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Autonomy Support, Elaborativeness, and Problem Solving During Families' Building Construction in a Children's Museum

Tayler Grashel
Loyola University Chicago

LOYOLA UNIVERSITY CHICAGO

AUTONOMY SUPPORT, ELABORATIVENESS, AND PROBLEM SOLVING DURING FAMILIES' BUILDING CONSTRUCTION IN A CHILDREN'S MUSEUM

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TAYLER N. GRASHEL

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ABSTRACT

The current study aimed to promote parent-child interactions that could foster children's early STEM learning. Specifically, the current study focuses on four dimensions of family interactions that have been found in prior work to support children's learning and development: problem solving, parents' and children's elaborative talk, and parental autonomy support. This study examined how levels of support on each of these dimensions related to children's abilities to build and fix skyscrapers made out of plastic building materials in the *Skyline* exhibit at the Chicago Children's Museum. The participants were 74 families with 4- to 8- year old children (M = 6.47).

Families were provided with an Engineering Demonstration during which they were shown a key engineering principle, namely that cross-bracing makes structures sturdier. Families were also randomly assigned to receive or not receive *Anticipated Transfer* instructions prior to building. Families in the *Anticipated Transfer* condition were instructed that what the children learned while working on the first task would help them to solve the problem of the second task without their parents help. It was thought that by encouraging families to think about transfer of learning across different problems with the same solution, their building interactions would promote it. Building interactions in the first task were characterized in terms of four focal dimensions: (1) problem

solving, (2) parental elaborativeness, (3) children’s elaborativeness, and (4) parental autonomy support. Sturdiness of the completed structures in both the first and second task was measured. There was also an effort to understand how children's prior knowledge might affect their building interactions and outcomes.

The results revealed that families who had received or had not received the *Anticipated Transfer* instructions did not differ from each other while building on the dimensions of problem solving, parental elaborativeness, children's elaborativeness, or parental autonomy support. The measure of problem solving was related to the sturdiness of the skyscraper in the first task. The measure of autonomy support was also related to the sturdiness of the second structure. Families with boys who were not in the *Anticipated Transfer* group built sturdier skyscrapers than those families with sons who received these instructions, but there were no differences by transfer group or child gender on the second, fixing task. Children’s prior knowledge was not related to measures of family interaction during building or building sturdiness. Results are discussed in terms of children’s STEM learning in informal educational environments, including museums.

CHAPTER ONE

INTRODUCTION

The *Framework for the K-12 Science Standards* (National Research Council, 2012) emphasizes the importance of early engagement in the practices of science in promoting interest in science, technology, engineering, and mathematics (STEM). In particular, this framework identifies problem solving as key to early education in science and engineering. Although learning of science and engineering routinely occurs in school settings, there is also an increasing attention to the fact that early education in STEM does not occur exclusively or even mostly in schools (National Research Council, 2009). One important place for early STEM learning opportunities is in informal educational settings, such as museums, aquaria, and zoos. Indeed, throughout the United States there are over a thousand informal science institutions where young children are exposed to scientific concepts and practices years before they are taught them in school (Dragonfly TV. GPS: Science Center |PBS KIDS GO!, 2006).

Much of the literature on children's early informal STEM learning focuses on the important role that parents can play in fostering children’s early interests in and understandings of STEM. This work is based on the sociocultural theory (e.g., Rogoff, 1990; Vygotsky, 1978), which states that learning can occur in social interactions, especially linguistic interactions between children and parents. This theory provides the grounding for work on how parents can support children’s early learning in museums

and other informal learning environments. More specifically, when parents work at their children's *zone of proximal development*, then they describe and explain concepts of the event or activity in a manner that is understandable to the children (Vygotsky, 1968, as cited in Anderson, 1997; Vygotsky, 1978). Therefore, children gain a better understanding of the task when parents describe it in a manner that the children can comprehend.

Sociocultural theory provides the theoretical backdrop for the current study. The study focused on how different ways that parents support children's early learning come together during a joint problem solving task in a children's museum exhibit. Specifically, the current study focuses on four dimensions of family interactions that have been found in prior work to support children's learning and development: problem solving, parents' and children's elaborative talk, and parental autonomy support. This study examined how levels of support on each of these dimensions related to children's abilities to build and fix skyscrapers made out of plastic building materials in the *Skyline* exhibit at the Chicago Children's Museum. Results of the work contribute uniquely to the existing literature in understanding conditions under which different dimensions of family interactions relate to successful building engineering. More generally, the work can contribute to efforts to increase early STEM learning opportunities for children.

The introduction to this study begins with a discussion of prior work that has focused on early science learning in museums. Then the review turns to research pertaining to each of the family interaction dimensions that were the focus of this study: problem solving, parents' elaborativeness, children's elaborativeness, and parental autonomy support. It is worth noting at the outset that much of the work on these four

focal dimensions has been done outside of museums, and has not specifically focused on children's informal STEM learning. The introduction concludes with a rationale for this study and the research questions and hypotheses related to how family interactions, as defined by problem solving, elaborativeness, and autonomy support, can contribute to building and learning outcomes.

Parent-Child Interactions During Informal STEM Learning in Museums

Much of the work on science learning in museum contexts has considered the important role parent-child interactions, and specifically their conversational interactions, can play in children's learning (see Haden, 2010, for review). Indeed, researchers have characterized the learning process in museums as *conversational elaboration* – involving rich discussions between parents and children both during their visit to a museum, as well as after their visit (e.g., Leinhardt & Crowley, 1998). One way that elaborative conversations may be important for learning is that they involve question asking (Haden, 2010). Elaborative questions request information, such as *Who*, *What, Where, When, Why, and How* (Haden, 2010). These so-called *Wh-* questions have been found to relate to children's learning across a range of observational and experimental studies in museums (e.g., Benjamin, Haden, & Wilkerson, 2010; Jant, Haden, Uttal, & Babcock, 2014). Elaborative conversations can also include a particular kind of explanatory talk, labeled *associations* or *analogies* (Benjamin et al., 2010; Callanan & Jipson, 2001; Crowley et al., 2001; Jant et al., 2014). These are used to connect aspects of an unfolding event with things that children may have experienced previously (e.g., when building a skyscraper in an exhibit and visiting the Hancock Center – a famous Chicago skyscraper),

or other information about which the child has prior knowledge (e.g. Crowley et al., 2001).

A study by Benjamin et al. (2010) illustrates the importance of elaborative conversations for children's learning in museums. The researchers provided some parents with information about the use of elaborative conversational techniques − specifically asking *Wh*- questions and making associations − before they engaged in a collaborative activity in a building exhibit at the Chicago Children's Museum. The researchers found that parents and children that received the conversation information engaged in more collaborative conversations than parents that did not receive this instruction. This is important because it suggests that when parents received the conversational techniques and incorporated them into conversations, then there was more talk occurring between the parents and their children. Also, when the parents received this instruction, then the children were more likely to respond during the conversations than those that did not receive this information.

During conversations, parents ask their children questions. They also make associations, which incorporate prior experiences that they shared with their children and relate them to the current activity (Callanan & Jipson, 2001; Crowley et al., 2001). During the current study, parents may make more of these associations if children have a lot of prior experience with building (e.g., LEGO, erector sets). Related to this idea, Palmquist and Crowley (2007) found that those children who were viewed as dinosaur experts had more access to activities during everyday settings, such as at home, than novices to activities that would promote learning about this topic. Moreover, Palmquist

and Crowley (2007) found that whereas children who were novices about dinosaurs and their parents contributed equally during a conversation about this topic during a visit to a museum exhibit about dinosaurs, children who were experts about dinosaurs contributed much more to the conversations than their parents. It is possible that in other scientific contexts, such as during building construction activities, children's prior knowledge may lead to differences in both parents' and children's elaborativeness.

Dimensions of Parenting Behaviors That Can Support Learning

Problem Solving

During science related activities, in addition to elaborative structure and parental autonomy support, children's learning can also be enhanced through problem solving. In educational contexts, children are expected to learn and utilize more advanced problem solving skills as they age. In fact, there are educational standards that indicate children should be able to utilize more advanced mathematical skills as they age (Common Core State Standards Initiative, 2015). Prior work also suggests that individuals utilize different strategies to solve problems depending on how old they are (see Siegler, Adolph, & Lemaire, 1996; Siegler, 1996, for review). An individual's use of strategies does not only occur during a classroom setting, but can occur in everyday or informal contexts, as well. In line with this, it is important to note that children engage in problem solving and learning long before they enter school (e.g., Van Schijndel, Franse, & Raijmakers, 2010). Because the current study was conducted in a museum setting, it is important to note that children frequently visit a museum with their parents where science learning opportunities abound (Crowley et al., 2001).

A number of prior studies have examined children's learning and problem solving skills in a laboratory setting. For example, a study by Wertsch, McNamee, McLane, and Budwig (1980) examined how mothers help guide their children's problem solving skills to complete a puzzle. The children in this study were between the ages of 2 and 9 years old. In this study, the children and their mothers were asked to create two puzzles and as they were creating them, they were provided with the opportunity to examine models of identical puzzles. They completed one puzzle at a time. Findings from this study indicate that mothers help guide their children's focus of important features of the task when the children are younger compared to older. This indicates that mothers help foster their children's understanding of key concepts in order to help them complete a problem solving task.

Parental support for children's problem solving has also been examined during visits to science museums. In a study conducted by Van Schijndel, Franse, and Raijmakers (2010), preschooler's exploratory behavior was observed while they were visiting two exhibits with their parents. Before exploring these exhibits with the children, the parents were randomly assigned to receive or not receive information about the exhibits. This information also provided parents content on how to help their children engage with the materials, as well as learn from them, during their visit to the two exhibits. The researchers measured the children's exploratory behavior. The findings indicate that parents who received the information prior to visiting the exhibits had children that engaged in more exploration during their visits to the exhibits than those children whose parents did not receive this information. Also, the Van Schijndel et al.

study suggests that children can use materials in various ways while exploring and learning about an activity.

By examining the key aspects or information of a task, children can develop hypotheses or beliefs, test or examine information, and then revise the hypotheses or beliefs (Dixon & Bangert, 2002; Schauble, 1996; Vosniadou et al., 2001). These are key processes to solving a problem, and when children engage in them, they may develop a more in-depth understanding of educational concepts (Dixon & Bangert, 2002; Vosniadou et al., 2001). Problem solving can involve deploying a number of strategies to reach a solution (see Harnishfeger & Bjorklund, 1990, for review). When trying to solve a problem, individuals may forgo or revise their use of a particular strategy, or utilize another one (Alibali, 1999; Kalish, Lewandowsky, & Davies, 2005; Vosniadou et al., 2001). When this occurs, the individual is conducting a conceptual change (Alibali, 1999; Kalish et al., 2005; Vosniadou et al., 2001). This process of conducting a conceptual change seems like it may be one reason that an individual may utilize different strategies during the current building activity at the Chicago Children's Museum. Overall, when children develop hypotheses and revise them, then they are engaging in problem solving to learn about the main concepts of the activity.

Children's problem solving skills have been studied in both a museum and laboratory context. In several of the laboratory contexts, researchers have examined how parents help guide their children's problem solving skills to complete a task. However, given the overall importance of parents' guidance in problem solving, it is important to examine how parents and their children work together in a museum context to complete a task. For example, during a joint problem solving activity, it is expected that parents will

engage in teaching their children strategies that they can then utilize at a later time. Therefore, in this project, we focused on joint problem solving when parents and children work together during a building activity. Moreover, we examined problem solving in conjunction with other interactional patterns demonstrated by parents and their children, namely, elaborativeness, and autonomy support.

Elaborativeness

Parents' use of elaborativeness can help to foster children's understanding and learning in a museum exhibit (Haden, 2010). Beyond the museum context, elaborativeness has been examined in the event memory literature in studies of conversations between parents and their children in which they discuss ongoing and past events (see Fivush, Haden, & Reese, 2006, for discussion). The characteristics of elaborative structure that are exhibited as an event unfolds (in a museum or elsewhere) and after it has occurred can be seen to parallel one another. In both contexts, an elaborative conversational style is characterized by the frequent use of *Wh*- questions and associations that connect children's prior knowledge to the current activity (e.g., Hedrick, Haden, & Ornstein, 2009).

Although prior research indicates that these questions and associations help to foster children's learning, there is variation among parents in their use of elaborativeness. More specifically, parents vary in the quantity and type of questions that they ask their children. Parents can also incorporate elaborative statements into their conversations with their children and these allow for parents to supplement their children's contributions by adding novel information to the conversation (Fivush et al., 2006). The variations in the use of questions and elaborative statements result in the parents demonstrating either high

or low elaborative styles of structuring conversations with their children (Cleveland & Reese, 2005; Fivush et al., 2006). More specifically, parents that demonstrate a high elaborative conversational style often utilize frequent *Wh*- questions that are aimed to elicit new information about the task, listen to their children's responses, and provide feedback about the children's responses (Boland, Haden, & Ornstein, 2003; Cleveland & Morris, 2014; Cleveland, Reese, & Grolnick, 2007; Fivush et al., 2006; Haden, 1998; Leyva, Reese, Grolnick, & Price, 2008).

In contrast, parents that demonstrate a low elaborative structure often utilize more close-ended questions and statements and may repeat the same question over and over again in order to obtain a desired response (e.g., Haden, 1998). The distinction between elaborative and repetitive conversational styles is particularly salient when parents are talking with young preschoolers (Cleveland & Reese, 2005; Cleveland et al., 2007; Reese, Haden, & Fivush, 1993). Parents who demonstrate high elaborative style also frequently positively evaluate and otherwise encourage their children's verbal participation in the conversation, but will elaborate even when children are not responding (Reese et al., 1993).

Also, as suggested above, elaborativeness has been investigated both during and after events. Focusing specifically on conversations after events – what has been called reminiscing – several longitudinal studies have found predictive relations between parents use of a high elaborative conversational style early in children's development and children's memory for events later (Cleveland & Reese, 2005; Laible, Panfile, & Augustine, 2013, Reese et al., 1993). For example, in a study conducted by Reese, Haden, and Fivush (1993), mothers engaged in conversations with their children about

three previous one-time events in which both the mothers and children were present. The study examined four time points in which these conversations occurred, when the children were 40, 46, 58, and 70 months old (Reese et al., 1993). Mothers increased in their use of elaborative conversational techniques, as their children aged from 40- to 70-months of age, and children increased in their provision of memory information in these conversations. Moreover, there were concurrent and longitudinal associations between maternal elaborativeness and child elaborativeness/memory responding. Parents' use of elaborative talk early in development predicted the children's abilities to provide details of their experiences up to 1-1/2 and 2-1/2 years later.

During reminiscing, the children's perspective of the event contributes to both the parents' and children's use of elaborativeness. Providing support for this idea, Laible, Panfile, and Augustine (2013) asked mothers to reminisce about an event they had shared with their child during which the child had a negative experience. The children in this study were 42 and 48 months of age. Many of the prior studies on elaborative talk have counted the number of elaborative comments made by parents and/or children. In contrast, Laible et al. utilized a 5-point scale to characterize the elaborative behaviors that mothers demonstrate during conversations with their children. The findings suggest that when children have negative feelings about an event, then mothers tend not to try to elicit conversations about it. The results of the study also indicated that when parent-child dyads discussed the past negative events, then mothers of sons were more elaborative than mothers of daughters. Overall, this study suggests that the children's gender, as well as the emotional valence of the event, may contribute to the parental elaborativeness. It is further worth noting that Laible et al. utilized a 5-point scale to characterize maternal

elaborativeness that will be adapted for the current study. It may be that in the context of a building activity, parents with sons will be more elaborative than parents with daughters.

Autonomy Support

When children and their parents are engaged in an activity together, then parental autonomy support is another family interaction dimension that has been shown to relate positively to child cognitive outcomes. This dimension is thought to tap different conversational goals than elaborativeness (Cleveland & Reese, 2005). More specifically, the dimension of parental autonomy support concerns whether or not parents encourage and accept their children's ideas and contributions during an activity (Cleveland & Reese, 2005). By examining this dimension, in addition to elaborativeness, in the current study, we were able to consider how these different aspects of family interactions contribute to children's performance during building activities in the exhibit.

The dimension of autonomy support ranges on a continuum from controlling to autonomy supportive behaviors (Cleveland & Morris, 2014; Cleveland & Reese, 2005; Cleveland et al., 2007; Grolnick, Frodi, & Bridges, 1984). Parents who demonstrate autonomy supportive behaviors help to maintain their children's current activity by using verbal and non-verbal communication (e.g. Grolnick et al., 1984). By contrast, parents that demonstrate lower autonomy support will use these communication methods to alter their children's activity (Grolnick et al., 1984). For example, parents that demonstrate high autonomy supportive behaviors tend to acknowledge and support their children's conversational turns by expanding on or following-up with their children's ideas throughout conversations (Cleveland et al., 2007; Cleveland & Morris, 2014; Cleveland

& Reese, 2005; Leyva et al., 2008). However, parents that demonstrate lower autonomy supportive behaviors tend to alter the conversation to align with their thoughts, instead of their children's contributions (Cleveland et al., 2007; Cleveland & Reese, 2005; Leyva et al., 2008).

With regard to the effects of autonomy supportive interactions, children who have parents that demonstrate autonomy supportive behaviors are often able to pursue their own interests and are more engaged in the current task than children of mothers who are less autonomy supportive (Cleveland et al., 2007; Cleveland & Morris, 2014; Cleveland & Reese, 2005). For instance, Cleveland and Reese (2005) reported that when parents demonstrated high autonomy supportive behaviors while their children were participating in an art activity, then their children tended to be more engaged in this activity. They also stated that when parents provide low autonomy supportive behaviors during an art activity, with the children being expected to follow their parents' ideas, then this resulted in the children becoming unengaged and disinterested in the activity (Cleveland & Reese, 2005).

Another study in which researchers examined autonomy supportive behaviors was one conducted by Cleveland, Reese, and Grolnick (2007). During this study, children (average 46 months old) visited a "pretend zoo" without their parents. The parents did not visit the "pretend zoo" with their children; however, they were able to observe their children's visit. Before the children engaged in the visit to the "pretend zoo," parents were either informed that their children would be asked to describe their perspectives of the visit or that their children would be asked to recall as much information as they could about their visit. The first conversation that the parents and children engaged was about a

one-time event and this conversation served as a baseline for gauging parents' natural style of autonomy support and elaborativeness. Then, after the children visited the "pretend zoo," the parents engaged in a conversation with the children about their visit. In comparison to baseline, the parents who were told that their children's perspective of their visit was going to be examined exhibited more autonomy supportive behaviors during the conversation about the children's visit. On the contrary, parents who were told to focus on the child's recall of information demonstrated lower autonomy supportive behaviors than at baseline. The findings of this study indicate that when parents are interested in their children's perspectives of an activity or event, then they demonstrate autonomy supportive behaviors during conversations with their children.

Although conversations can be observed for elaborativeness and autonomy supportive behaviors, it is important to mention that researchers have examined how these two dimensions are related to one another (Cleveland & Reese, 2005). Interestingly, work that has examined the association between elaborativeness and autonomy support finds that these constructs are relatively independent of one another (Cleveland & Reese, 2005; Leyva et al., 2008). In fact, during a study conducted by Cleveland and Reese (2005), mothers and their children were asked to recall information from one-time events that occurred in their lives when the children were 40 and 65 months old. The mothers were asked to engage the children in three conversations about events that they and their children previously experienced, as well as one event in which the mother did not participate. This study utilized a median split to separate mothers into four groups based on whether they demonstrated high and low levels of elaborativeness and autonomy supportive behaviors during the past event conversations. Mothers were

categorized as demonstrating: high elaborative and high autonomy supportive, low elaborative and low autonomy supportive, low elaborative and high autonomy supportive, or high elaborative and low autonomy supportive behaviors (Cleveland & Reese, 2005). Essentially, elaborativeness and autonomy support were separable dimensions, so that while some parents were low on both or high on both, other parents were high on one dimension and low on another. Parents who demonstrated high elaborativeness and high autonomy supportive behaviors had children at 40 months of age who were best able to recall their past experiences. By 65 months of age, effects of elaborativeness continued to be observed, with children whose mothers were highly elaborative at the early time point remembering the most about the past. In conclusion, these findings not only suggest that the dimensions of elaborativeness and autonomy support are independent of one another, but they also indicate that parents can help guide their children’s understanding and recall of events.

In sum, it is expected that the autonomy support and parent’s elaborative talk during the current study will be similar to prior findings by Cleveland and Reese (2005). First, it is expected that these two dimensions will be independent of one another. Also, it is expected that both autonomy support and parent’s elaborative talk will be important for children's learning during the building activity in this study. For example, parents that provide autonomy supportive behaviors during a STEM activity will allow for their children to develop their own ideas and contributions about it. By examining the dimensions of children’s elaborative talk, parents’ elaborative talk, and parental autonomy support individually during the current study, the role that social interactions play in helping children to understand STEM concepts may be further understood.

Overview of Current Study

This study utilized data that were collected at the Chicago Children's Museum. Parents and their 4- to 8-year old children engaged in building activities during a visit to the *Skyline* exhibit. Before engaging in these activities, all families received an Engineering Demonstration that provided them with information about the importance of cross-bracing to make a structure sturdier. Prior research findings suggest the importance of providing families with key engineering principles prior to engaging in a building activity (Benjamin et al., 2010; Haden et al., 2014). For example, Haden et al. (2014) found that when families were provided with information about the importance of cross-bracing prior to participating in a building activity, then they incorporated more braces in their structures than those families that did not receive this information. Receiving this engineering information also helps children to recall STEM concepts days and weeks after a museum visit (Benjamin et al., 2010). When families hear engineering principles prior to engaging in a building activity, it can help to facilitate their use of engineering concepts during a task, as well as their recall of these concepts at a later point in time (Benjamin et al., 2010).

Families were randomly assigned to receive *Anticipated Transfer* instructions or not receive them. The families that received these instructions were informed that after completing the first task together, then the children would work on a second task alone, without their parents help. It was thought that by highlighting that children would be able to utilize the knowledge that they gained from one learning context (i.e. during the building task) in another (i.e. during the fixing task), then parents might talk with children in a way that made the learning more portable and generalizable. When children

are able to utilize information learned in one learning context in another context, then this is referred to as transfer of knowledge (see Goldstone & Day, 2012, for review). Examples of contexts in which children may learn information are through engaging with physical objects or through social interactions, such as with their parents (Jant et al., 2014). During the current study, children were able to engage with the same physical objects during the two tasks. When they utilized the materials during the first task, it was hoped that they would learn how to solve the problem (i.e. make a sturdy skyscraper) and then transfer this same approach to the second task (i.e. fix a wobbly skyscraper). This would consist of them using the physical context, or materials, to help guide their knowledge of how to solve the two tasks.

While the children were working on the second task alone, the parents completed a questionnaire that assessed their children's prior building knowledge. It was important to obtain a prior building knowledge score for the children, because previous studies indicate that individuals may have different prior knowledge about a subject and that those individuals viewed as experts tend to have different perspectives on related concepts than novices (Palmquist & Crowley, 2007; Vosniadou et al., 2001). For example, Chi, Feltovich, and Glaser (1981) found that when individuals become experts in an area, then their investigation of materials transitions from one focused on the objects exterior to one focused on its in-depth characteristics. Furthermore, Chi et al. (1981) found that when individuals new to physics described an incline plane then they focused on characteristics such as the height of it, whereas experts were focused on concepts related to physics. In another study, Palmquist and Crowley (2007) found that when children had expertise in the subject of dinosaurs then they were able to identify

more behaviors and characteristics of dinosaurs. They also found that experts engaged in more talk with their parents than those who were considered novices in this subject (Palmquist & Crowley, 2007). These studies suggest that individuals use their prior knowledge to guide their approach to an activity. Therefore, in the current study, it was expected that the children's prior building knowledge would contribute to how they solve the building and fixing tasks. Sturdiness ratings were obtained for both the building and fixing tasks.

Current Study Questions and Hypotheses

Gender and Age

The first set of research questions examined whether the target child's age and gender were associated with the dimensions of problems solving, parental elaborativeness, child elaborativeness, and autonomy support. However, it was hypothesized that there would be significant differences in the dimension of parental elaborativeness, depending on whether the target child was a male or female. Prior work has suggested that parents' with daughters talk differently about science activities than parents of sons (Crowley, Callanan, Tennebaum & Allen, 2001; Tenenbaum & Leaper, 2003). For example, the study by Crowley et al. (2001) found that both boys and girls could become engaged in an informal science setting with their parents. However, the researchers also found that when fathers visited this context with their children, then they were more likely to provide explanations about the exhibit to their sons compared to their daughters. This difference in providing explanations could be due to the parents' beliefs that interests in science are more likely to be held by their sons compared to their daughters (Tenenbaum & Leaper, 2003). Importantly, the differences in fathers' talk with

their children were found even though the male and female children were no different in their interest in science (Tenenbaum & Leaper, 2003). However, it was also hypothesized that there would not be gender differences in the dimensions of problem solving, children's elaboration, or autonomy support, regardless of whether the target child was a male or a female.

It was also hypothesized that parents of older children would be more elaborative than parents with younger children. Differences in the ways parents' talk with children of different ages have been documented in many literatures, including the literature on reminiscing. For example, Reese et al. (1993) found that parents became more elaborative as children aged. Furthermore, it was hypothesized that families would receive higher scores on the problem solving dimension when the target child was older versus younger. This hypothesis stems from prior work that indicates that the strategy that an individual utilizes to solve a problem is dependent on the individual's age (see Siegler, Adolph, & Lemaire, 1996; Siegler, 1996, for review). Given that different strategies can be utilized depending on an individual's age, it may be that during the current building activities, older children may utilize more and different strategies than younger children. This increased strategy use could in turn lead older children to receive higher scores on the problem solving dimension compared to younger children. Lastly, it was hypothesized that children's elaborativeness and autonomy support would not be affected by the age of the target child.

The last set of hypotheses that were examined in regards to age and gender were about the sturdiness ratings of the first and second tasks. It was hypothesized that male target children would make the structures sturdier during the first and second task

compared to female target children, perhaps related to the additional support they were receiving from parents. It was also hypothesized that older children would make the structures sturdier during both tasks.

Independence of Focal Dimensions

The second research question concerned whether the dimensions of problem solving, parents' elaborativeness, children's elaborativeness, and parental autonomy support were independent of one another. This question stemmed from prior research findings by Cleveland and Reese (2005), which signify that autonomy support and mother's elaborative structure were independent of one another during reminiscing with their children. Given this prior finding, it was hypothesized that the four dimensions – problem solving, parents' elaborativeness, children's elaborativeness, and parental autonomy support – would be independent of one another in the current study.

Sturdiness Ratings

The third research question examined whether the sturdiness ratings for both tasks were related to the four focal dimensions. Because the problem solving dimension examined the different strategies and tests that the families performed on the structure, it was hypothesized that the scores on this dimension would be related to the sturdiness ratings for both tasks. Also, it was hypothesized that parents' elaborativeness, children's elaborativeness, and parental autonomy support would not be related to the sturdiness ratings of both tasks.

Anticipated Transfer

The fourth set of questions concerned whether there were significant differences in the scores on the four focal dimensions depending on whether or not families received

the *Anticipated Transfer* instructions. These instructions provided information to the families that the children would complete a second task alone, without their parents help. It was hypothesized that parents and children who received the *Anticipated Transfer* instructions would be more elaborative than families who did not receive these instructions. Put another way, parents' and children who received the transfer instructions would be rated higher on elaborativeness than those who did not receive *Anticipated Transfer* instructions. Further, it was hypothesized that there would not be any significant differences between the two transfer groups in the scores on problem solving and autonomy support, regardless of whether the families received these instructions or did not receive them. Additionally, it was hypothesized that families that received the *Anticipated Transfer* instructions would build sturdier structures during both tasks compared to those families that did not receive these instructions.

The last set of hypotheses related to *Anticipated Transfer* concerned whether the gender of the target child interacted with these instructions and then affected the scores on the four focal dimensions, as well as the sturdiness ratings for both buildings. It was hypothesized that whether the target child was male or female, and whether or not the participants received the *Anticipated Transfer* instructions, would affect the scores on the four dimensions, and the building outcomes for both tasks. Furthermore, it was hypothesized that families that received the *Anticipated Transfer* instructions and had a target child that was a male would build sturdier structures compared to families that consisted of a male target child but did not receive these instructions.

Prior Building Knowledge

The last set of research questions examined whether prior building knowledge was associated with the dimensions of problem solving, parent's elaborative structure, children's elaborative structure, and parental autonomy support. Prior studies have noted that the amount of expertise that individuals have affects how they view and approach topics (Glaser & Chi, 1988; Palmquist & Crowley, 2007; Vosniadou et al., 2001). Therefore, it was hypothesized that the children's prior building knowledge would be associated with their scores on the problem solving dimension.

Other research findings indicate the importance of parental autonomy supportive behaviors for children's interest and engagement in activities as they unfold (Cleveland et al., 2007; Cleveland & Morris, 2014; Cleveland & Reese, 2005). Given this, it was hypothesized that children's prior building knowledge would be associated with the autonomy support dimension.

The last set of hypotheses that were conducted in regards to children's prior building knowledge concerned whether how much parents thought their children knew about building would be related to the sturdiness ratings on the first, building task, and second, fixing task. It was hypothesized that children who had the greatest prior building knowledge would be able to construct sturdier structures in both tasks (i.e. building and fixing) compared to those with less prior building knowledge.

CHAPTER TWO

METHODS

Participants

The participants were 74 families with their 4- to 8-year-old children who were seen in the *Skyline* exhibit at the Chicago Children's Museum. The families were included in the sample based on completing at least eight minutes of the first task and the sound quality allowed the researchers to hear the participants' conversations. Of the families that were included in the final sample, there were 36 male and 38 female target children. When there were multiple children per family in the 4- to 8-age range, or children outside of this age range, the target child for this study was the oldest child in the family within the age range. The average age of the target children was 6.47 years (*SD* = 1.35). In the sample, 60.8% of the target children are Caucasian, 6.8% Asian, 13.5% Hispanic/Latino, 6.8% African American, and 12.2% are another race/ethnicity or more than one race. 75.7% of the mothers had either a college degree or higher. Also, 78.4% of the parents had an income of $75,000 or higher. For participating in the study, the children received a slinky and the parents received a $10 Target gift card.

Procedure

Families were invited to participate as they entered the *Skyline* exhibit at the Chicago Children's Museum. Parents completed informed consent forms and the children provided their assent. The building (i.e. first) and fixing (i.e. second) tasks were audio

and video recorded. The procedures described in detail below began with all families receiving engineering information at a demonstration station in the museum exhibit. Some families were also told about a project that their children would complete immediately after the family built together, whereas others were not provided this information, an experimental manipulation we called *Anticipated Transfer*. Then, all families built a skyscraper in the Skyscraper Challenge building area of the *Skyline* exhibit. Last, all children were asked to fix a wobbly skyscraper. Parents completed a background questionnaire as their children completed the second task.

Engineering Information

Prior to building in the Skyscraper Challenge, the families were directed to a demonstration station in the exhibit, shown in Figure 1, and the researcher guided them through the illustration of a key engineering principle: cross-bracing. Specifically, families were invited to examine the wobbly square and then the children were asked, “Where do you think I should put this middle piece to stop it from wobbling? Do you think I should put it here at 1? Or do you think I should put it here at 2?” If one of the children responded "1," then the middle piece was placed horizontally across the square and the sturdiness of the square was tested. Then, the researcher suggested moving the middle piece to the second position, where a diagonal was created. If one of the children responded "2," then the middle piece was placed at the bottom of the structure, creating a diagonal, and the sturdiness of this placement was tested. All families heard that placing the middle piece at the second spot created two triangles and that triangles are the strongest shape.

Figure 1. Engineering demonstration at the Chicago Children's Museum.

***Anticipated Transfer* Instructions**

Families were randomly assigned to either receive or not receive additional instructions about a second problem solving task that the children would perform immediately after building with their families. The *Anticipated Transfer* instructions involved telling the families that all of the children, including the target child, that participated in the study would be asked to work on their own to fix a wobbly skyscraper. A picture of the wobbly skyscraper can be found in Figure 2. Families in the *No Anticipated Transfer* condition began building immediately after the engineering

information demonstration and were not provided with information about the fixing task.

Figure 2. Wobbly skyscraper used during fixing task.

Building in Skyscraper Challenge

The building activity occurred in the Skyscraper Challenge area of the *Skyline* exhibit at the Chicago Children's Museum. This area of the exhibit offered families the opportunity to build skyscrapers from small-scale plastic pieces, including struts, braces, nuts, and bolts. Positioned over each building area is a puffy white cloud approximately 9 feet above the building area. A picture that indicates what the building station where the participants worked during the study looks like can be examined in Figure 3. The station where families built was also equipped with built in video and audio recording equipment to allow unobtrusive recording of the building interactions.

Figure 3. Building area in the Skyscraper Challenge area.

All children and their parents were asked to build a skyscraper together and find a way to brace it. Families were told that they would have twelve minutes to work on the task. After the twelve minutes passed, the researcher asked them if they needed more time to fix the structure. If they responded “yes,” then they received three more minutes to work on the task.

Fixing Task

Immediately after building with their families, the children were shown the wobbly skyscraper and asked to work on their own, without their parents’ help, to fix it so that it wouldn’t wobble anymore. The children were told that they would have twelve minutes

to fix the skyscraper. After twelve minutes, the researcher then asked the children if they would like more time to fix the skyscraper. If they responded with “yes,” then they received three more minutes to work on the task.

Background Questionnaire

While the children were fixing the wobbly skyscraper, the parents completed a questionnaire. As shown in the Appendix, the questionnaire assessed sociodemographic information including, parents and children’s ethnicity, gender, and race, as well as the children’s ages, and the parents’ education and occupation, and family income level.

As also shown in the Appendix, the background questionnaire included items concerning the children’s prior knowledge and interest in building. These items were assessed using 7-point rating scales, ranging from knew very little (1) to know a great deal (7). Parents also completed 12 questions about their children’s play habits, reporting the amount of time that their children used different kinds of toys. These play habits were also rated on a 1 to 7 scale, ranging from almost never (1) to daily (7).

To obtain information about the children’s prior building knowledge, the parents’ responses to several questions from the questionnaire were examined. Furthermore, the parents’ response to the question in which they evaluated the amount of information that the children knew about building before their museum visit was examined. Parents also completed two other questions that were examined to obtain information about the children’s prior building knowledge. These questions asked the parents to evaluate the children’s time spent playing with LEGOs and construction toys during an individual week.

Coding

Family Building Activity

Four separate coding systems were utilized, one to characterize each of the four focal dimensions: problem solving, parents' elaborative talk, children's elaborative talk, and parental autonomy support. Ratings for each dimension were on a 1 (low) to 5 (high) scale, and were utilized to characterize the entire family building interaction (approximately 12 to 15 minutes in duration). Separate coding passes were conducted, one for each dimension.

Problem Solving

The interactions during the building task were evaluated for parents and their children's joint problem solving. As shown in Table 1, the lower scores suggest that during the task there were limited efforts to make the structure sturdier or to test the structure. A higher score on this scale suggests that families applied materials to their skyscraper, tested their skyscraper, and then revised their strategies as a result of their tests.

Table 1. Scoring Criteria for the Problem Solving Coding Scheme

Code	Definition	Example
1	Families apply materials to the structure, but there is no overall plan or systematic attempt to solve the problem. They do not test the structure after adding materials to it.	They only use girders and mending plates to build the skyscraper. They also do not test the structure.
2	Families apply only one strategy to solve the problem. They test the structure one time. After testing, they continue to use the same strategy. They do not apply more than one strategy to solve the problem.	They tighten bolts, shake the structure, and then continue tightening bolts.
3	Families test the structure at least once and engage in two or more strategies to the problem. There is no attempt to revise unsuccessful attempts to stabilize the structure.	They utilize a triangle and add “more” to the structure, but do not revise the strategies. They also shake the structure to test the sturdiness of it.
4	Families test the structure at least once (e.g. shaking). One time during the task, families revise a previous strategy and then test the structure again. Afterwards, families either pursue the strategy or they revise and pursue a new strategy.	They utilize a cross-brace and then shake the structure. They then continue to use cross-braces or they change to triangles. They then shake the structure again.
5	Families test the structure at least once (e.g. shaking). Two times during the task, families revise previous strategies. The family will then test the structure again.	They tighten the bolts and then shake the structure. Next, they utilize a cross-brace and shake the structure again. They then continue to use a cross-brace or use triangles instead.

Parents' Elaborative Talk

Coding of elaborative talk was based on a system developed by Laible, Panfile, and Augustine (2013). Parents and children received separate ratings based on the elaborative

talk demonstrated across the entire interaction, with each rating being on a 5-point scale. The parental elaboration coding scheme focused on parents' use of open-ended *Wh*-questions (e.g., Who, What, Where, How, Why) and statements that contributed new information throughout the interaction. As shown in Table 2, lower scores were assigned when parents frequently repeated the same question or statement over and over again, and infrequently asked *Wh*- questions and provided new information in statements that moved the conversation forward. Higher scores were assigned when parents were frequently elaborative, as characterized by frequently asking *Wh*- questions and statements that followed-up on and extended children's talk and behaviors.

Table 2. Scoring Criteria for the Parental Elaboration Coding Scheme

Code	Definition	Example
1	Parents incorporate more repetitions than elaborations into the conversation. They ask the same or similar question several times. The questions are used to receive particular information and often result in the parent rejecting ideas that do not relate to the requested information. Also, the repetitions that are used occur when the parent repeats him/herself. In addition, there are no or very few open-ended questions. Parents rarely provide input, incorporate statements, or utilize elaborations throughout the conversation. The statements and questions that the parent contributes do not shape the conversation.	The parent suggests using a triangle to make the skyscraper sturdier. The child responds with an idea to use mending plates instead. The parent negates this idea and again repeats the idea that they should use a triangle.
2	Parents utilize slightly more elaborations than repetitions into their conversation. Parents utilize a high level of repetition and it does not seem warranted. The repetitions are used to repeat the child's talk more often than the parent's talk. The bulk of the parents' questions (besides a couple) are not open-ended. These questions may be used to obtain information about the task from the child. Parents occasionally contribute statements and questions to the conversation. These contributions are relatively brief and are not expanded on during the conversation.	Throughout the task, the parent asks whether their skyscraper is sturdy. The child responds with no and that they should use cross-braces. The parent then repeats that they should use cross-braces.

3	Parents use a balance of repetitions and elaborations. The parent uses half of the repetitions to repeat the child and the other half to repeat him/herself. Approximately half of the parents' elaborations are used to direct the child's attention to a particular aspect of the task. Also, half of the elaborations are used to obtain information about the task from the child. Half of the time, the parent then provides feedback on the child's response. Parents ask a balance of open-ended questions and yes-no questions throughout the conversation. The parents' contributions are expanded on during the conversation.	The parent states that they should check the sturdiness of the structure. The child does not respond to this and the parent then repeats him/herself. The parent then checks the sturdiness and the child suggests using a cross-brace. The parent then provides feedback on the child's idea.
4	Parents use slightly less repetitions than elaborations during the conversations with their children. Parents occasionally use repetitions, but these instances are justified. When parents use repetitions, they are used to repeat the child more than to repeat themselves. There may be several cases, however, where repetition is not warranted. The parents' questions are open-ended, although there may be several that are not. The parents' questions tend to be used to obtain the child's input about an aspect of the task.	The parent asks the child where they should add the triangle. The child states that it should be added as a roof. The parent then repeats the child's idea, but also asks if they could add it anywhere else on the structure.
5	Parents' inputs into the conversation are almost always elaborations and are rarely repetitions. Parents use repetitions throughout conversations only when it is justified. When parents use repetitions, they are used to repeat the child more than to repeat themselves. Most of the questions that the parents ask are open-ended. Parents incorporate statements and elaborations into their conversations to direct the child's attention to a particular aspect of the task or to obtain information about it. The statements and questions that the parents contribute provide the structure of the conversation, but they build on the child's responses.	The parent asks the child what they should use to build the base. The child responds that they should use triangles. The parent then repeats this idea and the parent questions if triangles would work. The child then provides the idea to use a girder instead.

Table 3. Scoring Criteria for the Child Elaboration Coding Scheme

Code	Definition	Example
1	The child rarely contributes a few ideas or responses about the current conversation.	The parent asks questions about using triangles in their structure. When responding to the parent, the child's responses include content other than building.
2	The child sometimes provides a few ideas or responses about the current task.	The parent asks if they should add a triangle to the structure and the child's response does not provide information about this strategy or other building concepts. The parent then continues to ask questions about building and the child's responses sometimes include information about building.
3	The child contributes either a response or idea for approximately half of the time that is about the current conversation.	The parent asks if they should test the structure and the child's response is not about building. Then, the parent asks more questions about the structure and approximately half of the child's responses are about building.
4	The child contributes many responses or ideas throughout the conversation that are about the current task.	After testing the structure, the parent asks if they should continue using triangles. The child's response is about this strategy. The parent continues to ask the child questions related to building. Most of the child's responses are about building; however, there are a few instances where the responses are related to another topic.
5	The child contributes ideas or responses throughout a majority of the conversation that are about the current task.	The parent asks if they should continue using cross-braces and the child's response is about this strategy. When the parent asks other building questions, the child's responses often include information about the task.

Children's Elaborative Talk

The children's elaborative talk was scored as described in Table 3. The children's elaborative talk coding scheme focused on differences between task-related and off-topic

spontaneous talk throughout the task. The lowest code suggests that the children contributed more off-topic spontaneous talk, whereas the highest code suggests that the children contributed mostly on-topic talk. Also, lower scores were assigned if children were rarely contributing ideas or responses, whereas the higher scores indicated children were frequently contributing new information to the conversation in response to parents' questions.

Parental Autonomy Support

The autonomy support coding system was adapted from Cleveland and Reese (2005) and Cleveland, Reese, and Grolnick (2007). The coding system provides an overall rating of the degree of autonomy support displayed across the entire interaction. As shown in Table 4, lower scores, which indicate lower autonomy support, characterize interactions where children's contributions were frequently ignored and parents' focused on their own plans all or most of the time. The higher scores correspond to higher autonomy support and were indicated by children's contributions to the conversation being frequently met with parents' conversational input that supported these contributions.

Table 4. Scoring Criteria for the Parental Autonomy Support Coding Scheme

Code	Definition	Example
1	Almost all of the parent's statements or questions function to change the topic of the conversation to their agenda. The parents also explicitly negate the child without providing helpful follow-up information.	The child suggests that they should utilize cross-braces, but the parent ignores this idea. Instead, the parent then states that they need to utilize mending plates without providing a reason why these would be useful.
2	Almost all of the parent's statements or questions function to change the specific focus of the conversation or gently negates the child.	The child states that they should utilize mending plates to build the walls. The parent then suggests that they try to use girders for this instead.
3	Almost all of the parent's statements or questions function to continue the general topic/agenda of the conversation, but in a specific direction.	The child states that they should use triangles to create a roof. The parents confirm that triangles would be useful to add. However, the parents then suggest that the triangles are used on the sides of the building instead of the roof.
4	Almost all of the parent's statements or questions function to sustain the child's topic/agenda in the conversation.	The child states that they should utilize triangles to make the structure sturdier. The parent confirms this idea and utilizes this strategy when building.
5	Almost all of the parent's statements or questions function to continue or expand on the child's topic/agenda in the conversation.	The child suggests that they should utilize triangles. The parent then follows up asking why these would be more useful than girders.

Coding of Final Structures

During the building task, the families were able to utilize different materials to make the structures sturdier. Functional pieces improved the sturdiness of the structures. Placements that improved sturdiness included triangular pieces that were connected at all three points, or using one or two straight pieces to create a diagonal brace or a cross-brace. In contrast, non-functional pieces were those that did not improve the sturdiness of the structure. We counted the number of functional pieces, non-functional pieces, and then summed the functional and non-functional pieces to obtain the total number of pieces added to each structure. Then, the ratio of functional pieces to total pieces for the structure was calculated by dividing the number of functional pieces and by the total pieces added. The method used to calculate the ratios was adapted from a prior study that examined parents and their children's building engineering in the *Skyline* exhibit at the Chicago Children's Museum (Haden et al., 2014).

Interrater Reliability

Shrout-Fleiss intraclass correlation coefficients were utilized to assess interrater reliability on 25% of the videos separately for the problem solving, parents' elaborativeness, children's elaborativeness, and parental autonomy support scales. Percentage agreements were 89% for problem solving, 87% for parents' elaborativeness, 88% for children's elaborativeness, and 83% for parental autonomy support.

CHAPTER THREE

RESULTS

Preliminary Analyses and Approach

As a first step, the distributions of ratings − illustrated in Figure 4 - 7 − for each of the four focal dimensions were examined. Whereas the frequencies − the number of parents/children receiving a rating of 1, 2, 3, 4, 5 − was fairly well distributed for problem solving (Figure 4), parent elaboration (Figure 5), and child elaboration (Figure 6) across the ratings, the autonomy support distribution (Figure 7) was skewed towards the lower scores. Given this, the decision was made to recode the autonomy rating to a dichotomous variable, with zero meaning autonomy support was absent (n = 23, or 31% of sample) and one meaning autonomy support was present (n = 51, 69% of sample). Chi-square tests were used in the analyses involving autonomy support.

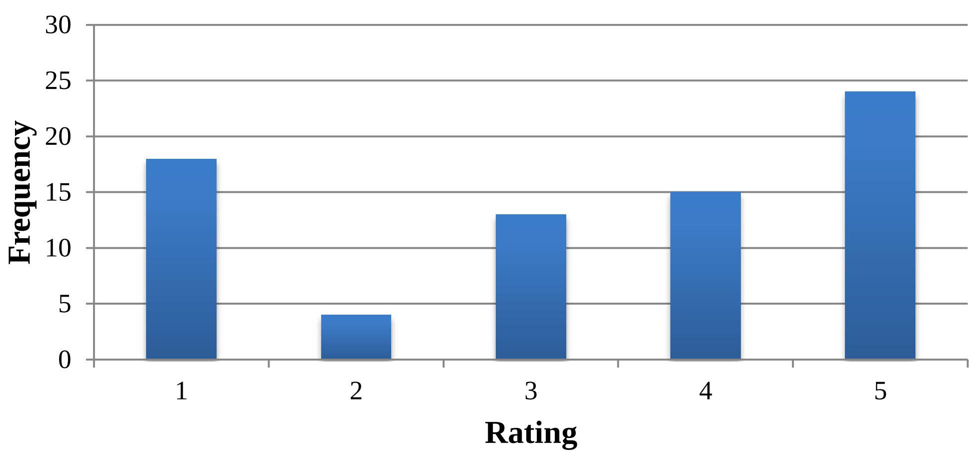


Figure 4. Number of families per problem solving rating.

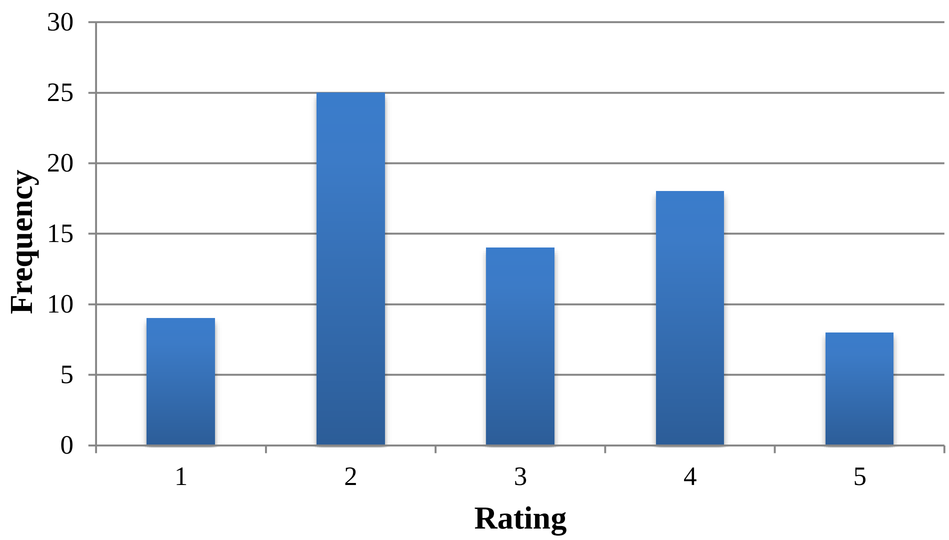


Figure 5. Number of families per parental elaboration ratings.

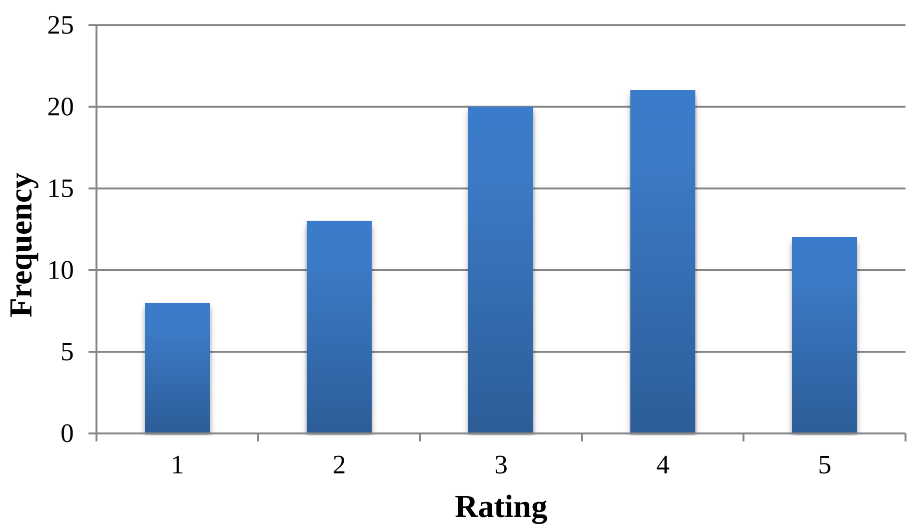


Figure 6. Number of families per children’s elaboration ratings.

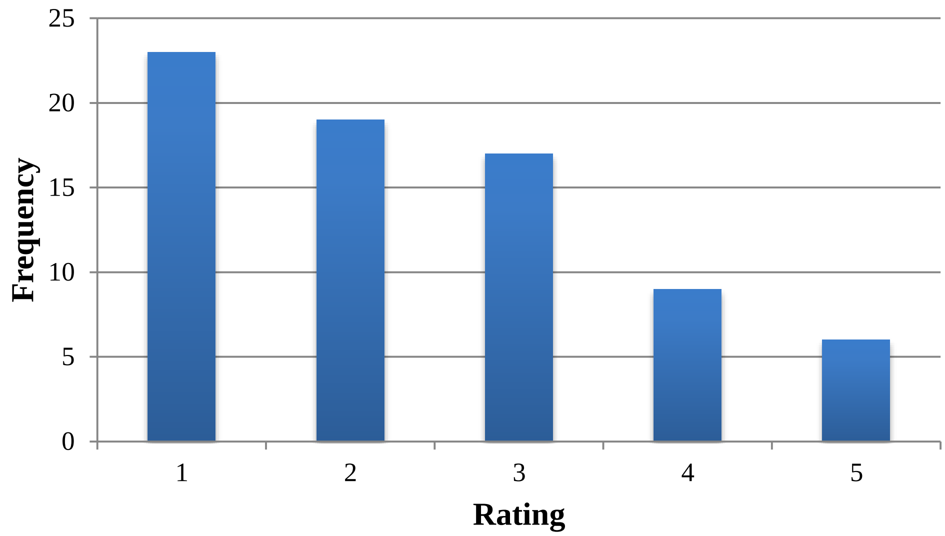


Figure 7. Number of families per parental autonomy support ratings.

Because the focal dimensions were ordinal scale data, it was appropriate to use Mann-Whitney U tests when comparing group differences (e.g., by gender, by *Anticipated Transfer*). However, with Mann-Whitney U, there is a possibility that a Type II error could occur (Wheater & Cook, 2000). This error occurs when two groups are actually different than one another, yet the results indicate that that they are actually equal to one another on the dependent measure (Field, 2013). Therefore, in preliminary analyses, independent samples t-tests were run alongside the Mann-Whitney U test, as a check for Type II error. The t-test and U-tests revealed the same results in every case. Therefore, only the Mann-Whitney U tests are reported in the main analyses.

With regard to the measurement of sturdiness, Table 5 provides information about the number of pieces added by families in the first, building task, and by the children in the second, fixing task. Figure 8 shows the distributions of the number of functional pieces added by the children in the fixing task. As shown, 38 children did not add a functional piece during the second task. Therefore, it was decided to examine the second

task sturdiness as a dichotomous variable where a 0 indicates that the children did not utilize at least one brace and a 1 indicates that children did utilize at least one brace during the second task.

Table 5. Range, Median, Mean, and Standard Deviation of Functional, Non-Functional, and Total Pieces Added During Both Tasks

Variable	Range	Median	Mean	Standard Deviation
First Task				
Functional Pieces	0.00 – 9.00	2.00	2.43	2.26
Non-Functional Pieces	6.00 – 50.00	19.00	19.92	9.10
Total Pieces	6.00 – 50.00	20.50	22.35	9.46
Functional/Total Pieces	0.00 – 0.35	0.09	0.11	0.10
Second Task				
Functional Pieces	0.00 – 16.00	0.00	1.88	3.01
Non-Functional Pieces	0.00 – 15.00	4.00	3.76	3.50
Total Pieces	0.00 – 16.00	5.00	5.64	3.73

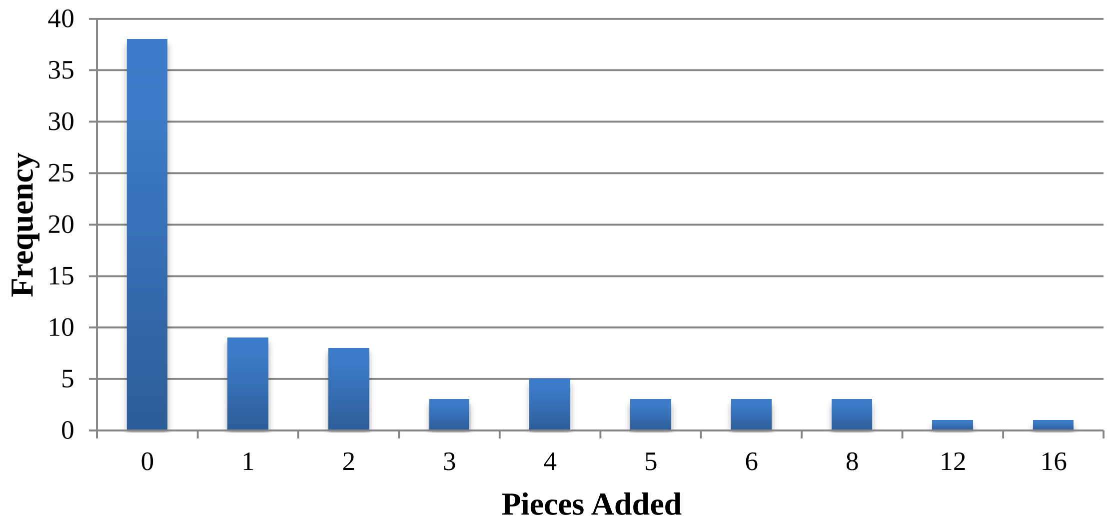


Figure 8. Number of children per functional pieces added during second task.

Main Analyses

Child Gender

The first research question concerned whether the gender of the target child (oldest child in the 4 to 8 age range in the family group) was related to ratings on the four focal dimensions, and with building sturdiness as judged on the first building and second fixing task. Table 6 displays the descriptive statistics for the target child's age and gender, for each of the four focal dimensions, and for the building sturdiness in the building (first) and fixing (second) tasks.

Table 6. Mean and Standard Deviations for Age and Four Focal Dimensions

Variable	Frequency	Range	Median	Mean	Standard Deviation
Age (Years)	74	4.01 – 8.98	6.59	6.47	1.35
Male	36	4.32 – 8.98	6.63	6.55	1.29
Female	38	4.01 – 8.97	6.17	6.40	1.41
Problem Solving	74	1.00 – 5.00	4.00	3.31	1.57
Parental Elaboration	74	1.00 – 5.00	3.00	2.88	1.23
Child Elaboration	74	1.00 – 5.00	3.00	3.22	1.23
Parental Autonomy Support	74	0.00 – 1.00	1.00	0.69	0.47
Building Sturdiness					
First Task	74	0.00 – 0.35	0.09	0.11	0.10
Second Task	74	0.00 – 1.00	0.00	0.49	0.50

Mann-Whitney U tests were conducted to examine if there were significant differences by target child gender in the scores on the problem solving, parental elaboration, and child elaboration dimensions. Although the Mann-Whitney test computes and examines mean ranks when examining whether there are significant differences between two conditions, these ranks may be difficult to interpret. Therefore, Table 7 provides mean ranks along with medians, means, and standard deviations for the problem solving, parental elaboration, and children's elaboration dimensions by child gender.

Table 7. Mean Ranks, Means, Standard Deviations, and Medians for Each Focal Dimension by Target Child's Gender

Focal Dimension by Gender	Mean Rank	Median	Mean	Standard Deviation
Problem Solving				
Male Children	38.56	4.00	3.42	1.52
Female Children	36.50	3.00	3.21	1.63
Parental Elaboration				
Male Children	38.74	3.00	2.94	1.17
Female Children	36.33	2.50	2.82	1.29
Child Elaboration				
Male Children	34.24	3.00	3.03	1.30
Female Children	40.59	4.00	3.39	1.15

It was hypothesized that there would not be a significant difference between male and female children for ratings of problem solving while building. This hypothesis was confirmed with a Mann-Whitney U-test, $U = 646.00$, $p = .67$, $r = -.05$. It was also hypothesized that parental elaborativeness would be rated as higher when the target child was a male versus a female. This hypothesis was not supported with a Mann-Whitney U-test, $U = 639.50$, $p = .62$, $r = -.06$. It was hypothesized that there would not be significant differences between male and female children in ratings of child elaborativeness. Confirming this hypothesis, the Mann-Whitney U was not significant, $U = 566.50$, $p = .19$, $r = -.15$.

It was also hypothesized that there would not be significant differences by target child gender for ratings of autonomy support. To examine this hypothesis, a Pearson chi-

square was performed. Table 8 shows the observed number of male and female children in the two autonomy support groups (absent, present). The chi-square was not statistically significant, X^2 (1) = .36, p = .55, confirming the hypothesis of no child gender differences for autonomy support.

Table 8. Observed (and Expected) Values for the Distribution of Families in the Autonomy Support Condition by Children's Gender

Autonomy	Gender		
Support	Male	Female	Total
Absent	10.0 (11.2)	13.0 (11.8)	23.0 (23.0)
Present	26.0 (24.8)	25.0 (26.2)	51.0 (51.0)
Total	36.0 (36.0)	38.0 (38.0)	74.0 (74.0)

It was hypothesized that compared with female target children, male target children would build a sturdier structure as indexed by the sturdiness ratio (functional pieces/total pieces) for the first task. An independent samples t-test was conducted to test for child gender differences on the ratio variable. Contrary to this hypothesis, the result of the independent-samples t-test was not statistically significant, $t(72) = .03$, $p = .98$. Thus, the male target children ($M = .11$, $SD = .10$) did not build sturdier skyscrapers during the first task compared to the female target children ($M = .11$, $SD = .10$).

It was also hypothesized that male children would make the wobbly structure sturdier than female children. This was measured in terms of whether or not the children used at least one brace/functional piece the structure. A Pearson chi-square was conducted to examine this hypothesis. The observed and expected number of male and female children who did and did not brace the structure is shown in Table 9. The chi-

square was not significant, X^2 (1) = .05, p = .82. Therefore, there were no differences in children's performance of the second fixing task by child gender.

Table 9. Observed (and Expected) Values for the Distribution of Children That Braced or Did Not Brace Second Structure by Children's Gender

Sturdiness	Gender		
	Male	Female	Total
No Brace	18.0 (18.5)	20.0 (19.5)	38.0 (38.0)
Brace	18.0 (17.5)	18.0 (18.5)	36.0 (36.0)
Total	36.0 (36.0)	38.0 (38.0)	74.0 (74.0)

Overall, the analysis for effects of child gender revealed no statistically significant differences between male and female target children on any measure. This means that the hypotheses indicating that there would not be significant differences in the problem solving, children's elaboration, and autonomy support dimensions were supported. However, the hypothesis that parents would demonstrate more elaborativeness with their sons than their daughters was not supported. The hypotheses that males would make the skyscrapers sturdier during the first and second tasks also did not receive support.

Child Age

It was hypothesized that the target child's age would be significantly associated with ratings on the parental elaboration and problem solving dimensions, but not with the children's elaboration and autonomy support dimensions. To examine these hypotheses, Spearman rank-order correlation coefficients were computed between the target child's age and the problem solving, parental elaboration, and children's elaboration dimensions. There was not a significant correlation between the target child's age and problem

solving, $r_s(74) = .05$, $p = .69$, parental elaboration, $r_s(74) = -.21$, $p = .08$, nor the children's elaboration dimension, $r_s(74) = .13$, $p = .29$. Next, the hypothesis of age being related to autonomy support was examined through an independent-samples t-test. There was not a difference between families where autonomy support was present ($M = 6.42$, $SD = 1.34$) versus absent ($M = 6.59$, $SD = 1.37$), $t(72) = .52$, $p = .61$, for child age.

It was hypothesized that the target child's age would be significantly related to the sturdiness ratings of both tasks. A Spearman rank-order correlation was conducted to examine the relatedness of age and sturdiness for the first task. Contrary to the hypothesis, there was not a significant correlation between children's age and the sturdiness ratio on the first task, $r_s(74) = -.12$, $p = .33$. Next, an independent-samples t-test was conducted to examine child age differences in bracing the structure in the second task. Also contrary to the hypothesis, there was no age difference between children who braced ($M = 6.68$, $SD = 1.33$) or did not brace ($M = 6.28$, $SD = 1.35$) the wobbly structure on the second task, $t(72) = 1.29$, $p = .20$.

Overall, there were no effects of age for any of the measures. This indicates that the hypotheses suggesting that age would be related to the dimensions of problem solving and parental elaborativeness were not supported. There was support for the hypotheses that age would not be related to the dimensions of children's elaborativeness and autonomy support. The hypotheses suggesting older children would build sturdier structures than younger children was also not supported.

Independence of the Dimensions

The second research question concerned whether the four dimensions – problem solving, parents' elaborative structure, children's elaborative structure, and autonomy

support – were independent. It was hypothesized that all four dimensions would be independent of one another. To examine this hypothesis, Spearman rank-order correlation coefficients were computed among the problem solving, parents' elaborative structure, and children's elaborative talk dimensions. There was not a statistically significant correlation between problem solving and parental elaboration, $r_s(74) = -.17$, $p = .15$, nor problem solving and children's elaborative talk, $r_s(74) = -.01$, $p = .91$. Therefore, the hypothesis of independence of the dimensions of elaborativeness and problem solving did receive support. However, contrary to the hypothesis, parent and child elaborativeness were significantly correlated, $r_s(74) = .23$, $p < .05$. This means that as ratings of parental elaboration increased, so did the child elaboration ratings.

To test for associations with autonomy support, Mann-Whitney U tests were used. Table 10 shows the mean ranks, means, standard deviations, and medians for problem solving, parental elaboration, and child elaboration by autonomy support (presence, absence). Ratings of problem solving did not differ by presence or absence of autonomy support, $U = 584.00$, $p = .98$, $r = -.003$, suggesting these two dimensions were independent. However, parents that demonstrated autonomy supportive behaviors had significantly higher parental elaboration scores than those that did not demonstrate autonomy support, $U = 241.50$, $p < .001$, $r = -.48$. Also, parents who demonstrated autonomy support had children with higher child elaboration ratings than parents who did not demonstrate autonomy support, $U = 397.00$, $p = .02$, $r = -.26$.

Table 10. Mean Ranks, Means, Standard Deviations, and Medians for Each Focal Dimension by Autonomy Support

Focal Dimension by Autonomy Support	Mean Rank	Mean	Standard Deviation	Median
Problem Solving				
Autonomy Support Absent	37.39	3.35	1.50	4.00
Autonomy Support Present	37.55	3.29	1.62	4.00
Parental Elaboration				
Autonomy Support Absent	22.50	2.00	0.80	2.00
Autonomy Support Present	44.26	3.27	1.18	3.00
Children's Elaboration				
Autonomy Support Absent	29.26	2.70	1.33	3.00
Autonomy Support Present	41.22	3.45	1.12	4.00

Although the hypothesis was that the four focal dimensions would be independent of one another, the results provided only partial support for this idea. Problem solving was independent, as judged by the lack of correlation with the other dimensions. However, parental elaborativeness was associated with child elaborativeness. Moreover, also contrary to the hypothesis, autonomy support was related to parental and child elaborativeness.

Sturdiness of the Two Structures

It was hypothesized that the sturdiness rating for the first task would be related to the sturdiness rating of the second task. An independent samples t-test was conducted to examine this hypothesis. The results indicate that children who braced the second structure did not have sturdier first structures (M = .13, SD = .09) than those that did not

brace the second skyscraper (*M* = .09, *SD* = .10), *t*(72) = 1.77, *p* = .08. Overall, this suggests that the sturdiness ratings for the first task did not affect the sturdiness ratings for the second task.

Focal Dimensions and Sturdiness Ratings

It was hypothesized that the problem solving dimension would be related to the building sturdiness of the first task. This hypothesis was in fact confirmed by a Spearman rank-order correlation, $r_s(74) = .27$, $p = .02$. It was also hypothesized that building sturdiness on the first task would not be related to parental or child elaborativeness. The results indicate that parents' elaborativeness, $r_s(74) = .09$, $p = .45$, and children's elaborativeness, $r_s(74) = .10$, $p = .40$, were not related to the sturdiness of the first skyscraper. It was also hypothesized that sturdiness of the first building would not differ by whether or not the parents demonstrated autonomy supportive behaviors. The results of an independent samples t-test indicate that this hypothesis was supported and that there were no differences in the sturdiness for parents who did (*M* = .12, *SD* = .10) and did not demonstrate autonomy support behaviors (*M* = .09, *SD* = .10), *t*(72) = 1.14, *p* = .26.

It was hypothesized that there would be a significant difference in the scores on the problem solving dimension depending on whether the children braced or did not brace the second structure. It was also hypothesized that there would not be differences in parental or children's elaborativeness between children who did and did not brace the second skyscraper. Mann-Whitney U tests were conducted to examine these hypotheses. The descriptive analyses for these results can be examined in Table 11. The results indicate that there were no significant differences between children who did and did not brace the second structure for problem solving, *U* = 646.00, *p* = .67, *r* = -.05, parents'

elaborativeness, U = 615.00, p = .44, r = -.09, nor children's elaborativeness, U = 586.50, p = .28, r = -.13.

Table 11**.** Mean Ranks, Means, Standard Deviations, and Medians for Each Focal Dimension by Second Task Sturdiness Rating

Focal Dimension by Sturdiness Rating	Mean Rank	Median	Mean	Standard Deviation
Problem Solving				
Brace	38.56	4.00	3.42	1.52
No Brace	36.50	3.00	3.21	1.63
Parental Elaboration				
Brace	35.58	2.00	2.78	1.20
No Brace	39.32	3.00	2.97	1.26
Child Elaboration				
Brace	40.21	3.00	3.42	1.05
No Brace	34.93	3.00	3.03	1.37

Then, it was also hypothesized that there would not be significant differences in whether children braced or did not brace the second task between children with parents who were or were not autonomy supportive during the first task. However, the results of a Pearson chi-square indicated that whether parents demonstrated autonomy supportive behaviors during the first task did actually affect whether the children utilized a brace during the second task, X^2 (1) = 5.85 p = .02. The expected and observed values for this analysis are provided in Table 12. The results of the Pearson chi-square indicate that 60.78% of children who had parents that granted autonomy support during the first task did not utilize a brace during the second task. However, only 30.43% of children who had

parents that did not grant autonomy during the first task did not utilize a brace during the second task. This suggests that when parents granted autonomy during the first task, then the children were less likely to utilize a brace during the second task compared to children whose parents did not grant autonomy during the first task.

Table 12. Observed (and Expected) Values for the Distribution of Children That Braced or Did Not Brace Second Structure by Autonomy Support

Autonomy	Brace Second Task		
Support	No	Yes	Total
Absent	7.0 (11.8)	16.0 (11.2)	23.0 (23.0)
Present	31.0 (26.2)	20.0 (24.8)	51.0 (51.0)
Total	38.0 (38.0)	36.0 (36.0)	74.0 (74.0)

To summarize, two hypotheses received support. Problem solving during building was related to sturdiness of the structure constructed during the building task. Also consistent with the hypotheses, parents' and children's elaborativeness, as well as parental autonomy support, were not related to the sturdiness of the first skyscraper. Other hypotheses were not supported. Whether or not the children braced the second structure was not related to problem solving, parent elaborativeness, and child elaborativeness during the first building task. Moreover, autonomy support was related, but not in the way we might have expected. Specifically, the results indicated that children who received autonomy support during the first task were less likely to utilize a brace during the second task compared to those that did not receive autonomy support during the first task.

***Anticipated Transfer* and Focal Dimensions**

Another key question concerned the effects of *Anticipated Transfer* instructions on family interactions during the building and fixing tasks. It was hypothesized that those families that received the *Anticipated Transfer* instructions would receive higher ratings for the dimensions of parents' elaborative talk and children's elaborative talk compared to families who did not receive *Anticipated Transfer* instructions. It was also hypothesized that there would be no difference between families who received or did not receive *Anticipated Transfer* instructions for the problem solving or autonomy. Mann-Whitney tests were conducted to examine these hypotheses. Table 13 displays the descriptive statistics for these analyses. Contrary to the hypothesis, there were no significant differences in whether the families received the *Anticipated Transfer* instructions or not on problem solving, $U = 538.50$, $p = .19$, $r = -.15$, parents' elaboration, $U = 621.00$, $p = .72$, $r = -.04$, nor children's elaboration, $U = 493.00$, $p = .07$, $r = -.21$.

Table 13. Mean Ranks, Means, Standard Deviations, and Medians for Each Focal Dimension by *Anticipated Transfer*

Focal Dimension by *Anticipated Transfer*	Mean Rank	Mean	Standard Deviation	Median
Problem Solving				
Anticipated Transfer	34.97	3.11	1.61	3.00
No *Anticipated Transfer*	41.43	3.62	1.47	4.00
Parental Elaboration				
Anticipated Transfer	38.20	2.93	1.32	3.00
No *Anticipated Transfer*	36.41	2.79	1.08	3.00
Children's Elaboration				
Anticipated Transfer	33.96	3.02	1.18	3.00
No *Anticipated Transfer*	43.00	3.52	1.27	4.00

Moreover, the chi-square test of differences in autonomy support by *Anticipated Transfer* was also not significant**,** X^2 (1) = .000, p = .99. As shown in Table 14, the presence or absence of autonomy support was no different by *Anticipated Transfer* instruction condition.

Table 14. Observed (and Expected) Values for the Distribution of Families in the *Anticipated Transfer* Instruction Condition by Autonomy Support Rating

Autonomy Support	*Anticipated Transfer* No	Yes	Total
Absent	9.0 (9.0)	14.0 (14.0)	23.0 (23.0)
Present	20.0 (20.0)	31.0 (31.0)	51.0 (51.0)
Total	29.0 (29.0)	45.0 (45.0)	74.0 (74.0)

Overall, the hypotheses that there would be no significant differences between families who did and did not receive *Anticipated Transfer* instructions for problem solving and autonomy support were confirmed. However, contrary to hypotheses, families who received the *Anticipated Transfer* instructions or not were also no different on parental or child elaborativeness during building.

***Anticipated Transfer* and Building Sturdiness**

It was hypothesized that families who received the *Anticipated Transfer* instructions would build sturdier buildings than those who did not receive the instructions. An independent samples t-test was conducted for the sturdiness ratio variable to examine the first part of this hypothesis regarding sturdiness in the building task. Opposite to what was hypothesized, the results indicate that the families that did not receive the *Anticipated Transfer* instructions (M = .15, SD = .10) built sturdier structures than those who did receive these instructions (M = .09, SD = .09), $t(72) = 2.45$, p = .02. A Pearson chi-square was conducted to examine the hypothesis that those that received the *Anticipated Transfer* instructions would have a sturdier structure during the second task than those that did not receive these instructions. The observed (and expected) values for this Pearson chi-square are shown in Table 15: the presence or absence of bracing by *Anticipated Transfer* instruction condition. As is apparent from the Table 15, the test was not statistically significant, $X^2(1) = .18$, p = .67.

Table 15. Observed (and Expected) Values for the Distribution of Children That Braced or Did Not Brace Second Task Structure by *Anticipated Transfer*

Sturdiness	*Anticipated Transfer*		
	No	Yes	Total
No Brace	14.0 (14.9)	24.0 (23.1)	38.0 (38.0)
Brace	15.0 (14.1)	21.0 (21.9)	36.0 (36.0)
Total	29.0 (29.0)	45.0 (45.0)	74.0 (74.0)

In sum, the hypotheses that children who received the *Anticipated Transfer* instructions would make the sturdiest structures were not supported. In fact, the children who did not receive the *Anticipated Transfer* instructions actually built sturdier structures compared to those that did receive these instructions. For the second task, there were no significant differences between children who did and did not receive the *Anticipated Transfer* instructions in terms of the sturdiness of the structure.

***Anticipated Transfer* and Child Gender**

When exploring gender effects on their own, none were found. Nevertheless, it seemed possible that child gender could interact with instructions provided to parents to affect building interactions and building sturdiness. To begin to test this idea, a grouping variable with four levels was created: child male – no *Anticipated Transfer*; child female – no *Anticipated Transfer*; child male – *Anticipated Transfer*; child female – *Anticipated Transfer*. A Kruskal-Wallis H test was then conducted to test for differences among these four groups on the dimensions of problem solving, parent elaboration, and child elaboration. Table 16 provides the descriptive analyses for this test. The results indicate that there were in fact no significant differences among the groups for problem solving, X^2 (3) = 1.89, p = .60, parental elaboration, X^2 (3) = 1.26, p = .74, nor children's

elaboration, X^2 (3) = 5.30, p = .15. Overall, scores on the focal dimension of problem solving, parental elaboration, or children's elaboration did not differ by child gender and *Anticipated Transfer*.

A Pearson chi-square was conducted to test if there were differences in the presence or absence of autonomy support among families with male versus female children who did or did not receive the *Anticipated Transfer* instructions. As shown in Table 17, the chi-square results were not statistically significant, X^2 (3) = 5.44, p = .14. This suggests that the scores on the autonomy support dimension did not significantly differ depending on whether or not the target child was a male or female or they received the *Anticipated Transfer* instructions or did not receive them.

Table 16. Mean Ranks, Means, Standard Deviations, and Medians for Each Focal Dimension by Gender x *Anticipated Transfer* Term

Focal Dimension by Interaction Term	Mean Rank	Mean	Standard Deviation	Median
Problem Solving				
Male No *Anticipated Transfer*	42.97	3.73	1.44	4.00
Female No *Anticipated Transfer*	39.79	3.50	1.56	4.00
Male *Anticipated Transfer*	35.40	3.19	1.57	4.00
Female *Anticipated Transfer*	34.58	3.04	1.68	3.00
Parental Elaboration				
Male No *Anticipated Transfer*	40.33	3.00	0.85	3.00
Female No *Anticipated Transfer*	32.21	2.57	1.28	2.00
Male *Anticipated Transfer*	37.60	2.90	1.37	3.00
Female *Anticipated Transfer*	38.73	2.96	1.30	3.00
Children’s Elaboration				
Male No *Anticipated Transfer*	40.37	3.40	1.30	3.00
Female No *Anticipated Transfer*	45.82	3.64	1.28	4.00
Male *Anticipated Transfer*	29.86	2.76	1.26	3.00
Female *Anticipated Transfer*	37.54	3.25	1.07	3.00

Table 17. Observed (and Expected) Values for the Distribution of Families in the Autonomy Support Condition by the Interaction Term of Gender and *Anticipated Transfer*

Interaction Term	Autonomy Support		
	No	Yes	Total
Male and No *Anticipated Transfer*	2.0 (4.7)	13.0 (10.3)	15.0 (15.0)
Female and No *Anticipated Transfer*	7.0 (4.4)	7.0 (9.6)	14.0 (14.0)
Male and *Anticipated Transfer*	8.0 (6.5)	13.0 (14.5)	21.0 (21.0)
Female and *Anticipated Transfer*	6.0 (7.5)	18.0 (16.5)	24.0 (24.0)
Total	23.0 (23.0)	51.0 (51.0)	74.0 (74.0)

It was hypothesized that the combination of gender and *Anticipated Transfer* might lead to differences in the sturdiness ratings of the first and second task. A one-way ANOVA was conducted to examine whether there were significant differences in the first task sturdiness ratio based on the four groups: child male – no *Anticipated Transfer*; child female – no *Anticipated Transfer*; child male – *Anticipated Transfer*; child female – *Anticipated Transfer*. The results indicate that there was a statistically significant difference between the four groups, $F(3,70) = 2.92$, $p = .04$. The Tukey HSD post hoc test indicated, contrary to expectations, that males in the no *Anticipated Transfer* condition ($M = .17$, $SD = .09$) had statistically higher sturdiness ratings on the first task compared to males in the *Anticipated Transfer* condition ($M = .08$, $SD = .08$). No other differences were found among the groups (male no *Anticipated Transfer* and female *No Anticipated Transfer*, $p = .62$; male no *Anticipated Transfer* and female *Anticipated Transfer*, $p = .21$; female no *Anticipated Transfer* and male *Anticipated Transfer*, $p = .43$; female no *Anticipated Transfer* and female *Anticipated Transfer*, $p = .94$; male

Anticipated Transfer and female *Anticipated Transfer*, p = .69). This suggests that male target children who did not receive the *Anticipated Transfer* instructions performed significantly better on the first task than those who did receive these instructions.

To further examine the hypothesis about sturdiness in the fixing task, a Pearson chi-square was conducted to see if there was a significant difference in whether or not at least one brace was added to the second skyscraper depending on gender by *Anticipated Transfer*. Table 18 displays the observed (and expected) values for this Pearson chi-square. Males and females who did and did not receive the *Anticipated Transfer* were no different in their use (or non-use) of a brace to fix the second structure, X^2 (3) = .23, p = .97.

Table 18. Chi-Square Table for Gender and *Anticipated Transfer* Interaction Term and Second Task Sturdiness

Interaction Term	Autonomy Support		
	No	Yes	Total
Male and No *Anticipated Transfer*	7.0 (7.7)	8.0 (7.3)	15.0 (15.0)
Female and No *Anticipated Transfer*	7.0 (7.2)	7.0 (6.8)	14.0 (14.0)
Male and *Anticipated Transfer*	11.0 (10.8)	10.0 (10.2)	21.0 (21.0)
Female and *Anticipated Transfer*	13.0 (12.3)	11.0 (11.7)	24.0 (24.0)
Total	38.0 (38.0)	36.0 (36.0)	74.0 (74.0)

In sum, males in the no *Anticipated Transfer* condition built structures that were rated sturdier than those families with sons that did receive these instructions. This finding, as well as other findings that indicate that the combination of gender and transfer

instructions did not affect sturdiness of the second structures, were contrary to the hypotheses.

Associations with Prior Building Knowledge

The third research question concerned links between the measures of building interactions and sturdiness of the structures and children's LEGO and construction play habits, as well as their parents' evaluation of their prior building knowledge. The distributions of the parental report of children's LEGO play, construction play, and prior building knowledge are shown in Figures 9-11.

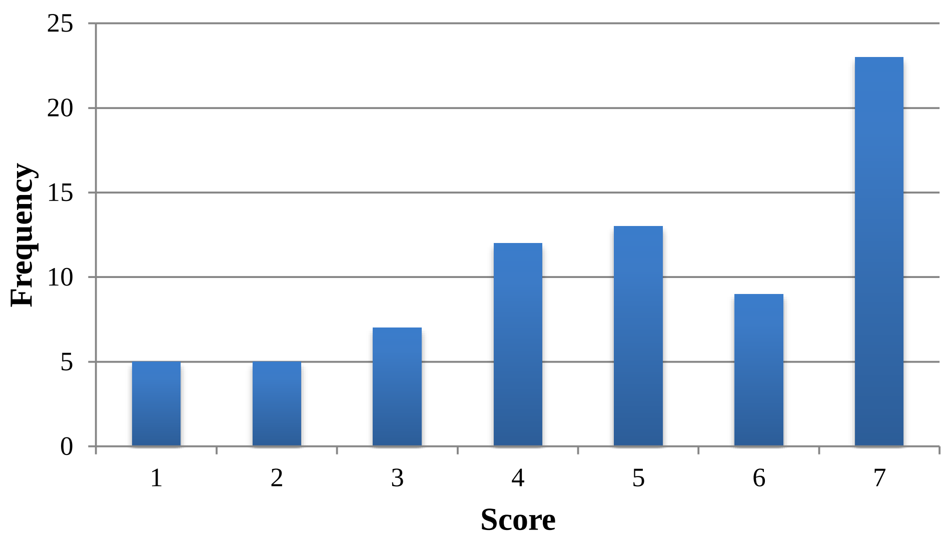


Figure 9. Number of children per scores on LEGO play question.

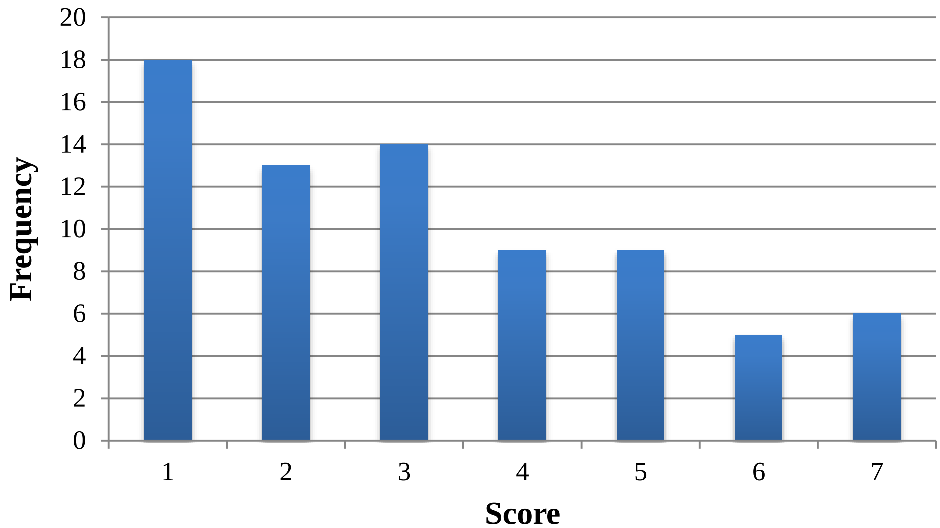


Figure 10. Number of children per scores on construction play question.

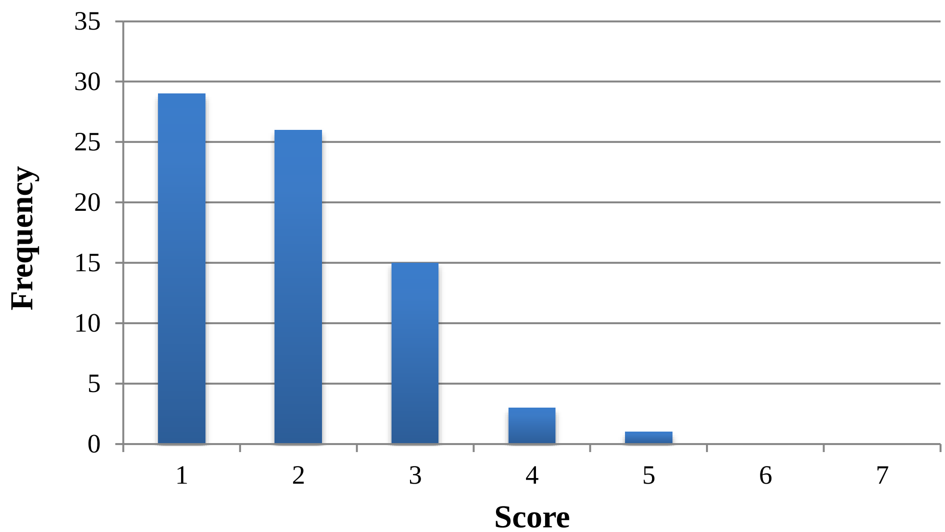


Figure 11. Number of children per scores on prior building knowledge question.

First, it was hypothesized that there would be significant positive correlations between family problem solving while building in the exhibit and measures of children's prior knowledge. Contrary to this hypothesis, there were no significant correlations between problem solving and the parents' reports of their children’s LEGO play habits,

$r_s(74) = -.09$, $p = .47$, construction play habits, $r_s(74) = -.12$, $p = .33$, nor the rating of children's prior building knowledge, $r_s(74) = -.16$, $p = .17$.

Second, it was hypothesized that parents' autonomy support during building would be related to their reports of the children's prior knowledge. Mann-Whitney tests were conducted to examine this hypothesis. The descriptive statistics for the measures of the children's prior building knowledge by autonomy support are provided in Table 19. Contrary to the hypothesis, there were no significant differences by autonomy support (present, absent) and for the children's LEGO play habits, $U = 539.50$, $p = .58$, $r = -.07$, construction play habits, $U = 551.00$, $p = .67$, $r = -.05$, nor children's prior building knowledge, $U = 566.50$, $p = .80$, $r = -.03$.

Table 19. Mean Ranks, Means, Standard Deviations, and Medians for Lego Play, Construction Play, and Children's Prior Building Knowledge by Autonomy Support

Focal Dimension by Autonomy Support	Mean Rank	Mean	Standard Deviation	Median
Lego Play				
Autonomy Support Absent	39.54	5.04	2.08	6.00
Autonomy Support Present	36.58	4.86	1.84	5.00
Construction Play				
Autonomy Support Absent	39.04	3.39	2.04	3.00
Autonomy Support Present	36.80	3.16	1.87	3.00
Children's Prior Building Knowledge				
Autonomy Support Absent	38.37	1.96	0.93	2.00
Autonomy Support Present	37.11	1.92	0.96	2.00

It was also hypothesized that there would be significant differences in the sturdiness rating for the first task depending on the children's play habits and prior building knowledge. To examine this hypothesis, Spearman rank-order correlation coefficients were calculated. Contrary to this hypothesis, the results indicate that there was not a statistically significant correlation between the sturdiness rating on the first task and the parents' reports of children's LEGO play habits, $r_s(74) = -.003$, $p = .98$, construction play habits, $r_s(74) = .01$, $p = .91$, nor their prior building knowledge, $r_s(74) = .01$, $p = .91$.

It was hypothesized that there would be significant differences in the sturdiness ratings for the second task depending on the children's play habits and prior building knowledge. Mann-Whitney tests were conducted to examine this hypothesis and the mean ranks, means, standard deviations, and medians are shown in Table 20. The results indicate that children who did and did not utilize at least one brace on the second tasks were no different in their LEGO play habits, $U = 570.00$, $p = .21$, $r = -.15$, construction play habits, $U = 616.5$, $p = .46$, $r = -.09$, nor their prior building knowledge, $U = 586.50$, $p = .26$, $r = -.13$.

Table 20. Mean Ranks, Means, Standard Deviations, and Medians for Lego Play, Construction Play, and Children's Prior Building Knowledge by Second Task Sturdiness Rating

Focal Dimension by Sturdiness Rating Second Task	Mean Rank	Mean	Standard Deviation	Median
Lego Play				
Brace	40.67	5.19	1.82	5.00
No Brace	34.50	4.66	1.98	4.50
Construction Play				
Brace	39.38	3.39	1.93	3.00
No Brace	35.72	3.08	1.91	3.00
Children's Prior Building Knowledge				
Brace	40.21	2.08	1.05	2.00
No Brace	34.93	1.79	0.81	2.00

In summary, although it was expected that the building interactions would be associated with parents' assessment of their children's LEGO and construction play habits, as well as their prior building knowledge, this was not supported by the results. Also, it was expected that there would be significant differences in the parental autonomy support dimension depending on the parents' ratings of the children's prior building knowledge and play habits. However, this hypothesis was also not supported by the results. It was also hypothesized that there would be significant associations between the children's LEGO and construction play habits, as well as their prior building knowledge and the sturdiness of the first task. However, the results indicate that these associations were not statistically significant. Lastly, it was hypothesized that the parents' evaluation

of their children's play habits and prior building knowledge would lead to significant differences in the sturdiness of the second task. Yet, this hypothesis was also not supported.

CHAPTER FOUR

DISCUSSION

The current study aimed to examine how parent-child interactions during a building activity related to building outcomes. Moreover, the study considered how providing some families with instructions that suggested how what they learned in one task might be applied to another might affect their interactions, and children's subsequent performance on the second task. Interactions during the building activity were characterized in terms of four dimensions: problem solving, parental elaborativeness, children's elaborativeness, and parental autonomy support. Associations between ratings on each of these dimensions and the sturdiness of the buildings families produced in the first task, and that children fixed in the second, were tested.

A discussion of the results from the project and connections to prior work is first presented. This is followed by a description of the limitations and future directions of the work, as well as the implications of the research for museum practice.

Summary of Findings and Linkages to Prior Work

Gender and Age

Although it was expected that parents would demonstrate more elaborativeness with their sons than their daughters, as well as make the structures sturdier during the first and second task, it is actually potentially good news that these differences were not found. Indeed, the Chicago Children's Museum designed the exhibit in such a way as to

attempt to minimize gender differences in interest and engagement. For example, the materials are brightly colored - even in some cases speckled - to appeal to a broad group. One of the main goals of these museums is that children of different ages and genders have equal opportunities to engage in the exhibits and activities (Association of Children's Museums, 1992/2012). Therefore, it seems that the absence of differences in age and gender for the four focal dimensions, as well as the sturdiness ratings, may indicate that this goal is being satisfied in the *Skyline* exhibit at the Chicago Children's Museum. This may suggest that children, regardless of age or gender, have equal opportunities to learn STEM content in this exhibit.

Interactions During Building

A main hypothesis was that the four focal dimensions would be independent of one another. The results indicate that the parental elaborativeness was related to the children's elaborativeness. Here our findings do square with work in the reminiscing literature (e.g., Reese et al., 1993) where associations between parental and child elaborativeness have been documented concurrently and longitudinally. However, the finding that autonomy support and elaborativeness were linked was not consistent with the hypothesis and prior work by Cleveland and Reese (2005). Specifically, Cleveland and Reese (2005) found that autonomy support and mother's elaborative structure were independent of one another.

One reason for the differences between the findings and prior work pertains to contextual effects. Whereas Cleveland and Reese (2005) examined autonomy support and elaborative structure during reminiscing, the current study examined these dimensions during an ongoing activity. Different conversational styles may be used by the same

parent in different contexts, corresponding to different conversational goals that the parents hold for interactions with their children (e.g., Fivush, 2014, for review). For example, Kulkofsky, Wang, and Koh (2009) found that one prominent goal of reminiscing is the establishment and maintenance of social bonds and sharing of a joint history. In contrast, during a play activity considered in this study, parents and children were presented with a specific objective - to build a skyscraper to the clouds. This instruction may have lead parents to be directive, and less conversation-eliciting in their speech to their children, in an effort to complete the goal in a limited time frame (Haden & Fivush, 1996).

Another example of the important role that goals can play during conversations was identified in the study conducted by Cleveland, Reese, and Grolnick (2007). They either provided parents with the goal that their children's perspective of a visit to a "pretend zoo" or the children's recall of information about it would be examined (Cleveland et al., 2007). Depending on the goal that was provided to the parents, they either demonstrated more or less autonomy supportive behaviors during the conversation with their children about the visit, in comparison to the level of these behaviors demonstrated at the baseline examination. This finding is critical to note, because it could help to identify another potential reason for the association between autonomy support and elaborativeness. In the current study, it could potentially be that parents were concerned about the goal of building a skyscraper within the specified time limit. This then could have caused their autonomy supportive behaviors to be altered in a manner that would not have occurred if they were having a conversation with their children, without the presence of this goal. It is also possible that the parents were more concerned

about remembering specific information about the task, such as how they utilized girders as the base, than about the children's perspective on the task. Again, this could have caused the parents to demonstrate less autonomy supportive behaviors than would have occurred in the absence of this goal.

Another difference between reminiscing and the task involved in this study that may also play into the differing results is the presence of multiple individuals. Whereas much of the work on reminiscing has focused on dyadic interactions (e.g., Cleveland & Reese, 2005), this study involved observations of family groups. The presence of multiple family members may have led the parents to alter their elaborativeness or autonomy supportive behaviors in order to address the entire family as the activity unfolded. Granting of autonomy, and adjusting one's speech for an older versus a younger child may play out differently in family groups that are multi-aged and gendered. Parents may also be talking in more gender-neutral ways in family groups with male and female children. Essentially, the presence of more than one child could have contributed to the differences between the findings and hypotheses of the current study, as well as prior work.

Anticipated Transfer

Another set of main hypotheses concerned whether receiving or not receiving the *Anticipated Transfer* instructions led to differences in building interactions as measured by the four focal dimensions, as well as the sturdiness of the structures. There was also a hypothesis that child gender and *Anticipated Transfer* would combine to affect the scores on the four focal dimensions, as well as the building sturdiness. Essentially, differences among four groups were examined: male children – *Anticipated Transfer*, female children

– *Anticipated Transfer*, male children – no *Anticipated Transfer*, female children – no *Anticipated Transfer*. The results indicate that, in the first task, families with boys that did not receive these instructions built sturdier structures than those families with sons who did receive these instructions. There were no differences among the four groups for the four focal dimensions or whether or not the children braced the structure in the second task. Overall, these findings suggest that families' interaction styles while building were not affected by the transfer instructions. However, sturdiness of the structures during the first task was affected by this interaction. Families with male target children who did not receive the *Anticipated Transfer* instructions built significantly sturdier structures compared to those families with sons who did receive these instructions. Why this was the case is not clear, but it may be that the boys in this instructional condition were actually different from their peers in a way that would have enhanced their building knowledge, but that was not assessed in this study.

Another important aspect of the study is whether the children were able to utilize the information that they learned regarding the importance of cross-braces. Furthermore, it seems that some of the children were not able to transfer the knowledge they learned about the importance of cross-bracing during the Engineering Demonstration to the first or second task. After examining the distribution of functional pieces added during the second task, it seems that there may be an absence of transfer of knowledge about the importance of cross-braces. This is because approximately 51% of children did not utilize a functional brace during the second task. This could be due to a variety of reasons such as lack of interest, variation in time spent on the second task, or that the children understood the importance of cross-braces but were not able to utilize it in the second

task. However, it is important to note that some children were able to transfer the knowledge about cross-braces that they learned during the Engineering Demonstration to the first task. Overall, all children learned about the importance of cross-bracing; however, only approximately 49% of the children were able to transfer this knowledge to second task where they worked alone, without their parents help.

The finding of the current study that indicates there was an absence of transfer for the importance of cross-braces from one task to another aligns with past work by other researchers. Prior research indicates that it can be very difficult for individuals to utilize the solution from one problem to solve a completely different problem (see Goldstone & Day, 2012; Uttal, O'Doherty, Newland, Hand, & DeLoache, 2009, for review). Given this background, it may be that the information provided about the importance of cross-bracing during the current study was not conducive of children and their parents learning this concept, and then being able to utilize it during the building and fixing activities.

Children's Prior Building Knowledge

It was hypothesized that the parents' assessment of their children's prior knowledge about building would be related to parental elaborativeness during the building activity. It was also hypothesized that the children's prior knowledge would be related to the sturdiness ratings for both tasks. However, this was not the case in the current study. This could be because of how the measure of children's prior knowledge was assessed. For example, Palmquist and Crowley (2007) examined children's prior dinosaur knowledge by asking them to correctly identify different types of dinosaurs. Then, based on the children's responses, the researchers separated them into two conditions: experts and novices. This approach to prior knowledge is quite different than

the one utilized in the current study. Furthermore, in the current study, the parents were asked to assess their children's LEGO and construction play habits, as well as their prior building knowledge through a 7-point Likert scale. It may be that having the parents report this information, instead of having the children answer questions, could have contributed to the results for prior building knowledge and the four focal dimensions, as well as the sturdiness ratings for both the first and second tasks. Using multiple reporters - the parents and the children - to assess children's prior building knowledge and play habits may have provided a more valid measure, a point I return to in the discussion of limitations. This would also align more with the Palmquist and Crowley (2007) study, in which the researchers not only asked the parents to report how much their children knew about this topic, but they also asked the children to answer questions about this topic.

It also seems that parents' perspectives about the importance of children's prior knowledge may be different for the topics of building and dinosaurs. For example, in the current study, it could be that parents did not heavily value the children's prior building knowledge and this could be because they were under a time pressure to complete the two tasks. Also, parents may not have connected the importance of the children's prior building knowledge to the current activity, because different materials are utilized in a context of a home versus a museum. Overall, it seems that there may be several reasons why the parents' perspectives of children's prior building knowledge did not contribute to the building outcomes, or the scores on the four focal dimensions, in the current study.

Limitations and Future Directions

A main limitation of the current study is the method in which the dimensions were measured. Three of the focal dimensions – parents' elaborativeness, children's

elaborativeness, and parental autonomy support – were adapted from a reminiscing context, which is a quite different context than a play setting, such as where families build and fix skyscrapers. Also, it is important to note that the hypotheses were also drawn primarily from work on reminiscing. Given the discussion above about the differences in the two conversational contexts, it is possible that the ratings might not have been a valid measure of what we were trying to examine. One indication that this is the case was that the results from prior studies were not replicated, such as the two dimensions of autonomy support and elaborativeness being independent of one another. Given that the findings of this study do not replicate prior work, it seems that the measures need to be refined. For example, the autonomy support dimension should be amended so that all five points are representative of the family's behaviors during the first activity. Alterations to the autonomy support dimension might also raise reliability. Also, it might have been helpful to utilize multiple measures for the four focal dimensions to assess validity. For example, the ratings could have been compared to frequency counts of target behaviors (e.g., elaborative questions and statements) to determine convergent validity.

Along the lines of refining and adding measures to examine the four focal dimensions, it also seems that a self-report measure to assess children's prior building knowledge should be utilized in future studies. This added measure stems from the results in the current study that indicate parents' assessment of children's LEGO and construction play, as well as their prior building knowledge, did not contribute to the four focal dimensions or the sturdiness of either structure. However, given the findings from Palmquist and Crowley (2007), it seems that the children's prior knowledge would be

related to their approach to solving the tasks or the conversations that occur during this time. Therefore, it may have been beneficial to utilize an alternative measure of children's prior knowledge, including children's self-report measures, or even an observation of children's performance on an analogous task. For example, a future study could ask the children to respond about how frequently they play with certain toys, such as LEGOs, in order to obtain the children's assessment of their prior building knowledge. We could also observe the children building on their own, without their parents, and then utilize this observation as an assessment of their skill in building. These sorts of measures, in addition to a parent-report measure, might provide a more complete picture of children's knowledge about building and these might then be associated with the tasks assessed in this study.

In line with adding a measure, it seems that problem solving should be examined during the second task, in addition to the first task. In the current study, children's problem solving during the fixing (i.e. second) task was not measured directly; rather only whether or not they added a brace was assessed. By examining the problem solving in the second task along the same lines as it was assessed in the first, we might gain further insight into how children utilize scientific concepts, such as strategies and hypothesis tests, after engaging in a prior learning task with their parents. For example, by examining problem solving during the fixing task, whether children engaged in hypothesis testing and revision on their own without their parents' guidance could be assessed. Also, researchers would be able to note if the children utilized strategies that were similar or different to those utilized with their parents. Alongside other variables, such as the target child's age or gender, it seems that such an examination of strategy use

in the second fixing task could provide information about how children learn STEM content in a children's museum.

Benefits of Conducting Research in a Museum Setting

Ultimately, the research reported here aims to inform museum practice, and in turn, foster family learning in museums. Recently, Haden, Cohen, Uttal, and Marcus (in press) discussed that when museum staff and researchers form partnerships in these institutions, then they are able to examine different aspects of children's learning. Furthermore, it also appears that both museum staff and researchers are able to utilize the sociocultural theory as the framework for examining children's learning and this is beneficial because it allows for a common ground to be identified. With a common ground or theory identified, researchers and museum staff are both able to help provide support for children's learning through social interactions, albeit either during their visit to an informal setting or after they visited it. By working with the museum, researchers are able to ask a wide variety of individuals from different demographics to participate in their projects. This allows for a broader examination of social interactions and other support systems that are helpful for children's learning in these contexts to be conducted. Overall, both researchers and museum staff have the same end goal of helping children learn and by forming strong partnerships, they are able to achieve just that.

APPENDIX A

PARENT QUESTIONNAIRE

ID NUMBER______________________ Date______________

Parent Questionnaire

1. Not counting today's visit, how many times have you visited **<u>this exhibit</u>** ***Skyline***?
____

2. **<u>Within the past TWO years,</u>** have you been members of the Chicago Children's Museum?

□ Yes, Became Members Today! □ Yes □ No

3. **<u>In a typical year,</u>** how many visits to museums (including including art, history, natural history museums, as well as historic sites, botanical gardens, science centers, zoos, and children's museums) do you make with your child?

□	□	□	□	□	□
Once a week	Once or twice a month (at least 12 times per year)	Every other month (6 times per year)	4-5 times per year	2-3 times per year	Once per year or less

Please **<u>circle a number</u>** to answer the following questions:

4. How much did **<u>you</u>** know about building before your museum visit today?

Knew Very Little 1 2 3 4 5 6 7 Knew A Great Deal

5. How much did **<u>your child</u>** know about building before your museum visit today?

Knew Very Little 1 2 3 4 5 6 7 Knew A Great Deal

6. How much did **<u>you</u>** learn about building during your museum visit today?

Learned Very Little 1 2 3 4 5 6 7 Learned a Great Deal

7. How much did **<u>your child</u>** learn about building during your museum visit today?

Learned Very Little 1 2 3 4 5 6 7 Learned a Great Deal

8. Before your museum visit today, how interested in building were **<u>you</u>**?

Very Little Interest	1	2	3	4	5	6	7	Very High Interest

9. Before your museum visit today, how interested in building was **<u>your child</u>**?

Very Little Interest	1	2	3	4	5	6	7	Very High Interest

10. **<u>Gender</u>** of parent/guardian completing the survey: □ Female □ Male

11. Current **<u>Marital Status</u>**

□ Married

□ Partnered

□ Single (including never married, widowed, separated, or divorced)

□ Other, please specify: ____________________________

12. Please list the **<u>age and gender</u>** of each child in your household:

1) **<u>Child participating</u>** in the study today :	Age: ________years old	□ Female	□ Male

<u>Other</u> children in your household:

2)	Age: ________years old	□ Female	□ Male
3)	Age: ________years old	□ Female	□ Male
4)	Age: ________years old	□ Female	□ Male
5)	Age: ________years old	□ Female	□ Male
6)	Age: ________years old	□ Female	□ Male

13. **<u>Education</u>** (check <u>highest level completed)</u>

	You	Child's Other Parent/Guardian
• Some High School	□	□
• High School Graduate	□	□
• Some college/Vocational or Technical School Graduate	□	□
• College Graduate	□	□
• Master's Degree	□	□
• Doctoral/Professional Degree (PhD, MD, JD)	□	□

14. **Parent Occupation**

You: ______________________________

Child's Other Parent/Guardian: ______________________________

15. **Ethnicity, Race**

	Participating Child	You
• Hispanic/Latino ethnicity (one or more races)	◻	◻
• Non-Hispanic		
Caucasian or White	◻	◻
African American or Black	◻	◻
Asian	◻	◻
American Indian or Alaska Native, Native North, Central, or South Americans	◻	◻
Native Hawaiian or Other Pacific Islander	◻	◻
More than one race (non-Hispanic/Latino)	◻	◻
• Other (please write in)	______________________________	

16. **Family Household Income (check one)**

◻ Less than $20,000 ◻ $75,000 – $99,999

◻ $20,000 – $49,999 ◻ $100,000 to $149,999

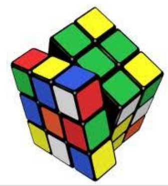
◻ $50,000 – $74,999 ◻ >$150,000

Play Questionnaire

How often does your child play with the following kinds of toys? Pictures are just examples of types of toys. (Circle number)

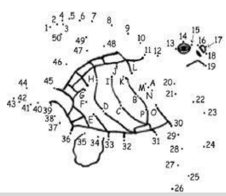
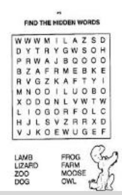
1. Puzzles

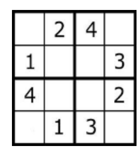




Almost Never 1 2 3 4 5 6 7 Daily

2. Puzzle Games



Almost Never 1 2 3 4 5 6 7 Daily

3. Legos



Almost Never 1 2 3 4 5 6 7 Daily

4. Construction (not Lego)



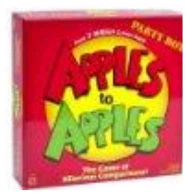
Almost Never 1 2 3 4 5 6 7 Daily

5. Art



Almost Never 1 2 3 4 5 6 7 Daily

6. Board and Card Games



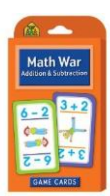
Almost Never 1 2 3 4 5 6 7 Daily

7. Music



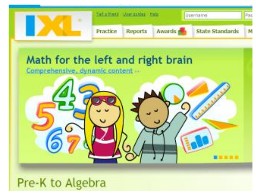

Almost Never 1 2 3 4 5 6 7 Daily

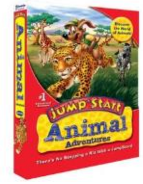
8. Math Games

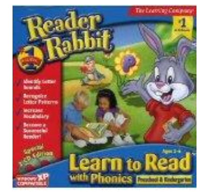



Almost Never 1 2 3 4 5 6 7 Daily

9. Education-Oriented Computer/Internet Games







Almost Never	1	2	3	4	5	6	7	Daily

10. Video Games



Almost Never	1	2	3	4	5	6	7	Daily

11. Pretend Play/Fantasy






Almost Never	1	2	3	4	5	6	7	Daily

12. Toys for Moving Arms and Legs







Almost Never	1	2	3	4	5	6	7	Daily

REFERENCE LIST

Alibali, M. W. (1999). How children change their minds: Strategy change can be gradual or abrupt. *Developmental Psychology*, *35*(1), 127-145. DOI: 10.1037/0012-1649.35.1.127

Anderson, A. (1997). Families and mathematics: A study of parent-child interactions. *Journal for Research in Mathematics Education*, *28*(4), 484–511. Stable URL: http://www.jstor.org/stable/749684

Association of Children's Museums (1992/2012). Standards for professional practice in children's museums. Retrieved from www.childrensmuseums.org/images/Library/Standards_for_Professional_Practice_in_Childrens_Museums.pdf

Benjamin, N., Haden, C. A., & Wilkerson, E. (2010). Enhancing building, conversation, and learning through caregiver–child interactions in a children's museum. *Developmental Psychology, 46*(2), 502-515. DOI: 10.1037/a0017822

Boland, A. M., Haden, C. A., & Ornstein, P. A. (2003). Boosting children's memory by training mothers in the use of an elaborative conversational style as an event unfolds. *Journal of Cognition and Development*, *4*(1), 39-65. DOI: 10.1080/15248372.2003.9669682

Callanan, M. A. & Jipson, J. (2001). Explanatory conversations and young children's developing scientific literacy. In K. Crowley, C. D. Schunn, & T. Okada (Eds.), *Designing for science: Implications from everyday, classroom, and professional science* (pp. 21-49). Mahwah, NJ: Lawrence Erlbaum Associates.

Chi, M. T. H, Feltovich, P. J., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science*, *5*(2), 121-152. DOI: 10.1207/s15516709cog0502_2

Cleveland, E. S. & Morris, A. (2014). Autonomy support and structure enhance children's memory and motivation to reminisce: A parental training study. *Journal of Cognition and Development*, *15*(3), 414-436. DOI: 10.1080/15248372.2012.742901

Cleveland, E. S. & Reese, E. (2005). Maternal structure and autonomy support in conversations about the past: Contributions to children's autobiographical memory. *Developmental Psychology*, *41*(2), 376-388. DOI: 10.1037/0012-1649.41.2.376

Cleveland, E. S., Reese, E., & Grolnick, W. S. (2007). Children's engagement and competence in personal recollection: Effects of parents' reminiscing goals. *Journal of Experimental Child Psychology*, *96*(2), 131-149. DOI: 10.1016/ j.jecp.2006.09.003

Common Core State Standards Initiative (2015). *Standards for mathematical practice*. Retrieved from http://www.corestandards.org/Math/Practice/

Crowley, K., Callanan, M. A., Jipson, J. L., Galco, J., Topping, K., & Shrager, J. (2001). Shared scientific thinking in everyday parent-child activity. *Science Education, 85*(6), 712-732. DOI: 10.1002/sce.1035

Crowley, K., Callanan, M. A., Tenenbaum, H. R., & Allen, E. (2001). Parents explain more often to boys than to girls during shared scientific thinking. *Psychological Science*, *12*(3), 258-261. DOI: 10.1111/1467-9280.00347

Dixon, J. A., & Bangert, A. S. (2002). The prehistory of discovery: Precursors of representational change in solving gear system problems. *Developmental Psychology*, *38*(6), 918-933. DOI: 10.1037/0012-1649.38.6.918

Dragonfly TV. GPS: Science Center |PBS KIDS GO!. (2006). Retrieved from http://pbskids.org/dragonflytv/gps/gps_localize.php

Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. Thousand Oaks, CA: Sage Publications, Inc.

Fivush, R. (2014). Maternal reminiscing style: The sociocultural construction of autobiographical memory across childhood and adolescence. In P. J. Bauer & R. Fivush (Eds.), *Wiley-Blackwell Handbook on Children's Memory* (pp. 568 - 585). New York, NY: Wiley-Blackwell.

Fivush, R., Haden, C. A., & Reese, E. (2006). Elaborating on elaborations: Role of maternal reminiscing style in cognitive and socioemotional development. *Child Development*, *77*(6), 1568-1588. DOI: 10.1111/j.1467-8624.2006.00960.x

Glaser, R. & Chi, M. T. H. (1988). Overview. In M. T. H., Chi, R. Glaser, & M. J. Farr, (Eds.), *The Nature of Expertise* (pp. 15 – 28). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Goldstone, R. L., & Day, S. B. (2012). Introduction to “new conceptualizations of transfer of learning”. *Educational Psychologist*, *47*(3), 149-152. DOI:10.1080/00461520.2012.695710

Grolnick, W., Frodi, A., & Bridges, L. (1984). Maternal control style and the mastery motivation of one-year-olds. *Infant Mental Health Journal*, *5*(2), 72-82. DOI: 10.1002/1097-0355(198422)5:2<72::AID-IMHJ2280050203>3.0.CO;2-O

Haden, C. A. (1998). Reminiscing with different children: Relating maternal stylistic consistency and sibling similarity in talk about the past. *Developmental Psychology*, *34*(1), 99-114. DOI*:* 10.1037/0012-1649.34.1.99

Haden, C. A. (2010). Talking about science in museums. *Child Development Perspectives*, *4*(1), 62-67. DOI: 10.1111/j.1750-8606.2009.00119.x

Haden, C. A., Cohen, T., Uttal, D. H., & Marcus, M. (in press). Building learning: Narrating and transferring experiences in a children’s museum. In D. Sobel & J. Jipson (Eds.), *Fostering cognitive development in children’s museums.* New York, NY: Psychology Press.

Haden, C. A., & Fivush, R. (1996). Contextual variation in maternal conservational styles. *Merrill-Palmer Quarterly*, *42*(2), 200-227. Stable URL: http://www.jstor.org/stable/ 23087877

Haden, C. A., Jant, E. A., Hoffman, P. C., Marcus, M., Geddes, J. R., & Gaskins, S. (2014). Supporting family conversations and children's STEM learning in a children's museum. *Early Childhood Research Quarterly*, *29*(3), 333-344. DOI: 10.1016/j.ecresq. 2014.04.004

Harnishfeger, K. K., & Bjorklund, D. F. (1990). Children’s strategies: A brief history. In D. F. Bjorklund (Ed.), *Children’s strategies: Contemporary views of cognitive development* (pp. 1-22). Hillsdale, NJ: Lawrence Erlbaum Associates.

Hedrick, A. M., Haden, C. A., & Ornstein, P. A. (2009). Elaborative talk during and after an event: Conversational style influences children's memory reports. *Journal of Cognition and Development*, *10*(3), 188-209. DOI: 10.1080/15248370903155841

Jant, E. A., Haden, C. A., Uttal, D. H., & Babcock, E. (2014). Conversation and object manipulation influence children's learning in a museum. *Child Development*, *85*(5), 2029-2045. DOI: 10.1111/cdev.12252

Kalish, M. L., Lewandowsky, S., & Davies, M. (2005). Error-driven knowledge restructuring in categorization. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *31*(5), 846-861. DOI: 10.1037/0278-7393.31.5.846

Kulkofsky, S., Wang, Q., & Koh, J. B. K. (2009). Functions of memory sharing and mother-child reminiscing behaviors: Individual and cultural variations. *Journal of Cognition and Development*, *10*(1-2), 92-114. DOI: 10.1080/15248370903041231

Laible, D. (2004). Mother-child discourse in two contexts: Links with child temperament, attachment security, and socioemotional competence. *Developmental Psychology*, *40*(6), 979-992. DOI: 10.1037/0012-1649.40.6.979

Laible, D., Panfile, T., & Augustine, M. (2013). Predicting the quality of mother–child reminiscing surrounding negative emotional events at 42 and 48 months old. *Journal of Cognition and Development*, *14*(2), 270-291. DOI: 10.1080/15248372.2011.645972

Leinhardt, G. & Crowley, K. (1998). Museum learning as conversational elaboration: A proposal to capture, code, and analyze talk in museums. Retrieved from: http://www.lrdc.pitt.edu/mlc/documents/mlc-01.pdf

Leyva, D., Reese, E., Grolnick, W., & Price, C. (2008). Elaboration and autonomy support in low-income mothers' reminiscing: Links to children's autobiographical narratives. *Journal of Cognition and Development*, *9*(4), 363-389. DOI: 10.1080/15248370802678158

National Research Council. (2009). Learning science in informal environments: People, places, and pursuits. In P. Bell, B. Lewnstein, A. W. Shouse, & M. A. Feder (Eds.), *Committee on learning science in informal environments.* Washington, DC: The National Academies Press.

National Research Council. (2012). A *Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Washington, DC: The National Academies Press.

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. DOI: 10.1002/sce.20215

Reese, E., Haden, C. A., & Fivush, R. (1993). Mother-child conversations about the past: Relationships of style and memory over time. *Cognitive Development*, *8*(4), 403-430. DOI: 10.1016/S0885-2014(05)80002-4

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context*. New York, NY: Oxford University Press.

Schauble, L. (1996). The development of scientific reasoning in knowledge-rich contexts. *Developmental Psychology*, *32*(1), 102-119. DOI: 10.1037/0012-1649.32.1.102

Siegler, R. S., Adolph, K. E., & Lemaire, P. (1996). Strategy choices across the life span. In L. R. Reder (Ed.), *Implicit memory and metacognition*, (pp. 79-121). Mahwah, NJ: Erlbaum. Retrieved from: http://www.psy.cmu.edu/~siegler/siegleradolphlem96.pdf

Siegler, R. S. (1996). *Emerging minds: The process of change in children's thinking*. New York, NY: Oxford University Press.

Tenenbaum, H. R., & Leaper, C. (2003). Parent-child conversations about science: The socialization of gender inequities? *Developmental Psychology*, *39*(1), 34-47. DOI: 10.1037/0012-1649.39.1.34

Uttal, D. H., O'Doherty, K., Newland, R., Hand, L. L., & DeLoache, J. (2009). Dual representation and the linking of concrete and symbolic representations. *Child Development Perspectives*, *3*(3), 156-159. DOI: 10.1111/j.1750-8606.2009.00097.x

Van Schijndel, T. J. P., Franse, R. K., & Raijmakers, M. E. (2010). The Exploratory Behavior Scale: Assessing young visitors' hands-on behavior in science museums. *Science Education*, *94*(5), 794-809. DOI: 10.1002/sce.20394

Vosniadou, S., Ioannides, C., Dimitrakopoulou, A., & Papademetriou, E. (2001). Designing learning environments to promote conceptual change in science. *Learning and Instruction*, *11*(4-5), 381-419. DOI: 10.1016/S0959-4752(00)00038-4

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Wheater, C. P., & Cook, P. A. (2000). *Using statistics to understand the environment*. New York, NY: Routledge.

Wertsch, J. V., McNamee, G. D., McLane, J. B., & Budwig, N. A. (1980). The adult-child dyad as a problem-solving system. *Child Development*, *51*(4), 1215-1221. Stable URL: http://www.jstor.org/stable/1129563

VITA

Tayler Grashel received a Bachelor of Science in Chemistry and Psychology from Valparaiso University before entering the Developmental Psychology program at Loyola University Chicago. After completing her Master of Arts in Developmental Psychology, Grashel will attend Valparaiso University to receive training and become a school psychologist. The training and education that she received from Loyola University Chicago will allow her to examine how parent-child interactions contribute to a child's academic learning in a school setting.