Family Learning in Object-Based Museums: The Role of Joint Attention

Kaleen Tison Povis and Kevin Crowley

University of Pittsburgh, Pennsylvania, USA

About the Authors

Kaleen Tison Povis is a doctoral student at the University of Pittsburgh. Her research and evaluation focuses on designing exhibits and programs that foster opportunities for intergenerational learning. She is especially interested in messaging and facilitation strategies to scaffold learning. Address correspondence to: Kaleen Tison Povis, Learning Research and Development Center UPCLOSE Lab, University of Pittsburgh, 3939 O'Hara St, Pittsburgh, PA 15213. E-mail: kaleent@gmail.com.

Kevin Crowley is a professor of Learning Sciences and Policy at the University of Pittsburgh, where he also directs the University of Pittsburgh Center for Learning in Out-of-School Environments (UPCLOSE). He works in partnership with museums, community organizations, and other informal educators to develop innovative learning environments. Crowley's group conducts learning sciences research in informal settings and develops new theories of how people learn about science, technology, engineering, and art.

Acknowledgements

Thank you to our colleagues and research partners, especially the Carnegie Museum of Natural History, Mary Ann Steiner, Zahid Kisa, and all of the families who so willingly shared their time with us.

Citation: Tison Povis, K. & Crowley, K. (in press). Family learning in object-based museums:

The role of joint attention. *Visitor Studies*.

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.

Keywords: joint attention, family learning, natural history

Family Learning in Object-Based Museums: The Role of Joint Attention

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 lead 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?

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 1).

***Table 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 data set 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.

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.

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), $F(1, 50) = 7.59$, $p < .01$: a significant difference, as revealed by a two-way (self-illuminated vs. fully-illuminated) ANOVA.[1] 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 s 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

---

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

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 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 2*. Means (and Standard Deviations) for time spent, objects noticed, joint attention, and learning talk across conditions*

Lighting and Sign Type	Time (sec)	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)

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 suggest 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). 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

Summary of linear stepwise regression analysis for variables predicting Joint Attention

Variable	*B*	*SEB*	*β*
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 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 that 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 4

Summary of linear stepwise regression analysis for variables predicting Learning Talk

Variable	*B*	*SEB*	β
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.*

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. *(Learning Talk behavior)*
And then he grabs his face and then he--

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 *(JA for claws)* so he's dead and then eat him! *(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.

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 to be 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 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.

References

Allen, S. (2002). Looking for learning in visitor talk. In G. Leinhardt, K. Crowley, & K. Knutson (Eds.), *Learning conversations in museums* (pp. 259-304). Mahwah, NJ: Erlbaum.

Allen, S. (2004). Designs for learning: Studying science museum exhibits that do more than entertain. *Science Education 88* Supplement 1 (July), S17-S33. Retrieved from http://www.exploratorium.edu/partner/pdf/Allen_51web.pdf

Ash, D. (1995). *From functional reasoning to an adaptationist stance: Children's transition toward deep biology* (Unpublished doctoral dissertation). University of California, Berkeley.

Ash, D. (2002). Negotiation of biological thematic conversations in informal learning settings. In G. Leinhardt, K. Crowley, & K. Knutson (Eds.), *Learning conversations in museums* (pp. 357-400). Mahwah, NJ: Erlbaum.

Ash, D. (2003). Dialogic inquiry in life science conversations of family groups in a museum. *Journal of Research in Science Teaching*, *40*(2), 138-162.

Ash, D. (2004). How families use questions at dioramas: Ideas for exhibit design. *Curator*, *47*(1), 84-99.

Atkins, L. J., Velez, L., Goudy, D., & Dunbar, K. N. (2009). The unintended effects of interactive objects and labels in the science museum. *Science Education, 93*(1), 161-184.

Bangerter, A. (2004). Using pointing and describing to achieve joint focus of attention in dialogue. *Psychological Science, 15*(6), 415-419.

Benjamin, N., Haden, C.A., & Wilkerson, E. (2010). Enhancing building conversations, and learning through caregiver-child interactions in a children's museum. *Developmental Psychology, 46*(2), 505-515.

Bitgood, S. (2000). The role of attention in designing effective interpretive labels. *Journal of Interpretation Research, 5*(2), 31-45.

Borun, M., Cleghorn, A., & Garfield, C. (1995). Family learning in museums: A bibliographic review. *Curator, 38*(4), 262-270.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn: Brain, mind, experience, and school: Expanded edition.* Washington, DC: National Academy Press. Retrieved from http://www.nap.edu/openbook.php?isbn=0309070368

Carey, S. (1985). *Conceptual change in childhood*. Cambridge, MA: MIT Press.

Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development, 63*(4), 1-174.

Crowley, K., Callanan, M.A., Jipson, J., Galco, J., Topping, K., & Shrager, J. (2001). Shared scientific thinking in everyday parent-child activity. *Science Education, 85*(6), 712 - 732.

Dierking, L. D. (1989). The family museum experience: Implications from research*. Journal of Museum Education, 14*(2), *9-11.*

Eberbach, C., & Crowley, K. (2009). From everyday to scientific: How children learn to observe the biologist's world. *Review of Educational Research, 79*(1), 39-68.

Eberbach, C.E., & Crowley, K. (in press). From seeing to observing: How parents and children learn to see science in a botanical garden. *Journal of the Learning Sciences*.

Falk, J. H., & Dierking. L.D. (2000). *Learning from museums: Visitor experiences and the making of meaning*. Walnut Creek, CA: AltaMira Press.

Fender, J.G., & Crowley, K. (2007). How parent explanation changes what children learn from everyday scientific thinking. *Journal of Applied Developmental Psychology, 28. 189-210.*

Ford, D. (2005). The challenges of observing geologically: Third graders' descriptions of rock and mineral properties. *Science Education, 89*(2), 276-295.

Frischen A., & Tipper, S. (2004). Orienting attention via observed shift evokes longer term inhibitory effects: Implications for social interactions, attention, and memory*. Journal of Experimental Psychology: General, 133*(4)*,* 516–533.

Gopnik, A. (1996). The scientist as child. *Philosophy of Science, 63*(4)*,* 485–514.

Halliday, M.A.K. (1993). Towards a language-based theory of learning. *Linguistics and Education, 5*(2), 93–116.

Hmelo-Silver, C. E., & Pfeffer, M. G. (2004). Comparing expert and novice understanding of a complex system from the perspective of structures, behaviors, and functions. *Cognitive Science, 28*(1)*,* 127–138.

Hohenstein, J. (2006). Discussing the role of conversation in learning at informal science institutions. San Francisco, CA: The Center for Informal Learning and Schools. Retrieved from http://cils.exploratorium.edu/cils/resource.php?resourceID=1278

Hohenstein, J., & Tran, L. (2007). The use of questions in exhibit labels to generate explanatory conversation among science museum visitors. *International Journal of Science Education, 29*(12), 1557-1580.

Kidwell, M., & Zimmerman, D.H. (2007). Joint attention as action, *Journal of Pragmatics, 39*(3), 592-611.

Kim, K., & Mundy, P. (2012). Joint attention, social-cognition, and recognition memory in adults. *Frontiers in Human Neuroscience*, *6*, 1-11.

Kim, K.Y., & Crowley, K. (2010). Negotiating the goal of museum inquiry: How families engineer and experiment. In M.K. Stein & L. Kucan (Eds), *Instructional explanations in the disciplines (pp. 51-65)*. New York, NY: Springer.

Knutson, K., & Crowley, K. (2010). Connecting with art: How families talk about art in a museum setting. In M.K. Stein & L. Kucan (Eds), *Instructional explanations in the disciplines* (pp. 189-206). New York, NY: Springer.

Kita, S. (Ed.). (2003). *Pointing: Where language, culture, and cognition meet*. Mahwah, NJ: Erlbaum.

Klahr, D. (2000). *Exploring science: The cognition and development of discovery processes.* Cambridge, MA: MIT Press.

Leinhardt, G., Crowely, K., & Knutson, K. (Eds.). (2002). *Learning conversations in museums*. Mahwah, NJ: Erlbaum.

Leinhardt, G., & Knutson, K. (Eds.). (2004). *Listening in on museum conversations*. Walnut Creek, CA: AltaMira Press.

Marandino, M., & Oliveira, A. (2009). Discussing biodiversity in dioramas: A powerful tool to museum education. *ICOM Newsletter, 29 pp. 30-36.*

Marin, A. (2013). *Learning to attend and observe: Parent-child meaning making in the natural world* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses. (AAT 3605744)

Medin, D., & Ortony, A. (1989). Comments on part I: Psychological essentialism. In S. Vosniadou & A. Ortony (Eds.), *Similarity and analogical reasoning* (pp. 89–103). Cambridge, MA: Cambridge University Press.

Melber, L. M. (2007). Maternal scaffolding in two museum exhibition halls. *Curator, 50*(3), 341-354.

Mifsud, E. (2009). Dioramas – an untapped educational resource. *ICOM Newsletter, 29 pp. 5-6*.

Moore, C., & Dunham, P.J. (1995). *Joint attention: Its origins and role in development*. Hillsdale, NJ: Erlbaum.

Morris, P. (2009). A window on the world- wildlife dioramas. *ICOM Newsletter, 29, 27-30.*

Mundy, P., & Newell, L. (2007). Attention, joint attention and social cognition. *Current Directions in Psychological Science, 16*(5), 269-274.

Mundy P., Sullivan L., & Mastergeorge A. (2009). A parallel and distributed processing model of joint attention and autism. *Autism Research, 2,* 2–21.

Norris, S. P. (1984). Defining observational competence. *Science Education, 68*(2), 129- 142.

Palmquist, S., & Crowley, K. (2007). From teachers to testers: How parents talk to novice and expert children in a natural history museum. *Science Education, 91*(5), 783-804.

Rennie, L.J., & McClafferty, T. (2002). Objects and learning: Understanding young children's interaction with science exhibits. In S. Paris (Ed.), *Perspectives on object centered learning in museums* (pp. 37–54). Mahwah, NJ: Erlbaum.

Richardson, D., Dale, R., & Krikham, N. (2007). The Art of conversation is coordination: Common ground and the coupling of eye movements during dialogue. *Psychological Science, 18*(5), 407-413.

Sawyer, R.K. (2006). Analyzing collaborative discourse. In R.K. Sawyer (Ed.), *Cambridge Handbook of the Learning Sciences* (pp.187-204). New York, NY: Cambridge University Press.

Siegel, D., Esterly, J., Callanan, M.A., & Wright, R. (2007). Conversations about science across activities in Mexican-descent families. *International Journal of Science Education, 29*(12), 1447 - 1466*.*

Striano, T., Chen, X., Cleveland, A., & Bradshaw, S. (2006). Joint attention social cues influence infant learning. *European Journal of Developmental Psychology, 3*(3), 289 - 299.

Striano, T., Reid V., & Hoehl, S., (2006). Neural mechanisms of joint attention in infancy. *European Journal of Neuroscience, 23*(10), 2819 - 2823.

Takeuchi, L., & Stevens, R. (2011). The new coviewing: Designing for learning through joint media engagement. New York, NY: The Joan Ganz Cooney Center at Sesame Workshop.

Tessler, M., & Nelson, K. (1994). Making memories: The influence of joint encoding on later recall by young children. *Consciousness and Cognition, 3*(3-4), 307-326.

Tinworth, K. (2009). Enactor program: Diorama study. Denver, CO: Denver Museum of Nature and Science. Retrieved from InformalScience.org. http://informalscience.org/evaluation/ic-000-000003-317/Enactor_Program_Diorama_Study

Tomasello, M. (1995). Joint attention as social cognition. In C. Moore & P.J. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp. 103-130). Hillsdale, NJ: Erlbaum.

Tomasello, M., & Carpenter, M. (2007). Shared intentionality. *Developmental Science, 10*(1), 121 – 125.

Tomkins, S.P., & Tunnicliffe, S.D. (2001). Looking for ideas: Observation, interpretation and hypothesis-making by 12-year-old pupils undertaking science investigations *International Journal of Science Education, 23*(8), 791-813.

Tomkins, S. P., & Tunnicliffe, S. D. (2006). Bring back the Nature Table! *Environmental Education, 82*, 8-11.

Tunnicliffe, S.D. (2009). Inquiry at natural history dioramas – useful resource in science education. *ICOM Newsletter, 29, 16-20*

Tunnicliffe, S.D., & Reiss, M.J. (2000). What sense do children make of three dimensional life-sized "representations" of animals? *School Science and Mathematics, 100*(3), 128 - 138.