into the general content parents perceived as salient.

4.3.4.2 Attention and Behavioral Practices

As a means to determine whether condition affected exhibit use, the overall time spent in exhibition was calculated and the audio recordings of the visit conversations were tagged for indicators of exhibit area use. In this manner we were able to chart each exhibit area a family used (e.g., nocturnal sound wall, larger-than-life grass field, walk-through storybook, etc.), in order to determine if families in one condition attended to various exhibit elements at a different rate than families in another condition. Recall that the exhibition was arranged with interactive and kinesthetic exhibits related to the five insects/spider positioned around a central art studio (Figure 4.1). We hypothesized that the use of this art studio would differ among conditions, with artists spending more time in the central art studio while scientists might spend more time exploring the exhibits along the perimeter of the exhibition.

4.3.4.3 Learning Conversations

Our hypotheses also included differences in conversational content. This study relied heavily on the audio recordings of exhibit interactions between parent and child and produced almost 16 hours of audio data transcribed for analysis. To determine whether costumes changed conversational content though the exhibition context remained the same, the data were coded using inductive and deductive coding at the conversational level to capture instances of *learning talk*, at the word level searching for key terms, and at the thematic level pinpointing two key subjects of conversational exchange.

Thematic Level Analysis

Based on patterns heard across the data and areas of particularly salient conversations, we identified the themes of Eric Carle and the spider web as two key subjects that stimulated enough

varied conversational exchange for a condition-based comparison. All talk related to Eric Carle was tagged in the transcripts. This text was then pulled out and coded into statements about Eric Carle as an author, as an artist, as the subject of the exhibition, as statements about his life/biography, as statements noticing his artifacts, and statements describing his art process. Similarly, any talk related to the spider web was tagged, pulled out, and then coded into talk about form (spiders build webs) and function (webs catch food for the spider to eat).

Word Level Analysis

The presence and absence of language use at the simple word level was also used to analyze differences between groups and to inform coding schemes. For example, the presence of the words "artist/ic," "scientist," "notebook," and "sketchbook," served as another simple indicator of frame adoption. This word search method provided a quick way to identify words and therefore themes likely to have ample conversation around them for cross-condition comparison. For example, the difference in the presence/absence of the word "color" led to a search for every color word used (i.e., red, yellow, etc.) and to an interesting discovery around the word "brown" after noting a change in the pattern of prevalence by condition. This story is included in the results section below.

Conversational Level Analysis

Family conversations in the exhibition were also coded at the conversational level with sentence strings around the same theme coded as one instance of *learning talk* subdivided into exhibit comparisons, personal connections, and explanatory talk. We based our coding scheme on prior work on family conversations in museums (Leinhardt & Knutson, 2005; Palmquist & Crowley, 2007; Tison-Povis & Crowley, 2015) and further developed the codes iteratively through repeated familiarity with the data (listening to audio recordings, reading the transcripts,

and word level and theme level analysis that revealed patterns in the data). We defined *learning talk* as talk that makes connections between exhibit elements, connects exhibits to prior family experience, or constructs explanations. We counted each instance of *learning talk* thereby tallying the frequency with which each family made cross-exhibit connections between exhibit objects (e.g., "This book is in a different language than that one."), referenced personal connections including recalling the author's books (e.g., "That's Eric Carle when he was a young boy. He was probably five like you."), or constructed explanations including sharing prior knowledge ("They have eight legs like an octopus").

This final category "constructed explanations" or "explanatory talk," was further divided into science explanations, art explanations, and explanations of how something works. We acknowledge that science and art are not a dichotomy, there are certainly commonalities and overlap between these topics, but within this context it was relatively simple to distinguish science and art in ways that resonated with our data given the nature of the exhibition and ages of the children in our sample. Science talk included statements of what a scientist is or does, science techniques, and information or links to nature. Similarly, art talk included statements of what an artist is or does, art processes, and information about colors like color mixing. Still we maintained a general explanations category as well as a science/art combination category, so as not to force statements into a false dichotomy.

One researcher coded the entire dataset while a second researcher coded 25% of the data. Coders reliably identified 85% of learning talk across the data and resolved any differences in codes through discussion. Based on this agreement, coding categories were refined to more precisely designate sub-codes within the three main categories of exhibit comparisons, personal connections (including recalling the Eric Carle books), and explanatory talk (in the domains of

science, art, or other). All data were then coded at the sub code level, and an additional coder also coded 25% of the data to assess categorical coding reliability. The second coder reliably applied the codes, agreeing on 85% of occurrences for exhibit comparison, 90% of occurrences for personal connections, and 92% of occurrences for explanatory talk, which included 92% agreement for *art talk* and 100% agreement for *science talk.*

4.4 RESULTS

Here we present the results of our family learning intervention organized by our three primary research questions in order to determine if 1) the persona-linked costumes led to artist and scientist frame adoption, 2) how this frame adoption may have changed the attention and behavioral practices of families demarcated by the exhibit areas with which they chose to engage, and 3) if there was a difference in learning conversations across conditions that would suggest the intervention affected family learning talk and content. First however, it is important to note a few descriptive statistics. As shown in Table 4.1, child age and gender was fairly balanced across groups, though there were overall a few more girls in the study than boys. The after-visit survey completed by the parent in each dyad also revealed a fairly homogeneous sample with the majority of families identifying as college-educated (86% scientist condition, 86% artist condition, 90% control), Caucasian (86% scientist condition, 79% artist condition, 90% control), museum members (93% scientist condition, 79% artist condition, 90% control).

4.4.1 Frame Adoption: "I'm a scientist, I don't play around."

In both the scientist and artist conditions, ten families mentioned by name the frame to which they were assigned, either in a role-prompting way (e.g., "Alright, scientist; anything else we need to document?") or in a role-assumed way (e.g., "I'm an artist. I'm going to draw!"). The content around these role reinforcement comments provides insight into how families perceived the scientist and artist frame. Through their talk, families revealed their schemas related to scientists, stating that scientists observe, document, know a lot, figure things out, solve problems, think, wonder, experiment, make discoveries/find things, explore, go out in the field, go on safari, go on dangerous adventures, use walkie-talkies, note facts and important things, work together, and are brave, serious, and excited to be scientists. Similarly, their language revealed their conception of artists as people who draw, look at the objects they are drawing, paint, use other mediums, make masterpieces, sign their work, get messy, get tired, wear special outfits, are encouraged to express themselves, get ideas on adventures, see the world differently, and have an easy job.

The notebook/sketchbook supplied to the experimental costume conditions was also included in the exhibition experience to a similar extent by both groups. Eleven families in the scientist condition and 12 families in the artist condition used the book for documentation. The two conditions documented their experiences in the books at a similar rate, with 36 entries from the artist families and 26 physical entries plus an additional five, "I'm just going to pretend" entries discussed by the scientist families but not physically documented. All 36 of the artist entries were drawings, with the most popular objects of reproduction being the fruit and caterpillar (13 instances) from Eric Carle's *The Very Hungry Caterpillar*. Scientist entries took a

wider range of form with 16 word-only entries (e.g., “grass is small to us but not to bugs”), 6 drawing-only entries (e.g., Figure 4.2), and 4 with both drawings and words.

A: Look!
C: What? That’s what I discovered as a scientist!
A: Yes!
C: I’ll write that down. I’ll draw that down.
A: Okay! So what did you observe?
C: I observed that it goes the same thing that on the screen. Oh, I dropped my pen! I got my notebook. Now I’m gonna take out my notebook. How? How will I write it down Mom?
A: Well how do you think you can do it? What can you- what can you use to show what you saw?
C: This! How will I draw it down? How will I get it out though?
A: Get what out? I don’t think you’re supposed to take it all the way out. You’re supposed to just unzip it like that.
C: Oh.
A: Ah-ha!
C: Well… how does this look?
A: Very nice. I see the circles from there.
C: Mhm. {drawing} How does this look? Now I’m writing down that- starting to write down my experiment that I’m finding- that I find out. You know, this is fun!
A: I’m glad you like it.

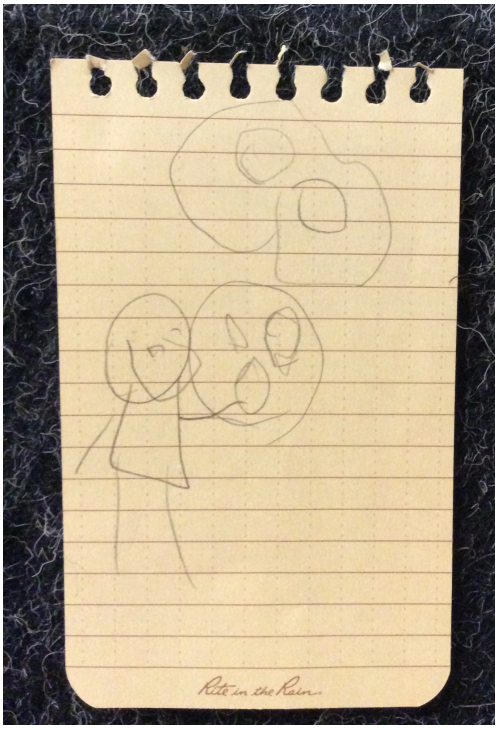

Figure 4.2: Notebook Artifact and Corresponding Transcript from Scientist Family 25

Additionally, open-ended responses from survey data asking parents “What do you feel your child learned in the Eric Carle exhibit today?” seems to reinforce the processing and encoding effects of framing. After coding these statements as science, art, or neither, we found a significant difference in response type by condition (χ^2 (6, N=38)=17.00, p<.01) with 64% of parents in each of the experimental conditions responding with statements in line with their framing condition. In other words scientist families responded with science-leaning learning statements (e.g., “He learned more about bugs.”) and artist families made art-leaning learning

statements (e.g., “We learned that his art is a collage and mistakes can be the best part.”). However, looking at the remaining 36% is informative. As Figure 4.3 below shows, those parents in the science condition who did not talk about science, generally made neutral statements (“Had fun!”), while those parents in the artist condition who did not talk about art, instead talked about science (“She learned more about the different insects she wasn’t familiar with.”). Note that statements could be coded in both the science and art learning categories (“Imagination, science and art“), which occurred two times in the artist condition.

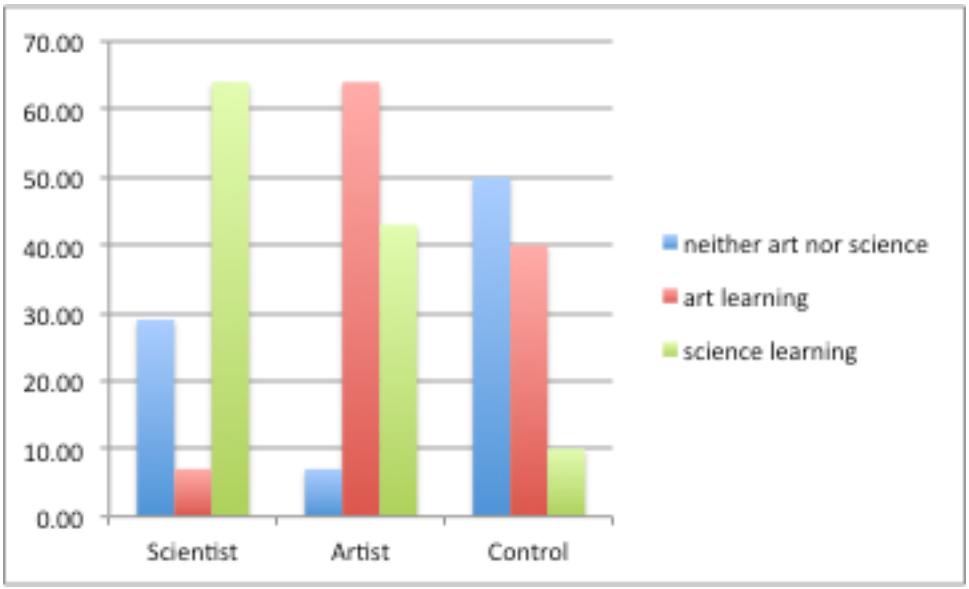

Figure 4.3: Responses to “What do you feel your child learned in the Eric Carle exhibit today?” Survey Question, Coded into Thematic Groups

In the absence of an assigned frame, just 10% of parents in the control group indicated their child learned science (“The life stages of a butterfly”), though 40% of parents indicated their child learned art (“New art techniques”). This leaves 50% of the responses as neither art nor

science leaning statements ("He had fun being in his favorite books." "Not sure, I felt that it was aimed at younger children and sensory.").

4.4.2 Attention and Behavioral Practice: "That's what it looks like when you're an artist."

Though artist families spent about 7 and a half more minutes (M = 29min, 50sec) in the exhibition than the scientist group (M = 22min, 21sec), who spent about a minute more than the control group (M = 21min 33sec) there was no significant difference across groups in overall exhibition time spent as revealed through an ANOVA. Which areas of the exhibition families attended to, as indicated by their verbal exchange and audio clues, was then analyzed through a series of Chi-squared tests. This analysis revealed a significant difference for only one of the 14 exhibit areas: the art studio. Given the nature of the physical space, both attending to the art studio area and engagement in an art project was noted in the data. A Chi-squared test tells us that families in the scientist condition both attended to (36%) (χ^2 (2, N=38)=5.89, $p<.05$) and engaged (14%) in art making in the art studio significantly less (χ^2 (2, N=38)= 9.81, $p<.01$) than the control (70% attended and engaged) and artist (79% attended, 64% engaged) groups. How the three groups allocated their time differed with scientists spending just 7% of their total exhibition time in the art studio while artists spent 23% of their time and the control spent about 30% of their time in the art studio (see Figure 4.1 for floor plan).

Next, we looked at time spent within the art studio only for those families who entered the studio. A one-way ANOVA verified that families in the artist condition (M=537s, SD=312s) and control condition (M=623s, SD=508s) spent more than twice as much time in the art studio than families in the scientist group (M=261s SD=181s). Though this difference is not significant,

$F(2, 22) = 1.53$, $p > .05$, art studio time nearly accounts for the difference in overall exhibition time spent between the artist and scientist groups.

Table 4.2: Time Spent Means, Standard Deviations, and Percentages In and Out of Art Studio

Condition	Total Exhibition Avg. Time (s)	Art Studio Avg. Time Spent (s)	Time spent in Studio (%)	Outside Studio Avg. time spent (s)	Time spent outside studio (%)
Scientist	1340.86 (601.54 SD)	93.286 (164.11 SD)	7.00 (12.99 SD)	1247.57 (619.12 SD)	93.00 (12.99 SD)
Artist	1789.86 (780.43 SD)	422.21 (356.90 SD)	23.21 (20.98 SD)	1367.64 (662.99 SD)	76.79 (20.98)
Control	1292.60 (821.88 SD)	436.40 (512.41 SD)	25.90 (20.09 SD)	856.20 (381.51 SD)	74.10 (20.09 SD)
Totals	1493.58 (747.26 SD)	304.76 (380.67 SD)	17.95 (19.62 SD)	1188.82 (606.49 SD)	82.05 (19.62 SD)

As Table 4.2 shows, this means that families in the two costume-conditions spent about the same amount of time at the non-studio exhibit areas and therefore had similar conversational opportunity in terms of time spent. The artist and control groups had similar conversational opportunity in terms of time spent in the art studio.

4.4.3 Conversational Content: "What are your observations, as a scientist?"

Given that our analysis to this point indicates that the families did adopt the suggested artist and scientist frames, and doing so may have affected their use of the exhibits, we now investigate family talk to see if there are cross-condition differences indicating that families extracted frame-aligned content.

Thematic Level

As mentioned in the Analysis section, we selected two topics–Eric Carle and the spider web–as thematic level case studies to compare conversation around two key features that stimulated varied conversational exchanges. As expected, the majority of families (71% scientist, 79% artist, 60% control) mention Eric Carle during their exhibition visit. However, the manner in which they reference him across the 60 instances of Eric Carle talk is markedly different. Of all nineteen Eric Carle comments made by scientist families, none mention his art process and only three acknowledge his being an artist (Table 4.3). This is in contrast to the twenty-one comments made in the artist condition about Eric Carle as an artist and his art process.

Table 4.3: Comparison table of statements referring to Eric Carle "artist" and "art process" with Adult (A) comments and Child (C) comments comprising the conversations

All Eric Carle "artist" and "art process" Scientist Condition Statements	Selected Eric Carle "artist" and "art process" Artist Condition Statements
A: Oh, there's – there's Eric Carle right there. C: There's him making the pictures A: Ahhhh! Wow. I didn't know he illustrated all of his books too.	A: And here they're showing him how he did his stuff with the paper. C: Um… A: Woah. C: Woah. A: Isn't that cool? He would use all these different pieces of cloth and stuff like that and cut them out and- C: Yeah. I'm gonna color one- a few of these different designs, but not all of them. A: Okay.
C: I'm watching the TV. It's an art show. A: You're watching the TV? There's an art show? That's Eric Carle. That's the man who made the Hungry, Hungry Caterpillar book and that's him working in his studio. C: On the Hungry, Hungry Caterpillar book? Look at it. He's hairy! At least on his face. A: He has a beard, huh?	A: See, there's Eric Carle on the TV screen, where he's painting. See? He's just painting away. You know what? Sometimes he makes mistakes and he makes them into trees! C: Done. Awesome, awesome, awesome. **…** A: Look! How he draws in one book and cuts it out and pastes it on another paper. That's how he gets all the different types of colors. It's kind of like a collage. See how he does that? So he cuts out from one painting that he did and puts it into another. Do you think you could do something like that when you get home? C: What? Yeah! A: Because Mommy needs a new painting. C: I'm gonna draw a tree. A: I didn't know he did that. So he doesn't paint the individual page. He paints other pages and then cuts them and pastes them into that page. That's kind of cool.
A: See, look at his painting outfit when he would paint the books.	A: You see that coat over there? C: What coat? A: That painted one. That was Eric Carle's coat when he was an artist when he was painting stuff. See how dirty it got? It's from all those paintings. Did you see his shoes? Go look at his shoes in there. They're all full of paint. Do you see them? Look it- he's on the video right there. See, he's an artist.

Other statements about Eric Carle as an author, as the subject of the exhibition, and about his life, are not as disparate across conditions. While twice as many artist families (57%) than scientist families (29%) commented on Eric Carle's personal artifacts on display, it is not the numeric difference that is impressive, but the conversational elaboration, or lack thereof that is noteworthy. For example, when viewing a picture of Eric Carle's colorful, worn, and paint-smeared artist coat, a scientist family remarked, "Would you like to see a picture of the author and what he wore when he wrote?" The fact that this family did not relate this object to art in any way contributes to the notion that non-art framing may have shifted their interpretation of the situation. This thematic case study around Eric Carle demonstrates a subtle way that art-focused content is highlighted by the artist condition and perhaps overlooked by the scientist condition.

All talk related to the spider web was also pulled out and then coded into talk about form (spiders build webs) and function (webs catch food for the spider to eat). Twice as many scientist families (57%) than artist families (29%) talked about the function of the web and only one artist family explicitly connected in conversation that spiders build webs. Not a single artist or control family talked about both the form and the function of the spider web while 30% of scientist families hit on both of these points. Three times across the data, the spider web weaving wall drew out personal connections. This personally connected learning talk happened to occur once in each of the three conditions and provides a glimpse into how framing may even be shaping the personal connections families draw into conversation (Table 4.4). Notice that the scientist family drew prior experiences within nature (seeing a web) into their conversation, while the artist family connected to an art making shared experience, and the control made a connection to literature.

Table 4.4: Comparison Table of Personal Statements Related to the Spider Web Weaving Wall in Adult (A) and Child (C) Conversation

Scientist Condition Connection to Nature	**Artist Condition** Connection to Art Making	**Control Condition** Connection to Literature
C: Let's make a web! Start spinning the web! What will our web be like? A: I don't know. What do you think a web should look like? C: I don't know. A: Hm… C: I never made a web before. A: No, but have you seen a web? C: Yep! A: Mhm. C: Lots of times actually!	A: This is cool because it's like a spider web but this is like the weaves Daddy makes on his bracelets. C: Cool A: Right?	A: You think Charlotte must have had a hard time spelling all the words? That would be tricky. It's hard- It's hard just to make a normal web. [12:06] C: From Charlotte's web? A: Mm-hmm.

Word Level

As could be expected from the role reinforcement analysis in the frame adoption section above, the prevalence of the words "artist" and "artistic" differed across conditions, with 79% of artist condition families compared to only 14% of scientist families saying the word "artistic" or "artist" at any point during their visit. Similarly, while 64% of families in the science condition said the word "scientist" or "scientific," none spoke these words in the art condition. To capture more art words we expanded the word search to include any art root words–"art," "arts," and "artwork"–which saw a decreased gap between conditions, but was still significantly different (χ^2 (2, N=38) = 10.04, p<.01), with 86% of artist families saying art root words and only 29% of scientist families and 40% of control families.

Though this could be an indication of the strength of frame adoption, in an exhibition about an illustrator with an art studio at its core, it still seemed unusual. In order to explore how far along this language trajectory such a discrepancy continued, we considered the age group in our sample and decided to check for the use of the word "color." We found that 43% of scientist

families said the word color which is significantly less than the artist (93%) and control families (90%); χ^2 (2, N=38) = 10.88, p<.01. Extending this, we went to the level of color names (red, yellow, pink, etc.) to see if this discrepancy persisted. Indeed, each color word appeared more in the artist condition than in the control group, with color words rarely appearing in the scientist condition. The only exception to this pattern was in the "brown" category, which saw more scientist families (65%) use the word than either control (50%) or artist (57%) families. Though not a drastic difference the break of pattern was noteworthy. Upon further analysis of the content of use, we found that science families were using the word *only* in reference to the book "Brown bear, brown bear" or in reference to the firefly interactive whose sign read, "Stand on the brown rug to attract a firefly." Artist families also used the word "brown" in this specific object-reference way, but they were the only group to use the word "brown" simply as a color descriptor. While seemingly trivial, "brown" was actually the impetus of a sustained four-minute exchange as Artist Family 6 worked to "make brown" through color mixing (Figure 4.4). The artifact of this work is displayed below as is the excerpt of this conversational exchange with between Adult (A) and Child (C).

Figure 4.4: Sketchbook Artifact from Artist Family 6 Showing Color Mixing Across Top of Page

C: Brown? [time stamp 22:30]
A: Um, there's no brown.
C: But how do you mix to make brown?
A: Well, you could do like a purple and-
C: I mean how do you make brown with mixing?
A: That's what I'm trying to say. Um, you might be able to do like a purple and- I don't know, you could try purple and maybe orange. I don't know. With these colors here, I'm not really sure.
C: Wait. We know purple is the first color.
A: Okay.
C: Purple is the first color.
A: Here, why don't you try this dark green then? Because that didn't really work. It worked a little bit.
C: Where's purple?
A: Here, I got purple here. Try purple and that green and see what you think.
C: Green
A: Hmmm, maybe add a little bit of yellow?
C: With the green?
A: Yeah, on that one.
C: and the purple.
A: Try a little bit of yellow.
C: Okay, I'll do it all separate. Purple. Green. Brown takes three colors to make it.
A: Yeah, it depends on what colors you have. I don't know, buddy. That's about as good as I can tell you.
C: I know what you can make brown a little bit.
A: What?
C: Orange and blue.
A: Oooh! Maybe that would work.
C: orange and blue
A: Yeah, that's- hey, that's pretty close, yeah! I think that that's the closest one. What do you think? Yeah?

(continued from column 1)

C: It makes black too. It's black-
A: Okay. Yeah, well that'd work. Alright, so orange and blue. Okay.
C: Wait, it is- do yellow.
A: Okay. What do you want?
C: Black. Is this black or dark green?
A: That's dark green.
C: It's- it's and…. A little bit of red.
A: Okay. Aw, yeah, I bet those would make a brownish. Here, watch that you don't throw those over there where someone can step on them.

C: Yellow.
A: Okay.
C: Green. Red.
A: Aw, look at that! It turned out more orange.
C: No! It turned out brown! Look!
A: Oh, there! Yeah.
C: Brown!
A: Okay. So-
C: What colors?
A: Red and green.
C: Red and green and what else color?
A: Well you used yellow in there and that's how you got the orangeish. But if you use red and green, it might just make your brown.
C: Let me see.
A: Okay.
C: Red. Green.
A: Still think you need that yellow? Here you go.
C: Now let's try yellow.
A: Yeah! If you get them all colored in there good, it does.
C: You still need yellow. Yellow, green, red.
A: Okay.
C: I'm just gonna make him- his boots blue.
A: Okay. [time stamp 26:30]

Though not always to the extent of the above example, color mixing was part of the exhibition experience for 57% of artist families, 30% control families, and only 7% of scientist families.

Conversational Level

Of the three components of *learning talk* we would expect no difference in the frequency at which families in the intervention conditions (M=1.29 SD=1.18) and control condition (M=1.10 SD=1.37) made connections between exhibit elements; $t(36)=-.41$, $p>.05$. Nor would we expect a difference in the frequency of making connections to prior family experience between the intervention conditions (MD=2.18 SD=2.04) and control condition (M=2.3 SD=1.63); $t(36)=.169$, $p>.05$. It is only in the subset of explanatory talk where we would expect to see effects of the framing intervention on talk since it is here that thematic content talk is accounted for. Given that families frequented the exhibit areas equally across conditions (apart from the art studio discussed above), explanations around exhibit use (e.g., how to use a projector) were expected to be similar as well; $t(36)=.408$, $p>.05$. Thus, we pull the exhibit explanations subset from our data for our analysis of content-extracted explanatory talk (talk that draws on science, art, or other explanatory learning talk). Here we see that there is indeed a significant difference in content explanatory talk comparing the framing intervention conditions

(scientist and artist: M=6.07 SD=6.45) to the control condition (M=2.40 SD=3.02); t(33)=-.2.37, p<.05. This indicates that families in costumes have more content explanatory talk than those in the baseline control group.

Looking then at just the two intervention conditions we see significant differences (t(13)=-3.09, p<.01) in explanatory art talk, with the artist group (M=4.5 SD=5.17) having over four times as many instances of explanatory art talk on average than the science group (M=.21 SD=.43). However, while the scientist group (M=4.21 SD=4.71) had, on average, two times as much science talk as the artist group (M=2.21 SD=2.11), this was not a significant difference partially due to high standard deviation; t(18)=1.45, p>.05. An ANOVA confirms that there are significant differences among the three conditions for both explanatory art talk ($F(2, 35) = 6.04$, $p < .01$) and explanatory science talk ($F(2, 35) = 3.21$, $p < .05$). The former stemming from the above mentioned artist and scientist contrast around art talk, and the latter explained by a Tukey post hoc test which revealed that the explanatory science talk difference lies in the comparison between the scientist condition (M=4.21 SD=4.71) and control condition (M=.90 SD=1.52); p<.05.

4.5 DISCUSSION: "THAT'S WHAT I DISCOVERED AS A SCIENTIST!"

In this study, we employed a simple costume assignment (scientist vest or artist coat) to examine if an exhibition-integrated intervention could affect families' interpretive frames and impact their subsequent behaviors and conversations. We found that families could adopt the suggested interpretive frame and that they seemed to notice, behave, and converse in frame-aligned ways ("That's what I discovered as a scientist!").

One indicator of frame adoption was the use of the term "scientist" or "artist" in role enactment statements ("I'm a scientist, I don't play around.") or role reinforcement statements ("As you go through the grass, think about that grass from your artist eye."), which occurred in 71% of both costume condition families. Not only did artist families speak about themselves as artists, but they identified Eric Carle (the popular children's books author featured in the exhibition) as an artist and discussed his art process. Though a similar number of scientist families (10 vs. 11 artist) spoke about Eric Carle, few mentioned him as an artist and none spoke of his art process in their conversations, which instead included content such as biographical information or literature connections. In fact, across their entire visit, artist families had about four times as much art talk as scientist families (who hardly mentioned art), who instead had about two times as much science talk as artist families. An example of this science talk difference can be heard in the thematic case study of "spider web" talk. Both the ecological form and function of a spider web are included in 30% of scientist family conversations, but not a single artist or control condition family talks about both the form and function of a spider web. In addition to word selection and conversational content differences, there were frame-aligned behavioral differences. Artist families self-selected to enter and engage with art making in the exhibition's central art studio significantly more than the scientist group. The behaviors of the control group (using the art studio for about the same amount of time as the control group and engaging in art talk) suggest that the Eric Carle exhibition was potentially perceived as an arts-linked experience more than a science experience. Therefore, seeing art talk suppressed in the scientist condition and a significant increase in science talk as compared to the control group is noteworthy. Interestingly, the artist group increased both their art talk and to a lesser extent their science talk. This interplay of art and science talk could speak to the integration of Arts into

STEM (science, technology, engineering, and math) education, if in fact, the promotion of art talk works in concert with an increase in science talk, but the promotion of science suppresses art talk.

The concept of framing suggests that providing an interpretive frame can shape how a situation is perceived, affecting how people think and act. This study shows that it is possible to relatively easily promote an interpretive frame to create functionally different learning experiences for families in museums. Costumes and perspective taking are a means to frame a situation and can serve as way to connect families with selected content or make an exhibit accessible to a particular audience. Imagine, for example, the behaviors that could transpire if families were invited to take a ballerina frame while exploring a sculpture gallery, or the conversations that might transpire if families were prompted to take the frame of an animal rights advocate at the zoo. The United States Holocaust Memorial Museum, for example, provides each visitor the passport of a Holocaust victim in an effort to personalize the experience. The findings of the present study would suggest that visitors then selectively pay attention to and learn more about the plight of particular groups of people who share characteristics of their passport person (e.g., country of origin, gender, etc.). A traveling exhibition about Jamestown (Minotaur Maze, 2016) prompts visitors to assume a historic era persona before engaging in a scenario about life in the 1600s. These two examples of perspective taking are more about coming to understand a history than drawing on a pre-existing frame. These nuances are important to explore when thinking through potential exhibit design interventions. Some exhibitions already include introductory elements like a video or docent talk that could serve to frame the exhibition experience for visitors. In fact, museums may implicitly or explicitly activate particular frames, so thoughtfully considering the framing of an experience may be useful to those interested in

supporting family learning in museums. Framing from a parent's perspective might offer some relief if they now feel like they can answer not only "what is going on here," but "what am I supposed to talk about here." From the museum's marketing perspective, framing might be a useful tool to invite repeatability or a second viewing since different framing could potentially offer a different museum experience.

There are limitations to the generalizability of this study in part due to the relatively homogenous sample of college-educated, Caucasian, museum-going families. Future studies should test framing with more diverse populations or focus on a particular contrast of interest (e.g. boys vs. girls). The strength of a frame could also be tested by more purposefully selecting participants with particular interest profiles or backgrounds to see if framing can shift the actions, behaviors, and conversations, of people who might carry with them an opposing frame. For example, in this study a few parents who self-reported having a science career were in the artist condition and vice versa, but the sample was not large enough to analyze this subset separately to see if they were able to adopt a conflicting frame in a similar manner to those who did not have a contrasting background to their condition assignment. Similarly, tracking the same families across multiple framing conditions could indicate the limits of the repeatability of using framing as a tool and explore what family characteristics might contribute to frame adoption.

In summary, we found that when parent-child pairs were prompted to adopt an interpretive frame they tended to extract frame-aligned conversational content, though the exhibition context remained the same. This suggests that framing could be a useful tool in designing for family learning in museums. In this particular case, framing provided a playful way to enhance science content in what was funded as a STEM-based exhibit housed in an arts-based

museum. We hope this study will prompt thinking about strategically integrating framing manipulations into exhibit design and programming to buttress family learning.

5.0 CONCLUSION: APPLYING THE CONCEPT OF TOGETHERNESS TO STRENGTHEN PARENT-CHILD LEARNING

Prior research has found that design interventions can impact family learning and how visitors engage with exhibits and with one another (e.g., Allen & Gutwill, 2009; Benjamin, Haden, & Wilkerson). Here I propose that the literature on family learning in museums can be understood through three underlying mechanisms–framing, joint attention, and conversation–and that manipulations to these mechanisms are promising avenues to increase family learning in museums. Furthermore, I offer the concept of "togetherness" as a way to think about designing for family learning in museums.

For over three decades, family learning in museums has been a topic of research. This research has described how families operate at exhibits, has tested various interventions, and has recently started to look more at the family as a social learning unit. Sociocultural theory makes it clear that social interaction is an important component of learning. Through exhibit design, we can intervene to manipulate these social interactions and therefore impact learning. Specifically, through a literature review, we found that interventions primarily work to foster family learning by leveraging framing, joint attention, or conversation (Tison-Povis & Crowley, under review). These three mechanisms, their definitions, underlying learning processes, findings from our research, and potential utility in practice are summarized in the table below.

Table 5.1: Mechanisms and Togetherness Terminology, Processes, Findings, and Utility

	Framing	Joint Attention	Conversation	Togetherness
Definition	Framing is the way people understand a situation-essentially the way a person might answer the question "What is going on here?"[1]	Joint Attention is a social-cognitive phenomenon in which people know they are attending to the same aspect of their shared environment.[2]	Also identified as parent-child joint talk, this talk with reciprocity often focuses on eliciting speech with *wh*-questions and encouraging parents to follow their child's conversational lead.[5]	Togetherness is the shared state where parent and child feel connected, are co-participating, are mutually invested, and are attuned to one another's actions and thoughts.
Learning Processes	Framing influences perception, noticing, behavior, processing, and recall.[3]	Joint Attention leads to deeper processing and increased conversational opportunity around a shared referent.[4]	Conversation influences learning during the activity and recall afterwards.[6]	Togetherness leverages framing, joint attention, conversation and their associated learning benefits.
Study Findings (In Research)	Simple costumes were used to promote frame adoption thereby shifting a family's mental space and affecting what they noticed, how they behaved, and the content of their conversations.	A flashlight was used to hone the visual space shared by parent and child thereby increasing joint attention and subsequent learning talk.	As in other research, here conversation is explored as a measurement tool/learning outcome rather than as a directly manipulated mechanism.	Togetherness is indicated by the degree to which parent and child are adopting aligned frames, are jointly attending to their shared environment, and are engaging in shared talk.
Utility (In Practice)	Framing interventions could be appealing to museums as they may add to the repeatability factor of the same exhibition area thereby promoting multiple visits.	Object-based museums, with many stimuli competing for attention, may be interested in using joint attention interventions to help visitors focus.	Museums might be interested in training their own docents and floor staff in these conversational strategies both to enrich the experiences they provide and role model for families.	Ideally, keeping this concept in mind could assist museums in designing for the family as a learning unit.

Table References: [1]Goffman, 1974; [2]Tomasello, 1995; [3] Hammer, Elby, Scherr, and Redish, 2005; [4] Frischen & Tipper, 2004; Kim & Mundy, 2012; Mundy & Newell, 2007; Striano, Reid, & Hoehl, 2006; [5] Benjamin, Haden, & Wilkerson, 2010; Eberbach & Crowley, 2016; [6]e.g.,Vygotsky, 1962, 1978.

Through a pair of design interventions studies we explored how manipulating two of these mechanisms (joint attention and framing) could affect parent-child learning in museums. The first study (Tison-Povis & Crowley, 2015), focused on how a flashlight can be used to hone the visual field and encourage families to establish joint attention, in turn increasing learning talk about ecological content. The second study (Tison-Povis & Crowley, in process), explored interpretative framing through a costume-based intervention. We found that families could make the mental shift to a scientist or artist frame and in doing so extracted themed-based content from the exhibit. These studies show that joint attention, framing, and conversation can be manipulated through simple, low-tech tools that integrate into museum exhibit experiences. The simplicity of these interventions, I hope, speaks to practice and utility–not that every exhibit should be explored by flashlight or clad in a costume.

The utility of any of these interventions may be thought of from three angles 1) What use is this to the family? How will they value it? Does it add to their experience? 2) What use is this to the museum? Does the intervention invite repeatability, thereby inviting another visit? 3) What use is this to research? Can this intervention contribute more to our body of knowledge? For example, the flashlight joint attention area was so popular with kids and families that it was left up past its experimental date as an exhibit. This study was useful to the museum because it gave a second-life to previously non-functional exhibit pieces. So while families were having fun and the museum saw repeat visitors, research demonstrated the learning potential of this newly designed space through its support of joint attention. Such intervention studies also speak to the shared nature of learning between parent and child and how manipulating these three primary mechanisms–framing, joint attention, and conversation–can bring families together, in their understanding of a situation, around the same visual aspects, and to talk with one another.

A few researchers have called for a focus on this proposed concept we term togetherness. In her 2010 review of science learning research in museums, Haden called for research exploring the joint aspect of conversation since an accumulation of prior research had indicated the importance of "joint verbal exchange" or "joint talk" (Benjamin, Haden, & Wilkerson 2010; Haden, Ornstein, Eckerman, & Didow 2001; Hedrick, San Souci, Haden, & Ornstein 2009; Ornstein, et. al. 2004). We join this call and believe that both research and practice focused on family learning can benefit from designing for and coming to understand togetherness across the three mechanisms discussed here—framing, joint attention, and conversation.

The three mechanisms comprising togetherness are theoretically distinct—each part of a different body of research and anchored to different learning processes, as reviewed above in Chapter 2 (Tison-Povis & Crowley, under review)—but are empirically and conceptually correlated. To what extent and in what fashion these mechanisms affect one another has yet to be fully explored. For example, joint attention has been found to mediate learning talk (Tison-Povis & Crowley, 2015). We could propose various models conjecturing how the mechanisms are more or less related. Could framing, attention, and conversation be visualized as distinct mountain peaks that families can ascend to a cloud state of togetherness? Are the three mechanisms more like the game paper-rock-scissors, in which there is a set of rules dictating when one prevails? We hypothesize that the relationship is much more complicated. Perhaps one mechanism is a catalyst for another or movement along one spectrum might have a magnetic effect upon the other spectra. For example, if we can maximize framing, do joint attention, and conversation/ learning talk naturally follow? Yet another fitting analogy might be that of nested Russian dolls with these mechanisms embedded in one another and accessed in a particular order. For example, an argument could be made that conversation interventions are a subset of

joint attention and that conversational strategies such as using wh- questions serve to focus attention on ideas present in the shared parent-child conversation. There might also be a threshold or tipping point to consider, and of course, there may be other items altogether, which we should consider including in this logic. At this nascent stage, rather than proposing a single model, it might be more useful to focus on the bigger notion of togetherness. Focusing explicitly on togetherness—the critical, joint nature of family learning—might serve as a useful outlook for both those in research and practice.

There is still a lot to learn about these three intervention mechanisms and how to support families. We can start by considering togetherness as we create learning environments by asking what affordances are present to enable families to look, talk, and think *together*. In doing so, we must remember that families are unique and come to the museum with various abilities and routines. If the goal is to strengthen family learning, we need to be cautious to avoid pushing uniformity and instead provide varied supports. This approach acknowledges that there is likely not just one way of achieving togetherness. While some families may reach a state of togetherness and join in imaginary play through a simple framing suggestion, it may be more comfortable for other families to use direct label prompts to reach togetherness through conversational routines. Families need autonomy, so interventions ideally provide suggestions or are integrated into exhibit design in order to buttress the ways family engage with one another. I am confident that designing for togetherness can strengthen family learning and even foster positive social change.

APPENDIX A

EXHIBIT INTRODUCTORY SCRIPTS

Science Condition

You are about to enter an exhibit based on the work of Eric Carle. You might recognize some of the characters from his books. The characters are **bugs and other critters** because, **like a scientist,** Eric Carle loves **exploring nature**.

Today, you get to act like a **scientist** and wear this special **field vest** just like many **scientists** do when they are working! If you reach inside your **vest** pocket you will find a **field-book**. This **field-book** is for you to document what you see the way a **scientist** does.

Are you ready to step in and explore the exhibit acting like a **scientist**?

Art Condition

You are about to enter an exhibit based on the work of Eric Carle. You might recognize some of the characters from his books. The characters are **made in a unique style** because Eric Carle loves **creating this art.**

Today, you get to act like an **artist** and wear this special **art coat** just like many **artists** do when they are working! If you reach inside your **coat** pocket you will find a **sketchbook**. This **sketchbook** is for you to document what you see the way an **artist** does.

Are you ready to step in and explore the exhibit acting like an **artist**?

Control Condition

You are about to enter an exhibit based on the work of Eric Carle. You might recognize some of the characters from his books.

Are you ready to step in and explore the exhibit?

APPENDIX B

POST-EXHIBIT PARENT SURVEY

The last part of the study is to complete this survey, which should take less than 5 minutes. Please let me know if you have any questions. Thank you for your thoughts and time!

Please indicate how interested YOUR CHILD is in each topic:

	not at all	slightly interested	fairly interested	highly interested
Art	❍	❍	❍	❍
Crafts	❍	❍	❍	❍
Dress-Up/Acting	❍	❍	❍	❍
Reading/Books	❍	❍	❍	❍
Science	❍	❍	❍	❍
Nature	❍	❍	❍	❍
Bugs	❍	❍	❍	❍
Physical Play	❍	❍	❍	❍

Please indicate how interested YOU are in each topic:

	not at all	slightly interested	fairly interested	highly interested
Art	❍	❍	❍	❍
Crafts	❍	❍	❍	❍
Acting	❍	❍	❍	❍
Reading	❍	❍	❍	❍
Science	❍	❍	❍	❍
Nature	❍	❍	❍	❍
Bugs	❍	❍	❍	❍
Physical Play	❍	❍	❍	❍

Why did you come to the museum today? (Select all that apply)

- ❑ It's an educational opportunity for our family
- ❑ To spend time together
- ❑ For fun
- ❑ To see a specific exhibit
- ❑ There was bad weather today
- ❑ We had a free pass
- ❑ We wanted to take out of town visitors here
- ❑ Other, please explain _____

How familiar are you with The Children's Museum of Pittsburgh?

- ❑ This is my first time visiting the museum.
- ❑ I've come before, but this is my first time in the Eric Carle exhibit.
- ❑ I've been to the museum AND the Eric Carle exhibit before.
- ❑ I'm a member of the museum.

As a family, we typically visit museums:

- ❍ 0 to 1 times a year
- ❍ 2 to 4 times a year
- ❍ 5 or more times a year

What is your family's favorite type of museum? (Select one)

- ❍ Art
- ❍ Natural History
- ❍ Botanic Garden
- ❍ Children's Museum
- ❍ Science Museum/Center
- ❍ Zoo
- ❍ History Museum
- ❍ Historic Sites
- ❍ Nature Center
- ❍ Aquarium
- ❍ Other, please specify _____

Where on this spectrum would you place the Eric Carle exhibit?

- ❍ Art-Focused
- ❍
- ❍
- ❍
- ❍ Science-Focused

How do you feel participating in this research study affected your family's use of the exhibit?

What do you feel your child learned in the Eric Carle exhibit today?

What is your child's birthdate? (MM/DD/YEAR)

What is your child's gender?

What is your age?

What is your gender?

How do you racially identify? Please choose all that apply.

- ❑ Black/African American
- ❑ White/Caucasian
- ❑ Latino/Hispanic
- ❑ Asian
- ❑ Indian Subcontinent
- ❑ Native American
- ❑ Other _____

What is the highest level of schooling you have completed?

- ❍ High School
- ❍ Some College
- ❍ Undergraduate
- ❍ Graduate Degree

Please indicate which statements are true for your science education. (Select all that apply)

- ❑ I took science classes in high school
- ❑ I took sciences classes in college
- ❑ I majored/minored in science in college
- ❑ My job involves science
- ❑ I am a scientist
- ❑ None of the above

Please indicate which statements are true for your art education. (Select all that apply)

- ❑ I took art classes in high school
- ❑ I took art classes in college
- ❑ I majored/minored in art in college
- ❑ My job involves art
- ❑ I am an artist
- ❑ None of the above

Thank you for your thoughts and time! We hope to see you at The Children's Museum again soon. If you have any additional comments, we welcome your suggestions.

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