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**“This is a learning opportunity”: How parent-child interactions and exhibit design foster the museum learning of prior-to-school aged children.**

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**Abstract**

Recent research indicates that museums hold great potential for children’s engagement and learning. To date, most research has either focused on school-aged children or young children’s independent learning engagement and, as a result, little has investigated how museum spaces may foster and enhance the interactive learning of families with prior-to-school-age children. The current study sought to investigate which features of museum spaces might promote rich learning conversations within such families when visiting three metropolitan museums. Applying an interpretivist lens on video data generated from child and parent videos, and analyzing post-visit interview data, this study found shared attention, questioning, technical vocabulary and cognitive connections featured in the learning conversations in such spaces. Further, intricate detail, different perspectives, interactivity and multi-modality were significant exhibit design features that appeared to promote such learning conversations. Implications for exhibit design are discussed in relation to the undergirding concept of *sustained shared thinking*.

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## Introduction

Contemporary approaches to early childhood education widely recognize that social interaction is a core component of effective learning experiences for prior-to-school aged children. Stemming from the theoretical writings of Lev Vygotsky, it is through social interactions that knowledge is communicated between individuals, and is therefore open to reflection, negotiation and change. Interactions thus permit the social construction of knowledge:

Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological)" (Vygotsky, 1978, p. 57).

From this perspective, learning is collaborative, as "what the child is able to do in collaboration today [s]he will be able to do independently tomorrow" (Vygotsky, 1987, p. 211). This approach proposes a dynamic view on learning, which does not focus solely on the product of learning (i.e. the demonstrated change in thinking or knowledge) but instead, on the *processes* by which children and others construct learning together.

To examine learning interactions between prior-to-school aged children and their families, the current study utilized the educational construct of *sustained shared thinking*. This concept, originating from a large study of effective early childhood learning and teaching methods in the United Kingdom, is defined as occurring "when two or more individuals 'work together' in an intellectual way to solve a problem, clarify a concept, evaluate an activity, extend a narrative etc. Both parties must contribute to the thinking and it must develop and extend the understanding" (Sylva, Melhuish, Sammons, Siraj-Blatchford, & Taggart, 2004, p. 5). It includes conversational features including opportunities to summarize, reflect, suggest, wonder, and to remember, recount and elaborate on ideas. Sustained shared thinking is therefore collaborative and bi-directional

–constituting a ‘meeting of minds’ where both parties interact and learn together through the introduction and reciprocal extension of ideas and knowledge.

Sustained shared thinking evolved from a detailed qualitative analysis of educator-child interactions that best predicted long-term child outcomes (Sylva et al., 2004). It is ideally suited as a framework for the examination of effective interactive learning processes of very young children in early childhood center contexts. Yet museum learning spaces are defined and delineated differently (Hackett et al., 2018). They are dynamic spaces, providing opportunities for movement and exploration as young children and their families engage with the physical exhibition space as well its content (MacRae Hackett, Holmes & Jones, 2018). Furthermore, parents and teachers vary in their expectations and motivations, and this variation will be reflected in the ways that they relate to the young children in their care (Author 1 et al, 2013). We therefore cannot necessarily expect that the learning interactions of families in museum contexts will demonstrate the same interactive and intellectual features as those associated with sustained shared thinking in early childhood classrooms.

### ***Young Children’s Learning Engagement in Museums***

Families are substantially represented in museums visitor profiles (Anderson, Piscitelli, Weier, Everett & Tayler, 2002; Kelly, 2011), but there is currently little research on the nature of learning-rich interactions between adults and very young children in museum contexts. As prior-to-school aged children predominantly visit museums with their families, the question of how these interactions promote learning warrants investigation.

To date, much of the research on children’s museum learning has focused on school-aged children (see Andre, Durksen & Volman, 2017 for a review). However, a growing body of work recognizes that museums can proactively encourage families of very young children to visit by providing family-oriented facilities and exhibits which

appeal to both young children and adults (Enseki, 2007; Mayfield, 2005; Piscitelli & Anderson, 2001). Museums have the potential to provide a unique environment to facilitate young children's learning through immersive exhibitions, dioramas and artefacts, and can facilitate learning about specific disciplines, such as biology and history (Geerdts, Van de Walle, & LoBue, 2015; Munley, 2012). Interactive exhibits allowing children to respond using their senses and bodies support exploration and self-directed inquiry (Lee, 2011).

Many studies identify play as a learning medium on the assumption that young children learn best when experiences are fun and provide opportunities to engage in imaginative scenarios and hands-on, active learning (Dockett, Main, & Kelly, 2011; Downey, Kranz & Skidmore, 2001; McInnes & Elpidoforou, 2018; Puchner, Rapoport & Gaskins, 2001). Museum spaces for young children are often designed to appeal directly to their innate motivation to play through the provision of child-centered materials that encourage pretense and physical manipulation (Leinhardt, Crowley, & Knutson, 2003; McInnes & Elpidoforou, 2018). However, by catering directly to young children's play-based learning style, museums may constrain parents' involvement in their children's learning experiences (Birch, 2018; Dockett, et al., 2011; Wolf & Wood, 2012). Sanford (2010) recognizes the challenge of appealing to both young children and adults, stating that "an activity that is popular with children may be seen as a nuisance for adults" (p.68). This mismatch between adults' and children's agendas may be further exacerbated by community attitudes towards play, which may associate children's play with entertainment rather than learning (McInnes & Elpidoforou, 2018). Children may then engage in a process of individual learning as they develop new ideas or work through problems by themselves, rather than in collaboration with family members (Munley, 2012; Wood & Wolf, 2012).

### ***The Significance of Conversation***

An increasing number of studies promote a social-interactive theoretical approach to understanding children's learning and identify conversations between young children and adults as a core learning feature. Research has illustrated that, when children converse with an adult, their engagement with museum exhibits is longer and their learning is deeper (Puchner, et al, 2001). While family conversations often meet social-emotional or instrumental needs (Halliday, 1978), *learning conversations* may be particularly relevant to museum contexts (Allen, 2002; Shaby, Ben-Zvi Assaraf & Tal, 2019), helping children make sense of objects or events in their environment by introducing new concepts and prompting the refinement of conceptual understandings (Sanford, 2010). Features of learning conversations include the presence of descriptive terms which label objects and their features, analytical talk which fosters problem solving, synthesizing talk which makes connections between exhibit features and children's existing knowledge, and explanatory talk which provides explanations about features of particular phenomena (Weier, 2004). Haden and colleagues (2014) also identify questions as significant features of learning conversations, contending that 'wh' questions (what, where, who) can be used to establish what children know, while open-ended questions (why, how) can motivate sustained engagement.

### ***The Significance of Design***

When exhibits are designed with collaborative participation in mind, young children and caregivers can engage in conversations that heighten their learning engagement (Kelly, 2011). However, both adults and their children need to be attracted to engage with the same exhibit content (Povis & Crowley, 2015; Sanford, 2010), so exhibits need to be designed with wide appeal so as to attract and hold the attention of both children and adult (Sanford, 2010). Borun and colleagues (1997) argue that family-

interactive exhibit spaces need to be designed so that they have ‘attracting’, ‘holding’ and ‘information-communicating’ power (p.179), and identify physical accessibility, space to accommodate multiple hands or bodies, the presence of readable text and multi-modal content as effective design features. While their evaluation of the modification of four exhibition spaces suggested that the presence of these design features did somewhat increase family participation, the study fell short in clearly explaining whether these features enhanced learning conversations or just joint participation. Borun et al. (1997) also focused on the learning of families with children aged five to ten and emphasized the addition of text-rich activity books and inquiry stations. Due to the different learning styles and literacy capabilities of younger children, it cannot be assumed that the same design features will also support social-interactive learning of prior-to-school aged children and their families.

### ***The present study***

This study investigated the social-interactive learning of prior-to-school aged children and their parents in three Australian museums. It employed a qualitative, multiple case study approach to analyze the features of episodes of sustained shared thinking. The study aimed to deepen current understandings of the nature of social-interactive learning of prior-to-school aged children in museum spaces and to investigate how the design features of exhibit spaces appeared to elicit learning-rich interactions. The following questions were addressed:

- (1) What are the intellectual characteristics of sustained shared thinking between prior-to-school age children, their families and peers in museum spaces?
- (2) What design features were associated with episodes of sustained shared thinking?

## **Methods**

### ***Participants***

The three participating museums were located in blinded city1 and city2, each with a different exhibit focus. One museum had an applied arts and science focus, one had a maritime focus and the third museum focused on cultural and natural history. These museums had entered into a collaborative research partnership with the research team to investigate the engagement and learning of families with prior-to-school aged children who visited their museums.

Six family groups, comprising one adult family member and at least one prior-to-school aged children (age range 2.25 – 5.00 years,  $M=3.51$ ) were recruited from each museum site, resulting in participation of 18 family groups. Some families were regular visitors to that museum, while others had never visited that museum before. Invitations to participate were sent to families with prior-to-school aged children on each museum's member database as well as to local early childhood centers.

### ***Data generation***

This study employed a multi-method approach, comprising the analysis of naturalistic observational data which was triangulated with parent-interview data. Each family group visited their museum once and traversed two exhibits. The exhibit selection was made by each museum, either based on its potential to engage young children and their families or because the museum saw the potential to make the space more engaging. Families could spend as long as they liked in each space and look at whatever interested them.

Family engagement was videoed using chest-mounted GoPro™ cameras on each parent and child in the designated exhibition spaces. Researchers held a GoPro™ at an inconspicuous distance to capture further contextual detail of the engagement.

Parent interviews were conducted approximately one week after their visit. These interviews investigated their perspectives about their family's museum engagement and learning, including any child recollections which extended beyond the visit, as "unexpected connections" are often formed often long after visits (MacRae, et al., 2018, p. 503). Video-stimulus methodology, in which three video extracts of sustained family interactions with their child, was used to prompt parents' responses. Parents were asked to watch each extract and then explain their own and their child's behaviors, intentions and learning.

Ethical approval for the study was gained through the (Blinded) University Human Research Ethics committee. Parents provided written participation consent. Children were informed verbally, "We want to learn about your visit to the museum," and were shown and allowed to play briefly with the video equipment before the observations commenced. Children and parents were informed that the researchers would cease recording and/or remove the GoPro on their request. Signage was installed in the exhibit spaces to provide other visitors with the choice to return once filming had ceased.

### *Analysis*

This study was grounded in an interpretive perspective on understanding children's experiences and their learning. Interpretive research seeks to understand how children construct knowledge in specific contexts. It pays particular attention to the way that children's learning is guided by the social and cultural resources afforded by their contexts (Gaskins, Miller & Corsaro, 1992; Graue & Walsh, 1998). Interpretive research therefore often focuses on understanding how interpersonal interactions and material provisions combine to form situated cultural resources which shape children's learning experiences (Lave, 1991).

Our qualitative analytical approach involved viewing each video in order to identify episodes that were consistent with the definition and characteristics of sustained shared thinking. To be segmented for analysis, episodes needed to involve mutual adult-child attention *and* include sustained, reciprocal conversations about the exhibit content that exchanged or extended the interlocutor's knowledge. Initial episodes from each video were identified collectively by the research team, and then remaining episodes were identified by Author 2 in consultation with Author 1. Once identified, the episodes were scrutinized to in order to answer the following questions: i) What features of the episode provoked knowledge exchange or extension? and ii) Which exhibit features appeared to elicit these episodes?

The data coding was emergent and iterative, using the process of constant comparison between episodes in order to develop and define categories (Strauss & Corbin, 1998). Author 1 made researcher coding notes in response to the above questions. Through progressive viewing and the back-and-forth comparison of episodes and coding notes, patterns were detected relating to the intellectual characteristics of the learning conversations and the associated exhibit features. The second author then scrutinized each episode to confirm, refine and finalize the definitions for each category. Author 1 and 2 met regularly to discuss the emerging definitions, and the coding process continued until both were convinced that the categories collectively captured the intellectual and exhibit features of the episodes of sustained shared thinking represented in this data set. The credibility of the findings was strengthened through ongoing corroboration with the whole research team as well as the collaborating museum staff across the three museums.

The final step was to triangulate the qualitative findings with the interview data. Interviews were entered into NVIVO 11 (QSR International, 2015) and were coded thematically in terms of two questions: i) 'What supports museum visiting, engagement

and learning?’ and ii) ‘What constrains this?’ A number of themes emerged, including provisions related to accessibility and facilities as well as those related more specifically to children’s learning engagement. For this analysis, we focused on parents’ perspectives about their children’s learning engagement which, when integrated with the categories derived from the video analysis, strengthened the interpretive credibility of the findings.

## **Findings**

### ***The intellectual features of sustained shared thinking***

Our analysis demonstrated four key intellectual features associated with episodes of sustained shared thinking in the museum spaces. In this section, we explain these features, and use video and interview data to illustrate their learning potential.

#### *Establishing shared attention*

The establishment of shared attention was fundamental to the occurrence of sustained shared thinking. Shared attention brings two interactants together, thus setting the scene for a learning conversation to occur (Povis & Crowley, 2015). However, when attention is coordinated, rich learning opportunities arise. Tomasello (1999) explains that conversations that take place in the context of shared attention support young children’s understanding of new words and ideas because children are able to derive meaning by associating the spoken word to the object or objects in their direct perceptual experience.

The dynamic museum context posed challenges associated with the establishment of shared attention because children and their parents were often attracted to different exhibit spaces. Children’s excitement at being in the museum was compounded by the sounds, movements and sights that were occurring all around. However, children and their parents negotiated these challenges, and children often enthusiastically instigated episodes of shared attention:

*Zac (4.5 years) and younger brother Ryan (2 years) have crawled through a tunnel into an enclosed space which houses an exhibit about Australian native animals and fauna. Once inside, Zac calls to his parents outside.*

*Zac: "Hey guys". He turns around and looks at the different exhibit features before looking through the tunnel entrance – "Hey Guys. Hey guys... look!"*

*He catches his mothers' attention as she looks through the tunnel.*

*Mother: "What are you doing in there?"*

*Zac: Beckons with his hand. "Come here".*

*Zac's mother crawls through the tunnel.*

*Zac: "Look" He points to direct his mothers' attention. "A dingo"*

*Mother "Oh my goodness"*

*Ryan: "This is a dingo"*

*Zac: "And look!" Zac points and his mother follows the point towards a different exhibit feature*

*Mother: "Oh. Can you see its nest?"*

*Zac: "Look up there"*

*Mother: "It's the bird. The one that laid the eggs. The warm eggs" (in reference to a previous exhibit display.)*

In this example, Zac's mother quickly responded to his call for attention, was willing to follow his clear verbal and non-verbal directions, and then to converse with him about his interests. In other instances, it was the parent who initiated the shared engagement, assuming a leading role to establish a conversation about a topic. For example, during a lengthy interaction about a touch screen exhibit of different animals, Matthew's father draws his attention to a particular animal:

*Father: "What else do you want to look at?"*

*Matthew (2.75 years) leans forward and points to a Polar Bear.*

*Father: "Polar bear?"*

*Matthew: "Yak". Matthew was leaning in to touch the polar bear on the screen, but his father pans up to the yak. Matthew points to the animal next to the yak and his father acknowledges "Oh brown bear".*

*Matthew touches the bear on the screen. He then indicates that he wants a different one. His father explains, "One at a time – brown bear"*

*Matthew leans in to touch the yak picture on the screen*

*Father: "Oh, you want the yak? We'll close brown bear down and click on yak." His father opens the yak page and reads the information to Matthew.*

When commenting during the interview about that experience, Matthew's father identified that his knowledge of Matthew's interest was an enabling factor in establishing shared attention:

*"Yeah, so anything that growls he's interested in. So, the polar bear, he thinks panda bears growl which may be incorrect, but I didn't think they growled. But whenever we point to the panda bear, he always growls as well and so anything that's like the yak is the new flavor of the month."*

### *Questioning and explaining*

The presence of to-and-fro inquiry is another defining feature of sustained shared thinking (Silva et al., 2004). The effective use of questioning has long been associated with this form of inquiry (Haden et al., 2014; Siraj-Blatchford & Manni, 2008), as questioning can encourage children to express their understandings and provide opportunities for interactants to provide explanations in order to extend knowledge and understandings:

*Braden (3.5 years) walks towards the ship display with his mother (Mother 1), peer and his mother (Mother 2).*

*Mother 1: "What's that, guys?"*

*Braden answers "a ship". His mother confirms and then asks "What does a ship have on board? ... What does it have?" Mother 1 prompts "Can you see other little things on the boat?"*

*Mother 2: "What does it have?"*

*Mother 1: "Let's see what you showed me before"*

*Braden responds to Mother 2: "A window".*

*Mother 1: It's got windows.*

*Braden: "And a cannon".*

*Mother 1: "And it's got cannons. It's got lots of them. (Pointing lower down) Look. It's got hidden cannons. Why do they have to have those? Why do they have to hide them?"*

*Braden: "Because they don't want people to steal them"*

*Mother 2: "They don't want people to steal them. They've got more cannons around the other side. They've got little cannons on top – on top of the [unintelligible]. And look what else they've got? They've got a big anchor. Do you remember the big anchor we saw up there?" (Referring to the life-size anchor they saw at the front of the display area).*

In examples like this, questioning was used to determine children's existing knowledge. While such questions are often regarded as 'closed' in that they require a short, factual answer, they nevertheless position young children as conversational partners and therefore serve to initiate and maintain reciprocal responses (Author1 et al, 2018). While rarer, open-ended questions, exemplified by the 'why' questions above, provided opportunities for explaining and reasoning, which have been identified as a key feature of learning conversations in museum contexts (Sanford, 2010; Weier, 2004). Together, both forms of questions functioned to draw children's attention to salient aspects of the exhibit and helped the children deepen their understanding by making connections to their recent experience or current knowledge. As Mother 2 explained later in the interview:

*"Ideally, like I always try and make the connection with – for example, there's a big anchor upstairs and I just and make the connect that it's a real anchor that real ships have used, rather than just being something we walk past [and] not make the connection that it's real."*

#### *Diverse and technical vocabulary*

A further intellectual feature evident in the episodes of sustained shared thinking related to children's and parents' use of diverse descriptive vocabulary that included precise technical words that referred to specific aspects of the exhibit. This cognitively sophisticated vocabulary is a strong predictor of subsequent academic outcomes as children learn new words that enable them to express and refine their conceptual

understanding to provide specific and detailed descriptions (van Kleeck, 2014). When children and their parents were deep in conversation, opportunities to express detailed conceptual understandings often arose. In most cases, it was the adult who introduced the technical language:

*Winona (4 years) and her mother are looking at the touch screen about the animal display*

*Winona: (Looks at, and then points at an animal on the screen. She calls out) "That's a (unintelligible) here!"*

*Mother: "Is that the Steenbok?"*

*Winona points again and replies "There"*

*Mother: "Yes. It's got horns. They're quite pointy aren't they."*

*Winona: (Points at another animal) "Mum. What's this?"*

*Mother: "What's this? Why did you press on that one? We'll have to go and find that one. (Mother reads) A plains (unintelligible)?"*

*Winona: "Dibata? There it is. See the ...?"*

*Mother: "Ah yes"*

*Winona: "A hyena."*

*Mother: "No that's an African wild dog, like the ones we see at the zoo. You know they've got the big ears like that."*

In this example, the mother provided the correct name of the animal and used descriptive terms to explicate technical detail and differences. On other occasions, the child also used sophisticated words, and their parent reinforced and extended through explanations of the object under investigation:

*Owen (5 years), Rick (4.75 years) and Rick's mother have approached the solar car exhibit.*

*Owen: "Oooh! It's got energy."*

*Rick's Mother points at the accompanying photo. "It's in the desert driving, 'cause there's lots of sun in the desert. So, there's lots of energy."*

*Owen: "And it's so hot, and the sun gets in to the plate and it makes it more powerful."*

Reflecting on this example in her interview, Rick's mother explained how she used the interaction to capitalize on the learning opportunity that the exhibit presented:

*"I don't think he's ever seen a solar vehicle and I thought, 'Oh, this is a learning opportunity'. He'll learn about the solar panels and I know he's interested in the solar system, so he knows that the sun is really hot and you can get power from that and then you get to go in the desert. So, then we got to talk about what it's like in the desert."*

#### *Making cognitive connections*

Finally, children's learning was deepened when their interactions involved opportunities to connect new information with existing knowledge. Some parents recognized that their children's engagement with the space may result from the connections that they were making with past experiences. For example, when reflecting with her child about model lifeboats in a ship exhibit, which was an interest of his, this mother explained:

*"(Asking the child) Well, we were actually on a cruise, weren't we? A year ago, today. And he was interested in the lifeboats on that and we have talked a couple of times about lifeboats and how they save people and everything, so that's probably why he was interested in that."*

Other parents used questioning to prompt the child to recall a past experience and connect it to the present:

*Ally (4.5 years) and her mother are in an area where Indigenous music is playing.*

*Mother: "Do you remember when we went to Kakadu?"*

*Ally: "Yeah."*

*Mother: "Do you remember when we heard lots of singing and things like that?"*

*Ally: "Yeah."*

*Mother: "Do you want to come and listen to this?" She leads Ally over to the Eora display and asks "Do you remember that sound?" – indicating the music playing over the speakers.*

*Ally: "What sound?"*

*Her mother explains that the music is Aboriginal singing and clapping. Her mother reads the sign and says “Arnhem Land! That’s where we were.”*

*Ally: “Is that Kakadu?”*

*Her mother notices a digital screen display and recognizes a name on it. She identifies the name and says to Ally, “They’re the people who lived in the area of Kakadu where we were.”*

This kind of shared reminiscing is a powerful tool in children’s cognitive and language development, with links to vocabulary development, the ability to form narratives, and the formation of autobiographical memory (Neale & Pino-Pasternak, 2016). Ally’s mother recognized the importance of shared memory in helping her child to understand and make meaning from the exhibit:

*“... that’s something else that I knew we’ve had experience before because we’ve looked at maps quite a bit, and I’ve shown her where Darwin is when we’ve travelled there, or Byron, or shown her where Sydney is, so that’s why I thought that was a good thing to get her to engage with rather than the other images that were available because she wouldn’t have had any history with those.”*

### ***Design features associated with episodes of sustained shared thinking***

Our second question was to determine the design features that appeared to foster sustained shared thinking. Four features were prominent in the data:

#### ***Intricate detail***

When exhibits included intricate detail, children and adults were mutually attracted to explore closely. Small replica items captured children’s interest, especially if these were exhibited in a way that focused their attention, thus encouraging close observation and attention to detail. Intricate detail on models provided our participants with opportunities to elaborate and explain and to use sophisticated vocabulary:

*Mother: "Look at how many little boats I can see." She counts them while pointing them out. "There's nine little boats on the side of the ship. And look at this. Look. What can you see on the outside of the ship?"*

*Marcus: "What?"*

*Mother: "They've got steps. When the boat moors next to the land, all the passengers can climb up the stairs, all the way up. Up into the cabin"*

*Marcus: "And when it gets to a station .... they go down again"*

*Mother: "Ah, yes. So, when they get to their stop, they will go back down the stairs – that's right."*

Intricate detail also extended to the accompanying written or diagrammatic material, and prompted parents to extend the conversation to beyond what their children could see:

*A mother draws her child's attention to the printed display of the inside of the ship that accompanies the physical display. She explains that this shows what is inside the ship (not visible on physical display).*

*Mother: "Can you see down here (indicating to printed display)? The people sleep inside and they have their food inside.... There's not very much room is there?"*

Later, this mother reflected on the intricate aspect of the exhibit when she talked to her son during the interview:

*"... Remember? We could see inside the boat, couldn't we? And we could see what was happening. We could see the people on the deck sweeping. Do you remember? There were little models, weren't there? Yes?"*

#### *Access to different perspectives*

Being able to see exhibits from different angles and vantage points appeared to stimulate discussions about different features of those exhibits. When they were able to do so, the children would walk around exhibit spaces to look at features from different angles. Many of the museum spaces had ramps, bridges and viewing platforms, all of which allowed

children to gain different perceptual perspectives. The parent below reported how this sustained their child's engagement in the space:

*“I think the Wild area, when we went over there from where I suppose where William (2 years) could see, they were looking directly up, so it was either up or at level and they weren't seeing anything in between, so when we actually went up the stairs, which we wouldn't have known about if you guys hadn't have said anything, and you can see it from above, that from me was a different perspective again.”*

It also allowed children to explore different features of the exhibits and make connections between items that were represented in more than one way:

*Owen, his father and their accompanying family have climbed the stairs into the raised signal box and are looking at an exhibition of toy trains and airplanes*

*Owen: “Look at that. Look at this airplane. Rick, come and look at this red airplane.”*

*Owen turns around to look out of the signal box window and exclaims “And you can even see out here!” – he points at the life-size airplane which is hanging from the high ceiling. “You can see it here.”*

*Rick's mother: “You can see on top of the train too.”*

*Owen: “You can ... you can see on top of the train.”*

*Father: “Whoa! We're right under the plane.”*

*Owen: “What?” and rushes over to his father. “You can see right under the train .... Wait ...”*

*Father: “Hey – look up!”*

*Owen: looks up and sees another life-size plane. “Oh yeah! It's so big .... So big.”*

### *Interactivity*

Unsurprisingly, interactive design elements increased and sustained children's engagement. Interactive elements included ‘hands-on’, active exploration opportunities (e.g. dismantling a robot), audio visual aspects (e.g. buttons to press to hear animal or transport noises), or play activities that accompanied the exhibition:

*Lana (4 years) and Mother have entered a small cubby house containing a hamper and tea set. Lana picks up some cups and a teapot.*

*Mother: "You're making me tea?"*

*Lana: "In this cup (unintelligible)"*

*Mother: "OK"*

*Lana: "Cups." She then puts a bowl in the hamper. "Um. Let's pack mum" She places the other cups and bowls into the hamper "And now we carry a basket"*

*Lana closes the basket and handles the leather buckles. "How we close this mummy?"*

*Mother: Threads the leather straps through the lid. "I think this bit goes through here" Lana observes and also places her leather strap through the hole in the lid.*

*Lana: "...this bit through there. Now, how do we carry it?"*

*Mother: "I think it needs to stay in here, 'cause I think it's (unintelligible) so it's for in here really."*

Real-life sized objects and real objects to walk on, crawl through, touch, pull, and push (e.g. large ships and trains) were also significant, as one parent commented: *"So, when you've got the pirate ship and you sit in the hammock, they (the children) go, 'Oh, this is how they used to go to sleep'"*. Being able to inhabit the same large object together provided opportunities for imaginative role playing in order to explore the functionality of the exhibit item:

*"We were talking about who was going to be the train driver and was that the train driver's seat and then she wanted to sit up...then we were kind of talking about...the fire pit...and then she insisted that I had a turn."*

Interactive touch screens featured heavily in many displays, which appeared to elicit shared explorations. In some instances, the combination of written and visual interactive touch screen displays prompted rich conversations around the topic area. In other instances, however, the learning conversation revolved also around the use of the technology itself as child and parent jointly discovered how to use it (Frost, 2002; Shaby et al., 2019):

*Sophie (4.5 years) and her mother notice a large table-top touch screen display which contained pictures of books.*

*Mother: "You can touch one ... look" She demonstrates how the electronic book opened when its cover was touched. She holds Sophie's hands to swipe it across the screen, thus demonstrating how to operate the display. "Look, you can go through the book."*

*Sophie touches the screen and her mother directs her "The arrow" Sophie swipes the screen again and her mother responds with "OK, you can do it that way."*

*As Sophie tries to operate the screen again, her mother reinforces "You can also use the arrow (she demonstrates) see – you go like that. Try pressing the arrow." Sophie follows these directions "See. There you go!"*

### *Multi-modality*

Finally, sustained shared thinking frequently occurred in exhibitions where content was represented in multiple ways. Sometimes, this involved children experiencing content through multiple senses, such as being able to touch, see and hear aspects of the exhibits (as in Eardley, Dobbin, Neves & Ride, 2018). When this piqued their curiosity, they were eager to find out more. If written material supplemented the physical aspect of the space, parents were able to provide new information:

*Zac has entered an interactive exhibit space of a malleefowl nest. Two eggs are exhibited at child height, clearly inviting children to reach and touch them. Zac does this, and rapidly withdraws his hands with an intake of breath. He points at the eggs "Look mum!" He reaches and touches an egg again*

*Mother: "Oh, the eggs. Are they warm?" She reaches and touches one. "Oh! They're warm eggs."*

*Zac. "Why are they warm?"*

*Mother: Because ... Let's read, shall we?" (Reading:) "It says 'The malleefowl digs a deep hole and fills it with leaves ... and it warms up like a compost heap'."*

While written text was useful, parents were sometimes challenged by the need to split their attention between conversing with their child and deriving useful information from the text. During her interview, one mother explained that she needed information in

quick-to-read and digestible formats in order to make a quick decision about the engagement potential of an exhibit:

*“I also felt that (there) was lots of words on all the bits to read, it was very detailed. There wasn’t really much that at a glance you could go, ‘Oh, that’s what I’m reading about’ or ‘That’s what it’s about.’ So, you had to really commit what you were looking at and work it out rather than just going, ‘Oh, that’s good but they’re not going to like that, so we’ll move on’ or ‘That’s good. We’ll definitely stop at this bit’.”*

Finally, interactive touch screens were significant in eliciting sustained conversations, especially when the various information modes were directly linked to the child’s immediate experience with the physical items:

*Winona (4 years) and her mother are exploring the images on a large interactive touch screen that accompanies a physical display of wild animals.*

*Mother points at an animal on the touch screen display: “Who’s ... what’s this one?”*

*Winona: “A lion. I’m going to do it.” She presses the lion which bring up a more detailed image of the display item.*

*Mother: “An African lion.”*

*Winona: “That is a lion.”*

*Mother: “Where is the lion in the exhibit?”*

*Winona swings around to look at the physical exhibit. “Where?”*

*Mother: “Where is it?”*

*Winona points at an image of a bear on the screen. “Here.”*

*Mother: “Are you sure?”*

*Winona: “Hey he’s a polar bear.” She swings around again to look at the exhibit, and then turns back to the screen. “It might be a lion. Maybe ....” She swings around again, and her eyes fix on the real lion some meters away. She takes a sharp intake of breath. “Ah Yeah! This is [unintelligible] the drawing!” She turns back to the screen). “Let me do it ... get it again.” She presses the animal on the screen again*

*Mother: “Yeah! That’s it.”*

*Winona: (excitedly). “That’s it ... really. Look” (she turns and points animatedly at the real animal. “This!!!” Winona then continues to converse with her mother about the animals represented both on the screen and in the physical exhibit.*

In this interaction, the learning interaction was not only constructing knowledge about the animals and about the way in which the touch screen worked, but it was also providing Winona with first-hand experience that information can be represented in many ways. This realization is cognitively challenging for pre-school aged children (Uttal, O’Doherty, Newland, Hand, & DeLoache, 2009), and when discussing this experience in the post-visit interview, Winona’s mother identified how salient this realization was for her child several days later:

*“... and they were talking to their Aunty yesterday about the screen that they could push, and then there was the lions, so they were talking about that. .... But yeah, they really got that connection [that the screen represented the taxidermized animals in the display], and that’s taken a few visits to get that connection. Yeah, so they were talking, and I didn’t instigate that conversation either, they were talking about going to the museum and doing that.”*

## **Discussion**

In this study, we used the concept of sustained shared thinking to examine very young children’s learning in museum spaces. Compared with research about older children’s museum learning, less attention has been paid to that of prior-to-school aged children and much of the existing research has concentrated on young children’s engagement in children’s museums or exhibits designed for play-based learning (e.g., Dockett, Main & Kelly, 2011). As a result, the focus has been on young children’s active, but largely independent or peer-interactive learning processes. In contrast, our study recognized that most prior-to-school aged children attend museums with family members, and thus sought to examine social-interactive family learning. Our findings move conceptualizations of young children’s engagement beyond play-based learning to demonstrate the potential learning opportunities afforded by conversation and inquiry-based learning. Our study further departs from the existing literature base by focusing on

interactive learning that took place largely in spaces designed for a general, rather than child-specific, audience. In a context where museums are seeking to encourage visitation by families with very young children, our findings can provide important implications for how museums can create spaces that appeal to, and consequently increase the involvement and learning engagement of both young children *and* their parents.

Carr and colleagues (2018) point out that interactive learning in early childhood centers differs from formal learning environments in that learning is generative, spontaneous and reliant on children's active involvement. Our research demonstrates that this kind of process-driven learning can equally apply to museum contexts. While the features of exhibits may take a much more active role in shaping the topics conversations than in typical educational contexts, our findings demonstrated how young children's and parents' interests and motivations were integral to the parent-child learning interactions that took place. The current study thus found that the sustained shared thinking framework is pertinent to museum contexts, and suggests that future research can use this framework to create synergy between the early childhood and museum sectors (Carr et al., 2018).

The sustained shared thinking framework shed light on the mutual contribution of both parent and child to the learning opportunities that occurred. The importance of sustained engagement has been identified by a number of studies as an essential condition for child learning (Sanford, 2010) on the assumption that time spent at an exhibit is an indicator of interest and, ultimately, learning. In our study, we saw many instances of sustained child engagement, but not all evidenced sustained shared thinking. For example,

*Lana has spotted a large car exhibit. She runs over to it, and climbs in, exploring the seat belts. Her mother watched on and takes a photo of Lana in the car. Lana continues to climb around the front car seat. At one point, Mother approaches, but when Lana sits back down, she retreats to watch again from a few meters away. After*

*another moment, Mother walks to the car, and sits in the back seat. Lana looks at her, and then back at the screen in front of the car. Another child has joined her on the front seat and they silently watch the screen together.*

*Lana: "Mummy"*

*Mother, leaning forward: "Do you want to sit here with me?". She picks up Lana and moves her to the back seat. "Want to see?", she asks, pointing at the screen, and she and Lana continue to watch together.*

Examples like this demonstrate that child engagement does not necessarily require adult involvement, and that adults are often content to allow children to explore exhibit spaces independent of adult involvement (Wood & Wolf, 2010). While it is likely that young children can and will learn from the museum content in situations such as the above (Shaby et al., 2019), their learning relies on individual learning processes. If, as Vygotsky (1978) claimed, the learning of very young children is extended through interpersonal interactions, then attention needs to be directed towards the features of learning interaction that stretch children's thinking. The concept of sustained shared thinking, with its focus on the sharing and exchanging of knowledge between interactants, therefore serves as a valuable framework from which museums can understand, and ultimately foster the dynamic social-interactive learning engagement of very young children and their families.

Our findings highlight the processes involved in parent-child learning by demonstrating how features of the interaction actively contribute to knowledge-construction when parents and their children engage in conversations about topics of mutual interest. The findings reinforce Borun and colleagues' (1997) contention that effective interactive learning takes place when exhibits have 'attracting', 'holding' and 'information communicating' power, but extend their argument to demonstrate that this power resides jointly in the features of the interaction and the exhibit design. The intellectual features of sustained shared thinking described in our research exemplify the

ways in which this power can be realized. When exhibit features captured their attention, parents and their children pro-actively invited each other to examine and discuss interesting exhibit content. Parents used questioning and explaining, not only to ‘hold’ or sustain the interaction, but also to prompt children to express and extend their ideas and understandings. Connections between prior and current experiences were made to help children to make sense of new information, and both children and their parents used rich, technical vocabulary to communicate detailed information to each other. These interactive, intellectual features illustrate the means by which young children and their parents established and maintained the learning-rich conversations that have been identified in previous research (Allen, 2002; Sanford, 2010; Weier, 2004).

Most significantly, we found that sustained shared thinking was most effectively established when *both* children and their parents were interested in, and curious about the exhibit content (Povis & Crowley, 2015; Sanford, 2010). Certain features, such as the presence of intricate detail and the ability to view objects from different perspectives, sparked the curiosity of both children and parents, and served to establish the shared attention that supports effective early learning (Povis & Crowley, 2015; Tomasello, 1999). Our findings are consistent with previous work that emphasizes the importance of interactivity (e.g., Lee, 2011), but not simply because the hands-on learning sustained children’s engagement. The interactive elements stimulated conversations about how to use, and therefore learn, from that part of the exhibit space. In particular, when the interactive element was new to both parent and child, the shared engagement shifted the parent from the position of the ‘more knowledgeable other’ to one of a co-learner, providing rich opportunities for both to learn. The combination of multiple modes of communication, including objects, written text and audio-visual displays prompted collaborative engagement as children and parents used different ways to access

information. This element prompted much questioning and explaining, not only about the topic of interest, but also about the developmentally challenging realization that phenomena can be represented in multiple ways (Uttal et al., 2009). Multimodality, for these young children, also included the ability to use different senses to explore the exhibit space, which again provided the catalyst for extended and learning-rich conversations (Eardley et al., 2019; Hackett, et al., 2018)

### **Conclusion**

This study has demonstrated that, when exhibit design captures the attention and curiosities of *both* parties, regular exhibit spaces have the potential to be mutually attractive and stimulating for young children and adults. That our findings are consistent with the features of early learning settings associated with the best outcomes for children across the school years (Sylva et al., 2004) suggests the types of interactions families can have within museum spaces may also be significant contexts for meaningful learning.

As our study aimed to conceptualize and portray the nature of sustained shared thinking interactions in museums, the question of individual family differences was not explored. With recent research demonstrating how both ‘new-ness’ and familiarity can shape how children’s museum engagement engage in museum spaces (Hackett et al, 2018), this presents opportunities for future analyses to investigate whether child or parent familiarity with the visited museum changes the dynamics of their learning interactions. Further, the question of how interactions may differ according to the age of the child is yet to be explored. Finally, with early childhood research demonstrating how very young children are capable participants in the research process (e.g., Fleet & Harcourt, 2018), future research is needed to capture children’s perspectives about when and how exhibits present deep and authentic learning opportunities for this very young audience.

This study was small-scale and exploratory, so caution is needed generalizing the findings to other museum contexts. However, our findings are promising in that the intellectual and design features that we found to characterize episodes of sustained shared thinking were evident in all three museums and across very different exhibit spaces and content. Our findings have implications for the development of museum spaces, as they highlight how the learning of prior-to-school aged children and their families may effectively be accommodated and promoted across diverse museum spaces. Our findings also pave the way for future studies to investigate the effectiveness of specific design features in promoting collaborative, interactive learning among very young children and their families. For example, recent work has highlighted the usefulness of reimagining young children's experiences in museum spaces by focusing on the dynamic relationship between children and non-human objects (MacRae, et al., 2018). Such an approach extends the focus beyond language, conversation and relationships to bring physical space and embodied experience to the forefront (Hackett, et al., 2018; MacRae, et al., 2018). Finally, the findings from this study highlight that learning in museum spaces extends beyond learning about the exhibit content, to include learning *how to learn* in museums. Many museums are seeking ways of including more families in their visitor profile with the ultimate aim of encouraging life-long museum learning. Our study reinforces the view that, with careful design, museum learning can start early in life as children and parents discover together to value of being a museum learner.

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