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Enhancing Building, Conversation, and Learning Through Caregiver–Child Interactions in a Children's Museum

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The authors adapted an experimental design to examine effects of instruction prior to entry into a children's museum exhibit on caregiver–child interactions and children's learning. One hundred twenty-one children (mean age = 6.6 years) and their caregivers were randomly assigned to 1 of 5 conditions that varied according to what, if any, preexhibit instruction the dyads received: (a) building and conversation instruction, (b) building instruction only, (c) conversation instruction only, (d) presentation of models of buildings and conversations without instruction, or (e) no instruction or control. Building instruction included information about triangular cross-bracing. Conversation instruction emphasized the use of elaborative *wh*-questions and associations. When observed in the exhibit, dyads in the groups that received building instruction included more triangles in their structures than those in the other groups. Caregivers provided with conversation instruction asked more *wh*-questions, made more associations, and engaged in more caregiver–child joint talk compared with those who received building instruction alone. Type of instruction was further linked to differences across conditions in the engineering content of talk, performance during immediate assessments of learning, and children's memory following 1-day and 2-week delays.

Keywords: caregiver training, conversational style, event memory, children's learning, cognitive development

A growing number of studies in children's museums and other everyday contexts reinforce a fundamental assumption held by developmental scientists that parent–child conversational interactions can facilitate children's learning and remembering (for a review, see Haden, in press). This idea derives from sociocultural theory (e.g., Vygotsky, 1978) that pinpoints collaborative verbal engagement as a potentially powerful mediator of cognitive change. Also in keeping with sociocultural approaches is an emphasis in research on individual differences such that what children understand and retain about their experiences in museums and elsewhere can be expected to vary with the conversational style that parents use in talking about the events with their children. For example, studies that have focused on conversations about previously experienced events indicate that parents differ in their "reminiscing styles" (for a review, see Fivush, Haden, & Reese, 2006). Children of mothers who use a *high elaborative* style—characterized by the use of many open-ended *wh*-questions that add new information about the event under discussion—recall more information about their experiences than children of parents with a *low elaborative* style (e.g., Fivush & Fromhoff, 1988; Haden, 1998; McCabe & Peterson, 1991). There is a dearth of research concerning maternal characteristics that may be associated with maternal reminiscing style. Nevertheless, there is clear evidence that maternal elaborative reminiscing is a unique predictor of children's remembering even when child characteristics such as language, temperament, self-awareness, and attachment status have been taken into account (e.g., Farrant & Reese, 2000; Haden, Ornstein, Rudek, & Cameron, 2009; Peterson, Jesso, & McCabe, 1999; Reese, Haden, & Fivush, 1993; Reese & Newcombe, 2007).

In addition to the impact of conversations after an event, talk between parents and children *during* an activity may be especially important for how children make sense of an experience as it is taking place and, therefore, what is initially learned and represented in memory (Ornstein, Haden, & Hedrick, 2004). Despite their potential importance, however, conversations during ongoing events have not been explored as extensively as reminiscing about past experiences, and relatively little research has addressed how to promote particular forms of verbal engagement during events that will influence children's understanding and remembering. This question sets the stage for the current study in which an experimental methodology was adapted to examine the impact of instruction about elaborative conversational techniques on caregiver–child interactions and children's learning in the context of a children's museum.

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The research presented here intersects with studies of children's memory that have focused on parent–child conversational exchanges during and after events (for reviews, see Fivush et al., 2006; Ornstein et al., 2004), as well as a subset of investigations in children's museums on family learning conversations (e.g., Crowley et al., 2001; Fender & Crowley, 2007; Tenenbaum & Callanan, 2008; for a review, see Leinhardt, Crowley, & Knutson, 2002). There is also a parallel with the work of researchers and evaluators in museums that has pointed to the role that a myriad of exhibit elements (e.g., label text, seating, experiential learning) and visitor characteristics (e.g., cultural background, motivation, prior experience) can play in promoting conversations and learning (e.g., Crowley & Callanan, 1998; Gaskins, 2008; Gelman, Massey, & McManus, 1991; Humphrey & Gutwill, 2005). Moreover, because the observations of caregiver–child talk took place in a building construction exhibit, and a second key manipulation involved the provision of information to families about engineering principles, the study connects as well with the informal learning literature that indicates that visitors to museums develop and practice scientific thinking skills (e.g., hypothesis generation and testing) and that knowledge and understanding of science-, technology-, engineering-, and math-related concepts can be fostered in museums (e.g., Crowley et al., 2001; Palmquist & Crowley, 2007; Schauble et al., 2002; Tenenbaum & Callanan, 2008).

The few investigations in the event memory literature that have focused on talk during ongoing activities have emphasized the importance of joint verbal exchanges between mothers and young children as being more strongly related to children's understanding and later recall of events than interactions characterized as primarily involving mother-only talk, child-only talk, or no talk (Haden, Ornstein, Eckerman, & Didow, 2001; Hedrick, San Souci, Haden, & Ornstein, 2009; Ornstein et al., 2004). For example, Tessler and Nelson (1994) found that 3-year-olds who were observed as they visited a museum with their mothers later recalled only the objects that had been talked about by both the mother and the child during the experience. Similarly, Haden et al. (2001) conducted a longitudinal investigation in which young children took part in three specially constructed activities (e.g., a camping event) with their mothers in their homes when they were 30, 36, and 42 months old. At each age, features of the activities (e.g., the fish in the camping event) that were jointly handled and jointly discussed by the mother and child were better recalled than those that were jointly handled but talked about only by the mother, which were better recalled than those jointly handled but not discussed.

Other work suggests specific forms of joint conversational interactions that may be particularly important in increasing understanding and subsequent remembering. In this regard, open-ended elaborative *wh*-questions such as What? Why? and How? have been highlighted in research focusing on mother–child conversations about ongoing (e.g., Boland, Haden, & Ornstein, 2003; Hedrick, Haden, & Ornstein, 2009) and previously experienced events (e.g., Fivush & Fromhoff, 1988; Haden, 1998; Haden et al., 2009; Harley & Reese, 1999) and in studies of learning conversations in museums (e.g., Falk & Dierking, 2000; Leinhardt & Knutson, 2004). Such questions may reflect and change what is understood about an ongoing experience in ways that include focusing attention on what is available to learn and pointing out obstacles and problem-solving strategies. Associative talk that links present experiences with that which children already know has been further implicated in research as enhancing learning (Falk & Dierking, 2000; Tessler & Nelson, 1994). In an experimental test of the effectiveness of these (and other) elaborative conversational techniques, Boland et al. (2003) instructed mothers to ask elaborative *wh*-questions and make associations. When observed engaging with their children in a camping activity in their homes, mothers who were asked to did indeed use these elements of style more than other mothers who were asked simply to talk as they naturally would. Moreover, the children of mothers who received instructions in the use of elaborative style produced longer and more detailed reports of their experiences days and weeks after the event than children of mothers who did not receive instructions.

The Current Study

The factorial experimental design of the current study afforded the examination of the independent and combined effects of instructions that were given to caregivers and children about building engineering and elaborative conversation on caregiver–child interactions in the exhibit, and on children's learning and subsequent remembering. Based on the perspective that the frequent use of elaborative conversational techniques is more effective in increasing children's learning than fewer of them (e.g., McCabe & Peterson, 1991; Reese et al., 1993), an aim of the conversation instruction was to boost the number of *wh*-questions asked and associations made by caregivers during interactions with their children in the exhibit. The provision of specific instructions about building engineering alone or in combination with elaborative conversation instruction was anticipated to enhance what caregivers and children built in the exhibit. Research on expertise (e.g., Chi & Ceci, 1987; Crowley & Jacobs, 2002) supports the expectation that museum visitors with more knowledge about building engineering might be better able to make sense of and subsequently remember their experiences in a building exhibit than those with less knowledge. But it also seems likely that the importance of joint parent–child talk during an event would vary as a function of the child's familiarity with or prior knowledge pertaining to the activity that is being experienced. Palmquist and Crowley (2007) recently found support for this idea in a museum-based study, reporting that parents who viewed their children as "novices" about dinosaurs were more likely to talk in a dinosaur exhibit in ways that supported their children's understanding, compared with parents of experts who talked hardly at all with their children. In novel situations about which a child possesses little prior knowledge or experience, joint parent–child talk may be critical for optimal learning.

In addition to the experimental groups that received instructions about building and/or conversation (build + talk instruction, build-only instruction, talk-only instruction) and a control group that received no instructions at all, a fifth (models) condition was included in the current design. The models group received no building instruction but was presented with models of strong structures built with exhibit materials. The models group also received no conversation instruction but viewed video clips of a separate sample of caregiver–child dyads in the exhibit demonstrating the use of *wh*-questions and associations. The models condition was included so it could be determined whether simply seeing building and conversation models in the absence of direct instruction would be sufficient to change behaviors in the exhibit in ways that would be comparable to the effects anticipated for the groups receiving instruction.

Measures of the strength of the structures built in the exhibit and the frequency of use of elaborative conversational techniques during building were supplemented with an examination of the engineering content of the caregivers' and children's talk. In addition, the assessments included caregivers' reporting of their own and their children's prior knowledge and interest in building. Learning and remembering were measured via several tasks, including the children's reports of their exhibit experiences to another adult member of their visitor group in a "reunion conversation" that took place in the exhibit immediately after building. A paired-comparison picture selection task tapped the children's understanding that frame structures that include triangle braces would be strong. Last, caregivers and children were invited to record memory conversations about their exhibit experiences 1 day and 2 weeks following their museum visit. Given the previously highlighted research findings, variation in caregiver–child conversation in the exhibit was expected to correspond to differences in what children reported about their experiences in the immediate reunion and delayed memory conversations.

Method

Participants

The sample of 121 children (61 girls, 60 boys) was recruited from the general admission line at the Chicago Children's Museum. The criteria for inviting participation were that (a) each child be between 4 and 8 years of age (sample mean age = 6.6 years; range: 4.0–8.9), (b) this was the child's first visit to the museum, and (c) there were at least two adults in the visitor group. Of the 337 visitor groups approached, 213 (63%) declined to participate. An additional three children and their caregivers took part in the study but were not included in the analyses because of missing videotape footage due to technical difficulties. The majority of the children built with a parent (110, or 91%) and the rest with an adult caregiver (e.g., grandparent, uncle). The children chose who in their visitor group they would build with. In all, there were 46 female child–female caregiver pairs, 44 male child–male caregiver pairs, 16 male child–female caregiver pairs, and 15 female child–male caregiver pairs who participated in the preexhibit instructions and exhibit interactions. The build + talk, models, and control groups were seen over the course of one summer; the build-only and talk-only groups were added subsequently to the design and enrolled the following summer.

The children's caregiver-reported ethnicities included White ($n = 89$), African American ($n = 8$), Asian ($n = 7$), Latino/Hispanic ($n = 4$), and Native American ($n = 3$); 10 caregivers did not report child ethnicity. Whereas 22.3% ($n = 27$) of the participants were from the Chicago area and 8.3% ($n = 10$) were from other parts of Illinois, 42.9% ($n = 52$) were from 20 other states and 2.5% ($n = 3$) from outside the United States. Another 17.3% ($n = 21$) of parents answered that they were not from the Chicago area but did not indicate where they were from, and 6.6% ($n = 8$) provided no information about where they resided. With respect to parent education, the mean education level was 15.57 years ($SD = 2.34$); 64% percent of the children's mothers and 65% of their fathers held a college degree (income information was not collected). All participants spoke English. The participants and all members of their visitor group received free admission to the museum for the day.

Design and Procedure

The design and procedure along with the measures associated with each aspect of the study are illustrated in Figure 1. The key manipulation involved the preexhibit experiences each caregiver–child dyad was invited to engage in prior to entering the exhibit. Within the two phases of data collection, caregiver–child dyads were randomly assigned (with gender of child balanced) to one of the five preexhibit conditions. In addition to the preexhibit experiences, the procedure involved caregiver–child interactions in the building exhibit, assessments of learning, and assessments of remembering. The portions of the study conducted at the museum were videotaped, and the caregivers and children wore wireless microphones that transmitted to a camera. The delayed memory conversations were audiorecorded by caregivers using tape recorders provided to them by the researchers.

Preexhibit experiences. All preexhibit activities took place in a quiet room adjacent to the museum entrance and, for each condition, lasted approximately 15 min per dyad. All dyads were seen separately. The preexhibit experience of the dyads that received building instructions—those in the build + talk and build-only groups—involved the provision of information about engineering concepts and practice in applying them to strengthen structures made of exhibit materials. Specifically, one of two female researchers began the building instructions by asking, "What inside us holds up our bodies?" and making the analogy that frames are to buildings as bones are to bodies and that like skeletons in the human body, frames are necessary to support buildings. The researcher then introduced the idea that not all frames are "strong" and that building frames that include triangle shapes to brace them are stronger than ones that comprise only squares or rectangles. The dyads were asked to test this engineering concept. They were presented with two wobbly frame structures: first the two-dimensional frame illustrated in Figure 2A and then the three-dimensional frame illustrated in Figure 3A. With each frame presentation, dyads were invited to test whether adding one (to Frame 2A) or two pieces (to Frame 3A) to create triangle braces in the frame would make the structure strong. The structures had been designed so that for each there was only one way to stop them from wobbling. Families worked until they reached the solutions for each frame structure illustrated in Figures 2B and 3B.

In contrast, dyads in the models, talk-only, and control groups received no building instruction. Dyads in the models condition, however, were presented with the structures depicted in Figures 2B and 3B, as the researcher suggested that they might understand the exhibit better if they saw some of the things that other visitors had made. Those in the models group were asked to decorate these frame structures with pipe cleaners and stickers, so that they were directing their attention and handling the frames for about the same amount of time as those in the build + talk and build-only groups.

The preexhibit experience of the dyads that received conversation instruction—those in the build + talk and talk-only groups—involved the researcher describing two elaborative conversational techniques that the caregivers were asked to use when talking with their children in the exhibit. For those in the build + talk group,

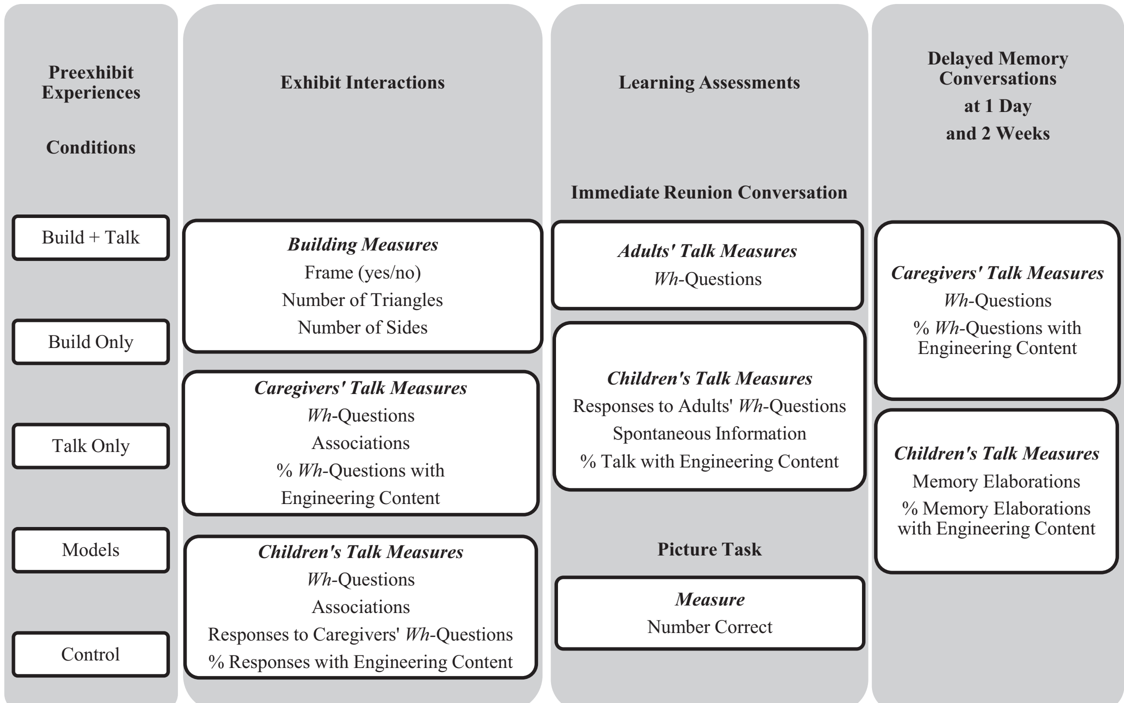

Figure 1. Overview of study design, procedures, and measures.

the conversation instruction was given immediately following the building instruction. Specifically, the build + talk group and the talk-only group (who did not engage at all with the frame structures) were encouraged to incorporate into their conversations with their children open-ended *wh*-questions that ask the child to provide information, such as where, why, what, and how (e.g., "Why would a workman wear these goggles?"), and to make associative comments that connected aspects of the exhibit to that which the child might already know or have experience with (e.g., "When have you worn goggles?"). The researcher suggested that children's understanding of the exhibit may be enhanced when caregivers used these techniques. To reinforce the conversation suggestions, the dyads were presented with a hard hat, and the researcher asked the adult to generate things they could say to their child about it, so that in the end, either the adult or the researcher had given several examples of *wh*-questions and associations.

The build-only, models, and control groups received no conversation instruction. Nevertheless, directly after decorating the model structures, dyads in the models group viewed a 4-min video in which a separate sample of families were shown in the exhibit modeling the use of *wh*-questions to elicit object names (e.g., "What is this called?") and the functions of tools (e.g., "What is a hard hat used for?"), and also the use of associative comments (e.g., "This hard hat keeps your head safe just like the helmet you wear when you ride your bike.")—the conversational techniques that had been emphasized to the build + talk and talk-only groups. Those in the models group were told that seeing what others had talked about might again help them during their interactions in the exhibit.

The preexhibit activity for the dyads in the no-instructions control group also took place in the same room adjacent to the museum entrance and was comparable in length to the activities of the other conditions. It involved the researcher prompting each dyad in this condition to "draw a picture of where you live" on a large sheet of paper using crayons and/or markers. When they were finished drawing, dyads in the control group were asked to use the picture as they together described where they lived to the researcher.

Exhibit interactions. Immediately after the preexhibit experience, all caregiver–child dyads were escorted to the approximately 1,500-ft^2 (139.35-m^2) Under Construction exhibit that featured large-scale building materials, including wood strut pieces of various lengths, and peg boards (sides) of assorted sizes and colors, washers, nuts, wing nuts, long and short bolts, nut drivers, tool boxes, aprons, and goggles. The informational labels in the exhibit were designed to didactically provide identification of the building materials (e.g., bolts, goggles) without indication of function. There were no signs about bracing, or triangles, or any messaging about how to build (e.g., right for tight), nor were there any pictures of adults and children building together. The attractive coloring of the pegboards relative to the plain wood frame pieces, and the fact that the pegboards naturally triangulated, obfuscated the key engineering principles that were emphasized in the building instructions in this study. All caregiver–child dyads were told they could build together for as long as they wished.

Learning assessment: Immediate reunion conversation. When each dyad indicated that it had finished building, a second adult from the visitor group who had not participated in or observed the preexhibit and exhibit experiences was paged and then joined the child in the exhibit. The researcher asked this adult to elicit the child's account of what she or he had built and learned in the exhibit by posing what, why, and how questions. The child and

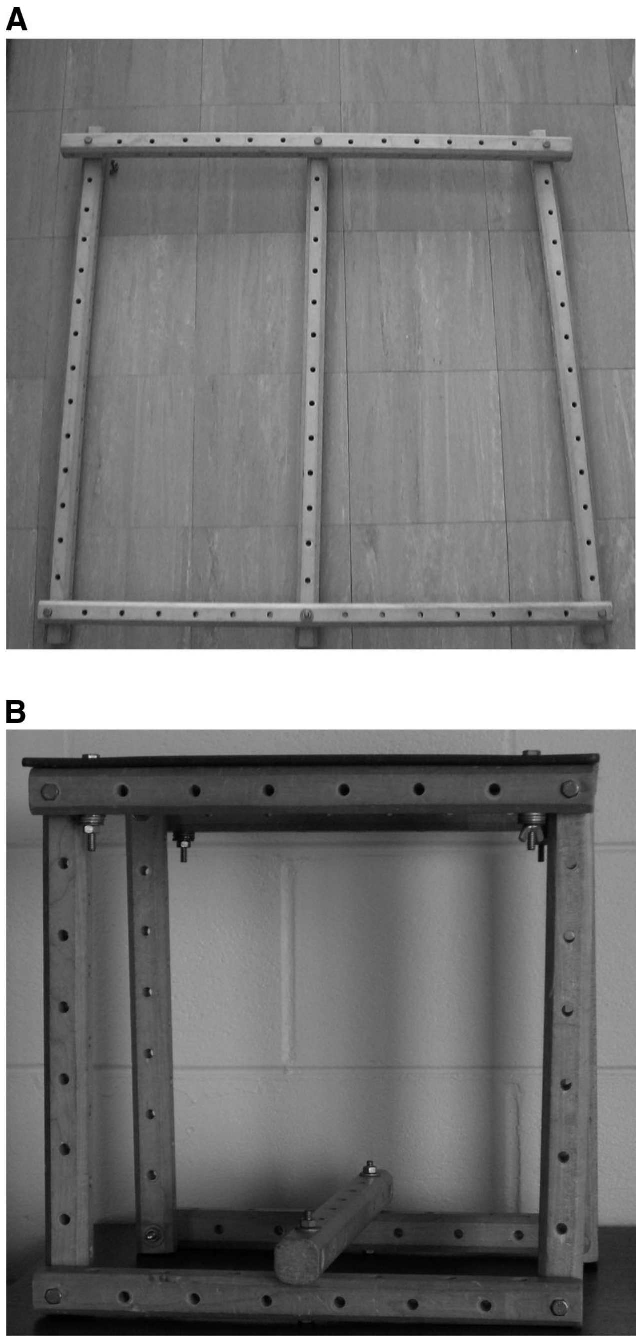

Figure 2. Two-dimensional (A) and three-dimensional (B) wobbly frame structures.

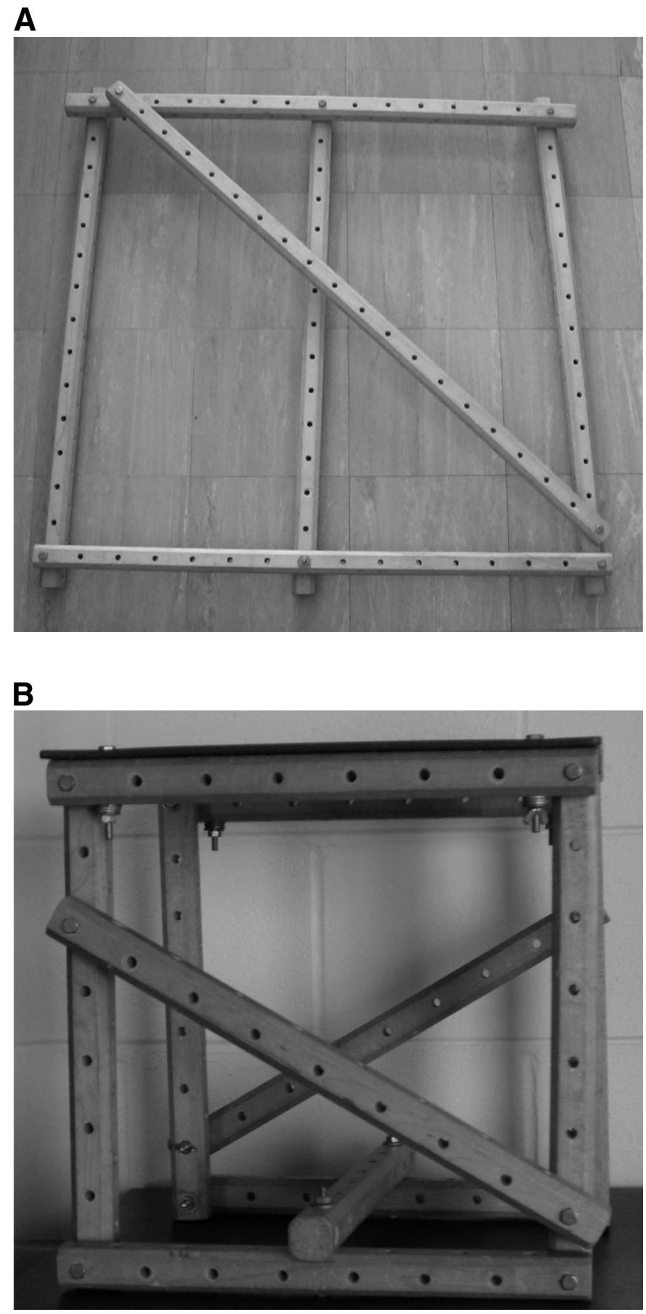

Figure 3. Two-dimensional (A) and three-dimensional (B) strong frame structures.

the second adult could look at and touch the structure the child had built as they talked. Meanwhile, the adult who engaged with the child in the preexhibit activities and exhibit interaction filled out a questionnaire that included, in addition to demographic questions, questions about the caregiver's and the child's level of knowledge about and interest in building activities prior to the museum visit rated on a scale of 1 (*low*) to 7 (*high*).

Learning assessment: Picture task. After the reunion conversation, the children and their caregivers were escorted back to the same room that had been used for the preexhibit experiences, and the children participated in a brief, paired-comparison picture task. Six pairs of photos were shown, one pair at a time, that depicted two-dimensional (three pairs) and three-dimensional (three pairs) structures that had been made with exhibit materials. Pairs of pictures were identical except for the one (three pairs) or two pieces (three pairs) that in one of the pictured structures composed triangle or diagonal cross-braces and in the other formed horizontal crosspieces that provided no structural support. The pairs of pictures were presented in one of two counterbalanced orders across the experimental groups. For each pair presented, the children were instructed to select the picture of the structure that "looked stronger," and a correct answer was scored each time the child selected the structure that contained the triangle braces for a maximum score of 6.

Delayed memory conversations. All dyads were invited to participate in an additional (optional) in-home assessment of the children's memory for the museum visit. Caregivers were asked to record two conversations with their children about their experiences in the construction exhibit, one 1 day and the other 2 weeks following the museum visit. Families that agreed to the memory portion of the study received a tape recorder and audiotape, an instruction sheet, and a postage-paid padded envelope that they were to use to return the recorder and tape once the conversations had been completed. Although families were also invited to talk about other aspects of their museum visit after talking about the construction exhibit, only the portions of the memory conversations that were about the experiences in the construction exhibit were analyzed for the current study.

Coding

Building measures. To determine the effectiveness of the building instructions, coders scored the videotaped records of the exhibit interactions for whether the dyads included a frame structure in their building. A frame structure was defined as three or more pieces of wood being connected to one another to form a side, top, and/or bottom form. In addition, the number of triangles and the number of sides the buildings contained were counted. By counting the number of sides, it was possible to determine whether, across groups, dyads were building the same types of structures (e.g., a four-sided structure), even if the effects of the experimental manipulation led to more frame structures and triangles being incorporated into the buildings constructed by those in the build + talk and build-only groups. Two coders viewed the masked video records and established reliability by independently coding 20% of the structures built by dyads in each experimental group. Percent agreement was above 95% for each of the three building measures.

Talk measures. Videotape records of the conversations in the exhibit were scored with Noldus Observer Pro software. The reunion conversations recorded during the learning assessment in the museum and delayed memory conversations were coded from verbatim transcripts of the audio records. For all conversation codes, the coding units were parsed by unique subject and/or verb (e.g., Reese et al., 1993), such that, for example, "I bolted them in" would receive credit for one unit of information, whereas "I bolted them in, and then screwed these nuts on, and Daddy made them tight," would be credited with three responses.

Caregivers' and children's talk during exhibit conversations. To determine the effectiveness of the conversation instruction, coders scored the caregivers' and children's talk during the exhibit interactions using a system adapted from Boland et al. (2003). Caregivers' open-ended *wh*-questions were defined as requests for new (not previously provided) information (e.g., "What is this called?" "What is this used for?"). Associations included any comment or question that invited the child to link any aspect of the exhibit to his or her prior knowledge ("Skyscrapers have lots of floors.") or past experiences (e.g., "What tools does Uncle Bob use when he builds houses?" "This looks like the Target they're building on the way to school."). The children's *wh*-questions and associations were coded with the same definitions used for the corresponding caregiver codes. In addition, all children's responses to their caregivers' *wh*-questions (e.g., "Goggles protect your eyes.") that provided new information not previously mentioned by either partner were coded.

The content of the caregivers' *wh*-questions, and the children's responses to their caregiver's *wh*-questions during the exhibit conversations, were subcoded if the content of these comments was about building engineering. Building engineering content was defined as talk about building mechanics or engineering concepts, such as the use of frames or triangles to brace structures ("What should we do to make this stronger?" "We need to add a triangle."), or about the strength (or lack thereof) of a structure (e.g., "Why do you think this is wobbling?" "This doesn't seem very sturdy."). Children's responses containing engineering content could have come following a caregiver's question that either did or did not include engineering content (e.g., a caregiver asks, "What should we do next?" and the child responds, "Brace it!"; the child's response, but not the caregiver's question, was coded as containing engineering content).

The exhibit conversation coding was conducted by two coders who viewed videos that masked the dyads' experimental group membership. Interrater reliability based on 20% of videotapes was, on average, 96% for *wh*-questions, 94% for associations, 96% for the children's responses, and 92% for the engineering content subcode.

Adults' and children's talk in the immediate reunion conversations. The coding for the transcripts of the reunion conversation focused on the number of *wh*-questions (e.g., "How did you get all these pieces to stay together?" "Who came up with this idea?") the children were asked by the familiar adults who had not built with them and the number of pieces of information the children provided (a) in response to the adults' *wh*-questions and (b) spontaneously. Engineering content of the children's talk during the reunion conversation was scored in the same fashion as for the exhibit conversations. Interrater agreement, based on 20% of the masked videotaped records of this task, averaged 96% for adults' *wh*-questions, 93% for information provided by the children, and 91% for the engineering content code.

Caregivers' and children's talk during the delayed memory conversations. Caregivers' *wh*-questions (e.g., "What did we do in the Under Construction exhibit at the museum?" "What did we use to build with?") and the children's memory elaborations that reported information about the exhibit experience (e.g., "We used a nut driver." "We built a house.") were scored via a system adapted from Haden (1998). In addition, the children's memory elaborations were subcoded for engineering content. Interrater agreement, based on 20% of the masked audiotaped records of this task, averaged 95% for the caregiver codes, 95% for the children's memory elaborations, and 93% for the engineering content code.

Results

Preliminary correlational analyses were used to determine what, if any, covariates should be included in the main analyses. Specifically, the correlations addressed whether caregiver characteristics (education, prior knowledge, interest), child characteristics (age, prior knowledge, interest), and time spent in the exhibit were correlated with the measures of the caregivers' and children's building and conversation in the exhibit, immediate assessments of learning, and delayed remembering.

Only one significant correlation was observed between paternal and maternal education and any of the other measures in this study, and therefore, education was not included as a covariate in the main analyses. Child age was found to be significantly correlated with the percentage of children's responses to caregivers' *wh*-questions in the exhibit that contained engineering content ($r = .26$), children's correct performance on the picture task ($r = .26$), and children's memory elaborations at the 1-day and 2-week delays (rs = .34 and .45, respectively; all ps $< .05$). Therefore, child age was retained as a covariate in the analyses of variance (ANOVAs) reported below that involved the variables with which it was correlated.

Caregivers' and children's knowledge and interest measures were intercorrelated (rs = .32–.74, ps $< .001$), but the only other variable in the study that knowledge and interest were significantly correlated with was the number of sides of built structures in the exhibit (rs = .21–.24, ps $< .05$). Child interest was selected as the covariate for inclusion in the analysis reported below involving number of sides. Time spent in the exhibit was correlated with six of the nine continuous measures of building and conversation in the exhibit (significant rs = .19–.35, ps $< .05$) but not with any measures of learning or remembering except for the percentage of the children's total talk in the immediate reunion conversation that was about building engineering ($r = .21$, $p < .05$). Time in the exhibit was retained as a covariate in all the exhibit building, exhibit conversation, and immediate reunion conversation analyses.

All 5 (condition) × 2 (gender) ANOVAs and analyses of covariance (ANCOVAs) reported below were run twice, once with child gender as the second between-subjects factor and again with caregiver gender as the second between-subjects factor. Main effects of caregiver gender are reported only when the results diverged from those found for child gender. All significant main effects of condition were followed by pairwise tests with a Bonferroni adjustment for multiple comparisons (all ps $< .05$, unless otherwise noted).

Caregiver and Child Characteristics and Time Spent in the Exhibit

Table 1 summarizes the average age of the children at the time of the museum visit, their caregivers' reported educational level, the children's and caregivers' prior knowledge about and interest in building as reported by caregivers, and time spent in the exhibit. Analyses of these descriptive measures were conducted via separate 5 × 2 ANOVAs for each variable.

There were no main or interactive effects of condition or gender for the children's age, Fs(4, 111) < 1.00, ps $> .43$, or maternal or paternal education levels, Fs(4, 111) < 1.20, ps $> .37$. Prior knowledge about and interest in building also did not vary by condition, Fs(4, 111) < 1.01, ps $> .41$. However, in comparison with female children, male children were rated by their caregivers as having more prior knowledge about (boys: $M = 3.18$, $SD = 1.24$; girls: $M = 2.47$, $SD = 1.20$) and interest in building (boys: $M = 5.14$, $SD = 1.38$; girls: $M = 3.53$, $SD = 1.51$; Fs = 8.69 and 39.86, η^2s = .07 and .26, respectively, ps $< .01$). Also, in comparison with female caregivers, male caregivers rated themselves as having more prior knowledge about (men: $M = 5.10$, $SD = 1.62$; women: $M = 3.41$, $SD = 1.68$) and interest in building (men: $M = 5.05$, $SD = 1.63$; women: $M = 3.40$, $SD = 1.68$; Fs = 8.09 and 8.54, η^2s = .06 and .07, respectively, ps $< .01$). The Condition × Gender interactive effects for prior knowledge about or interest in building were nonsignificant (Fs < 1.63, ps $> .17$).

The only difference among the conditions on the descriptive measures was for time spent in the exhibit, $F(4, 111) = 3.92$, $p < .01$, $\eta^2 = .12$. As illustrated by the last row of means in Table 1, the dyads in the talk-only instruction condition spent a longer amount of time in the exhibit than dyads in any of the other four groups. In addition, although boys and girls spent similar amounts of time in the exhibit, $F(1, 111) = 2.14$, $p = .15$, male caregivers ($M = 29.51$, $SD = 7.85$) spent more time in the exhibit than female caregivers ($M = 25.73$, $SD = 6.82$), $F(1, 111) = 10.89$, $p < .01$, $\eta^2 = .08$. The Condition × Gender interaction effects for time spent in the exhibit were not statistically significant (Fs $< .22$, ps $> .92$).

Building in the Exhibit

One main research question concerned whether the preexhibit experiences affected the dyads' building behaviors in the exhibit. Specifically, if the provision of building instructions to the build + talk and build-only groups was effective, it was expected that these two groups would be more likely to build frames and would include more triangles to brace their structures than their counterparts in the other three conditions. Three primary ways of characterizing the buildings were considered in the analyses: presence of frame (yes/no), the number of triangles in the structures, and the

Table 1
Means for the Children's Age, Parental Education, Prior Knowledge, and Interest Variables and Total Time Spent in the Exhibit by Experimental Condition

Descriptive variable	Build + talk	Build only	Talk only	Models	Control	*M*
Age (months)	82.14 (18.99)	78.38 (13.30)	79.18 (11.43)	81.23 (13.78)	74.22 (14.00)	79.21 (14.96)
Paternal education (years)	15.82 (2.36)	16.53 (2.12)	14.89 (1.84)	15.55 (3.38)	15.89 (2.05)	15.74 (2.43)
Maternal education (years)	15.23 (2.25)	15.21 (2.82)	15.35 (2.20)	15.38 (2.13)	15.86 (2.22)	15.40 (2.29)
Caregivers' knowledge	4.09 (2.01)	3.80 (2.02)	4.70 (1.63)	4.17 (1.85)	4.48 (1.70)	4.23 (1.85)
Children's knowledge	2.45 (1.15)	2.75 (1.45)	3.20 (1.15)	2.78 (1.28)	3.04 (1.30)	2.81 (1.27)
Caregivers' interest	3.90 (1.89)	4.10 (1.55)	4.75 (1.37)	3.96 (2.20)	4.47 (2.02)	4.21 (1.85)
Children's interest	4.35 (1.36)	4.05 (1.73)	4.60 (1.90)	4.35 (1.77)	4.22 (1.70)	4.32 (1.65)
Time in exhibit (min)	25.96_b (7.09)	27.02_b (9.01)	33.96_a (7.32)	26.35_b (5.69)	26.90_b (5.55)	27.78 (7.44)

Note. Means with different subscripts differ significantly at $p < .05$ in pairwise tests with Bonferroni adjustment for multiple comparisons. Standard deviations are in parentheses.

number of sides. Overall, 36.4% (or 44) of the dyads created frame structures, and the number of triangle braces averaged 0.51 (SD = 1.03; range: 0–4). Figure 4 illustrates the percentage of the sample in each condition that built a frame structure and whether a built frame structure varied by experimental condition. A chi-square test revealed that among those in the build + talk group, more dyads were likely to make a frame structure than would be expected (standard residual = 2.00), and among those in the control group, fewer dyads constructed a frame than would be expected to (standard residual = 1.95; $\chi^2 = 16.65$, $p < .01$, Cramér's $V = .37$).

With regard to the inclusion of triangles, the first row of means in Table 2 shows the number of triangle braces included in built structures by condition. Dyads in both building instruction conditions included more triangle braces in their buildings than dyads in the other three conditions. A 5 × 2 ANCOVA controlling for time spent in the exhibit indicated the significant main effect of condition, $F(4, 110) = 10.61$, $p < .001$, $\eta^2 = .26$. No main effect of gender or interaction effect was found for the number of triangles included in the built structures (Fs < .77, ps > .55).

Differences across conditions in the number of sides might indicate that the groups were building fundamentally different structures. Overall, dyads built structures comprising, on average, 3.42 sides (SD = 2.01; range: 0–8), but as illustrated in Table 2, the dyads in the models group included more sides in their structures than dyads in the talk-only condition. The main effect of condition for number of sides in a 5 × 2 ANCOVA controlling for child interest and time spent in the exhibit was significant, $F(4, 109) = 3.09$, $p < .05$, $\eta^2 = .09$. Moreover, although no main or interactive effects involving child gender were found (Fs < .27, ps > .90), dyads with male caregivers incorporated more sides in their structures (M = 3.98, SD = 2.00) than dyads with female caregivers (M = 2.88, SD = 1.87), $F(1, 109) = 4.79$, $p < .05$, $\eta^2 = .03$.

In sum, whereas the build + talk, build-only, talk-only, and control groups built similar buildings with respect to the number of sides composing their structures, the build + talk and build-only instruction groups included more triangle cross-braces than any of the others and, therefore, built stronger buildings.

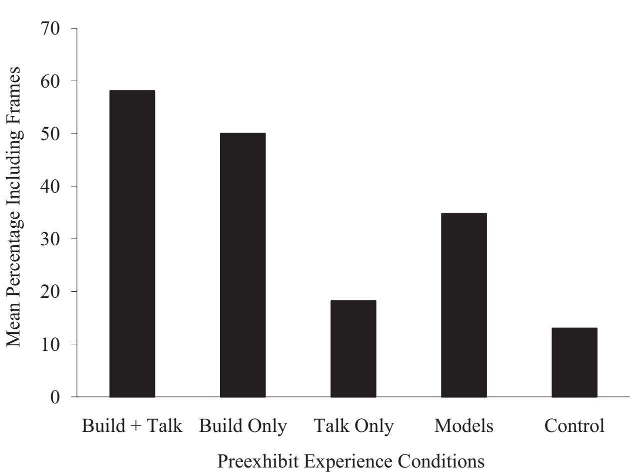

Figure 4. Percentage of caregiver–child dyads that included frame structures in their buildings.

Exhibit Conversations

Elaborative talk in the exhibit. A second key research question concerned whether the preexhibit experiences affected talk in the exhibit. In particular, because the build + talk and talk-only groups were asked to use *wh*-questions and associations while building in the exhibit, an initial step in these analyses was to test whether these elaborative conversational techniques were used more in the exhibit by dyads that received these conversation instructions in contrast to their counterparts who did not. On average, caregivers asked 14.57 (SD = 10.72) *wh*-questions and made 3.66 (SD = 4.57) associations during their time in the exhibit. Two ANCOVA analyses were conducted with time spent in the exhibit as the covariate, one for caregivers' use of *wh*-questions and the other for caregivers' associative comments. The top two rows of Table 3 display by experimental group the frequency of caregivers' use of *wh*-questions and associations when talking with their children in the exhibit.

As suggested by the means in Table 3, the caregivers appeared to be able to follow the conversation suggestions and used the targeted elements of an elaborative style when talking with their children in the exhibit. A main effect of condition for *wh*-questions, $F(4, 110) = 10.03$, $p < .001$, $\eta^2 = .23$, indicated that caregivers in the build + talk and the talk-only groups, who had been instructed to do so, asked their children significantly more *wh*-questions than caregivers in the models, build-only, and control groups. In addition, the main effect for associations $F(4, 110) = 5.88$, $p < .001$, $\eta^2 = .16$, revealed that caregivers in the build + talk group made more associations than caregivers in the build-only condition, and caregivers in the talk-only group provided more associations than those in the models, build-only, and control groups. There were no significant main or interactive effects of gender for *wh*-questions (Fs < 3.17, ps > .08) or associations (Fs < 1.14, ps > .29).

A second step in the analysis of talk in the exhibit concerned whether the children's verbal contributions to the conversations in the exhibit varied according to preexhibit condition. Overall, the children asked 1.30 (SD = 1.60) open-ended *wh*-questions and made 1.03 (SD = 1.92) associative comments while in the exhibit. The third and fourth rows of means in Table 3 display the frequency of children's *wh*-questions and associative comments by experimental condition. The ANCOVAs conducted with time in the exhibit as a covariate confirmed that there were no differences among the groups in the children's use of *wh*-questions, $F(4, 110) = 1.85$, or associations, $F(4, 110) = .99$, ps > .19. There were also no main or interactive effects of gender for children's *wh*-questions (Fs < 1.30, ps > .26) or associative comments (Fs < 1.57, ps > .19).

Additional analyses considered whether children were responding differentially to their caregivers' *wh*-questions according to their group membership. Overall, children responded to 11.46 (SD = 10.29) of the *wh*-questions their caregivers' asked in the exhibit, which corresponded to a response rate of 76%. As illustrated in Table 3, the children's responsiveness to caregivers' *wh*-questions varied by condition, with the ANCOVA covarying for time spent in the exhibit revealing this main effect of condition, $F(4, 110) = 13.44$, $p < .001$, $\eta^2 = .27$. Children in the build + talk condition responded significantly more often to their caregivers' *wh*-questions than children in the build-only and control

Table 2
Means for Number of Triangles and Number of Sides in Built Structures in the Exhibit by Condition

Building in exhibit	Build + talk	Build only	Talk only	Models	Control
Number of triangles	1.14_a (1.16)	1.14_a (1.09)	0.09_b (0.43)	0.22_b (0.85)	0.00_b (0.00)
Number of sides	3.10 (1.85)	3.71 (2.05)	2.48_b (2.09)	4.21_a (2.02)	3.89 (1.95)

Note. Across individual rows, means with subscript *a* differ from means with subscript *b* at $p < .05$ in pairwise tests with Bonferroni adjustment for multiple comparisons. Standard deviations are in parentheses.

conditions, and children in the talk-only group responded to significantly more of their caregivers' *wh*-questions than children in all other conditions. There were no significant main or interactive effects involving gender (Fs < 2.80, ps $> .10$). These results therefore demonstrate that children in dyads that received conversation instruction alone were engaging in the most joint talk with their caregivers, as defined by instances when the caregiver asked an elaborative what, where, why, or how question that was responded to with the provision of new information by the child.

Exhibit talk about engineering. Another step in the analysis of the conversations in the exhibit was to determine whether the preexhibit experiences affected the content of what was said. Specifically, the emphasis on the process of building during the preexhibit experiences of the build + talk and build-only groups might have led caregivers and children in these conditions to talk more about building engineering in the exhibit than those in the other groups. To examine this, we conducted two 5 × 2 ANCOVAs covarying time in the exhibit, one for the percentage of the caregivers' total *wh*-questions that contained engineering content and the other for the percentage of the children's total responses to caregivers' *wh*-questions in which the children referred to engineering. These percentages are presented in the upper portion of Table 4.

Overall, *wh*-questions about building engineering composed only 2.77% of the total number of *wh*-questions asked by the caregivers and 3.50% of the total number of children's responses to caregivers' *wh*-questions in the exhibit. But there were differences among the groups for both the percentage of caregivers' *wh*-questions pertaining to engineering, $F(4, 110) = 5.46$, $p < .001$, $\eta^2 = .16$, and the percentage of the children's responses to caregivers' *wh*-questions in which the children expressed engineering content, $F(4, 109) = 2.61$, $p < .05$, $\eta^2 = .12$. Caregivers in the build + talk condition asked a greater proportion of *wh*-questions that contained engineering content, with caregivers in the build-only condition showing a trend for this same result ($p = .10$), when compared with those in the models, talk-only, and control groups. Moreover, paralleling the results for their caregivers, a greater percentage of the responses to caregivers' *wh*-questions provided by the children in the build + talk and build-only groups contained engineering-related content, in comparison with the models, talk-only, and control conditions. No main or interactive effects of gender were found in any of these content analyses (Fs $< .52$, ps $> .63$). In sum, building instruction, with and without conversation instruction, appeared to enhance the caregivers' and children's joint talk about engineering in the exhibit.

Children's Performance on Assessments of Learning and Remembering

Paired-comparison picture task. One measure of learning involved assessment of the children's abilities to choose the stronger structure from pairs of photographs, with the correct choice in each pair being a structure featuring one or two triangle or diagonal cross-braces. Overall, the children averaged 3.50 ($SD = 1.67$) out of six pairs correct. The first row of means in Table 5 displays the children's performance on this learning assessment by condition.

As illustrated in the table, children in the build + talk and build-only groups were better able to identify strong structures in the picture task than children in the other three groups. An ANCOVA with child age as a covariate yielded a significant main effect of condition, $F(4, 110) = 13.13$, $p < .001$, $\eta^2 = .29$. No main or interactive effects of gender were obtained in the analysis of the picture task (Fs < 1.28, ps $> .28$). Thus, relative to their peers, the children in groups receiving building instruction, with or without conversation instruction, were more able to identify strong structures on the basis of the presence or absence of triangular bracing.

Table 3
Means for Caregivers' and Children's Wh-Questions and Associative Comments and Children's Responses to Caregivers' Wh-Questions by Condition

Verbal behavior in exhibit	Build + talk	Build only	Talk only	Models	Control
Caregivers' *wh*-questions	17.94_a (10.98)	7.70_b (5.79)	24.60_a (11.87)	13.09_b (8.03)	8.78_b (6.27)
Caregivers' associations	4.68_a (4.57)	$1.19_{b,d}$ (1.47)	$7.29_{a,c}$ (5.66)	3.26_d (4.73)	1.74_d (2.56)
Children's *wh*-questions	1.68 (1.89)	0.55 (0.83)	1.45 (2.01)	1.39 (1.41)	1.22 (1.35)
Children's associations	1.35 (2.65)	0.40 (0.60)	1.25 (2.10)	1.00 (1.76)	0.91 (1.44)
Children's responses	$12.65_{a,d}$ (8.68)	$5.05_{b,d}$ (4.04)	26.67_c (12.87)	9.74_d (6.34)	$5.41_{b,d}$ (3.16)

Note. Across individual rows, means with subscript *a* differ from means with subscript *b*, and means with subscript *c* differ from means with subscript *d*, at $p < .05$ in pairwise tests with Bonferroni adjustment for multiple comparisons. Standard deviations are in parentheses.

Table 4
Mean Percentages of Talk With Engineering Content in Exhibit, Reunion, and Memory Conversations by Condition

Percentage with engineering content	Build + talk	Build only	Talk only	Models	Control
Exhibit conversation					
Caregivers' *wh*-questions	6.52_a (2.96)	3.50_c (2.66)	$1.21_{b,d}$ (2.50)	$0.90_{b,d}$ (1.29)	$0.40_{b,d}$ (0.90)
Children's responses	6.89_a (2.06)	8.17_a (2.21)	0.70_b (1.34)	0.48_b (1.23)	0.01_b (0.00)
Immediate reunion conversation					
Children's information provided	9.57_a (9.78)	6.34 (7.56)	3.21 (6.56)	4.81 (10.28)	1.83_b (4.29)
Delayed memory conversation					
Children's memory at 1 day	25.00_a (23.06)	14.29 (14.40)	0.00_b (0.00)	9.14 (13.99)	2.31_b (7.30)
Children's memory at 2 weeks	$16.54_{a,c}$ (14.03)	4.76 (1.16)	1.25_b (3.54)	0.00_b (0.00)	1.79_d (4.72)

Note. Across individual rows, means with subscript *a* differ from means with subscript *b* at $p < .05$, and means with subscript *c* differ from means with subscript *d* at $p < .10$, in pairwise tests with Bonferroni adjustment for multiple comparisons. Standard deviations are in parentheses.

Immediate reunion conversation. What the children were able to tell about their exhibit experiences to a familiar adult who had not participated in the activities with them offered another assessment of their learning. On average, the conversations were about 2.39 min ($SD = 1.29$; range: 0.24–6.40) in length, with a trend for the conversations to be longer with children in the build + talk condition in comparison with those in the other four groups, $F(4, 111) = 2.39$, $p = .05$, $\eta^2 = .07$. The adults who engaged with the children in the reunion conversation asked 7.42 ($SD = 3.52$) *wh*-questions, while the children provided, on average, 11.21 ($SD = 6.55$) pieces of new information in response to these questions. In addition, the children spontaneously provided, on average, 1.24 ($SD = 1.67$) new units of information during the reunion conversation. The last three rows of means in Table 5 illustrate the frequency of these measures of the adults' and children's talk during the immediate reunion conversation by experimental condition.

A series of 5 × 2 ANCOVAs were conducted on these measures with time in the exhibit and time of the reunion conversation as covariates in all analyses, and the additional covariate of number of *wh*-questions asked by the adults in the analyses of the children's talk. There were no main or interactive effects of gender found in any of these analyses of talk during the reunion conversation (Fs ≤ 2.66, ps $\geq .11$). As shown in Table 5, there was also no difference in the number of *wh*-questions posed by adults during the immediate reunion conversation, $F(4, 109) = .76$, $p = .56$. The effect of condition for the number of new pieces of information provided by the children in response to the adults' *wh*-questions was also nonsignificant, $F(4, 108) = 1.41$, $p = .23$. Nevertheless, the amount of information that the children provided spontaneously, although minimal, did differ by their preexhibit condition, $F(4, 108) = 2.57$, $p < .05$, $\eta^2 = .07$. As shown in the third row of means in Table 5, children in the build + talk condition tended to provide more information spontaneously than those in the build-only and control groups ($p < .07$).

With regard to the content of the children's talk during the immediate reunion conversations, 5.45% of what the children said spontaneously and in response to questions was about building engineering. As illustrated in the middle portion of Table 4, the children's engineering talk in the reunion conversations varied by experimental group. The main effect of condition, $F(4, 108) = 2.59$, $p < .05$, $\eta^2 = .08$, indicated that children in the build + talk group spoke more of building engineering in comparison with children in the control group.

Thus, immediately after building, relative to the children in the control group, there was the suggestion that the effects of building and conversation instruction were additive in impacting both the children's provision of spontaneous information and the engineering content of their talk in conversations with a familiar adult who had not built with them.

Delayed memory conversations. Of the families that had participated in the museum-based portion of the study, 57 (47%) elected to participate in the memory task, although eight of these did not return any recordings. Nonetheless, 45 caregiver–child dyads recorded a conversation 1 day after their visit, and 39 did so after the 2-week delay; 35 families made recordings at both intervals. Although with the reduced sample size the analyses of the memory conversations should be viewed as exploratory, it is

Table 5
Children's Mean Number Correct on the Paired Comparison Picture Task and Amount of Information Provided in the Reunion Conversation by Condition

Learning assessment	Build + talk	Build only	Talk only	Models	Control
Picture task					
Number correct	4.52_a (1.73)	4.55_a (1.00)	2.65_b (1.18)	2.74_b (1.21)	2.74_b (1.66)
Reunion conversation					
Adults' *wh*-questions	8.87 (3.59)	7.02 (3.12)	7.00 (3.69)	6.23 (3.10)	7.43 (3.63)
Children's responses to *wh*-questions	11.97 (6.37)	11.96 (6.47)	10.85 (6.36)	9.87 (7.23)	11.17 (6.67)
Children's spontaneous information	2.19_a (1.91)	0.77_b (1.34)	0.90 (1.19)	1.23 (1.78)	0.78_b (1.44)

Note. Across individual rows, means with subscript *a* differ from means with subscript *b* at $p < .05$ in pairwise tests with Bonferroni adjustment for multiple comparisons. Standard deviations are in parentheses.

important to note that those who participated in the memory portion of the study were not significantly different from those who did not on any of the descriptive measures (e.g., child age, time in the exhibit), measures of building, or measures of exhibit and reunion conversations. Because of the reduced sample size, analyses of the memory conversations were conducted by condition without the inclusion of child gender as a second between-subjects factor. Moreover, because preliminary repeated measures analyses revealed only one effect of delay interval (caregivers asked fewer *wh*-question elaborations in the second memory conversation than in the first), the analyses were conducted separately for each delay so that all the available memory data from each delay interval could be considered.

Table 6 displays the means and standard deviations for the caregivers' *wh*-questions and the children's memory elaborations following the 1-day and 2-week delays. At the 1-day delay, across conditions, caregivers differed in their asking of *wh*-question elaborations, $F(4, 39) = 3.90$, $p < .01$, $\eta^2 = .29$. Caregivers in the models condition asked more elaborative *wh*-questions than those in the build-only and control conditions and tended ($p = .07$) to ask more of these questions than caregivers in the talk-only condition.

With regard to the children's recall of memory elaborations after 1 day, after controlling for child age and the number of elaborative *wh*-questions asked by caregivers during the memory conversation, the main effect of condition was nonsignificant, $F(4, 37) = 1.24$, $p = .31$. In addition, at this delay interval, 10.3% of the children's total recall could be characterized as about building engineering. As illustrated in the lower portion of Table 4, the engineering content of the information the children recalled at the 1-day delay did vary by experimental group. After controlling for child age and the number of caregivers' *wh*-questions during the memory conversation, a significant effect of condition was found for building engineering, $F(4, 36) = 3.81$, $p = .01$ $\eta^2 = .27$. As shown in the lower portion of Table 4, compared with children in the talk-only and control groups, a greater percentage of the recall of children in the build + talk group was about engineering following a 1-day delay.

After the 2-week delay, as illustrated in the lower portion of Table 6, there were no differences by condition for caregivers' *wh*-question elaborations, $F(4, 34) = 1.28$, $p = .30$. However, at this delay interval, the children did appear to recall different amounts of information depending on their experimental group. The ANCOVA for children's memory elaborations after 2 weeks, after controlling for children's age and caregivers' *wh*-questions during this memory conversation, was statistically significant for condition, $F(4, 32) = 3.97$, $p = .01$, $\eta^2 = .25$. Children in the build + talk group recalled more information, and those in the talk-only group tended to do so ($p < .09$), in comparison with children in the models condition. Further, at the 2-week delay, 4.8% of the content of the children's recall could be characterized about building engineering, with the content of the children's talk again varying across conditions. After controlling for child age and the number of caregivers' *wh*-questions in the 2-week delayed memory conversation, there was a significant effect of condition for building engineering content, $F(4, 31) = 4.89$, $p < .01$, $\eta^2 = .38$. As shown in the last row in Table 4, the percentage of recall that was about engineering for children in the build + talk group was higher than for those in the models and talk-only groups and tended ($p = .07$) to be higher than for control children.

Taken together, the analyses of the memory conversations suggest that the children's overall recall of the exhibit experience following a 2-week delay was linked to whether they were in a group that received conversation instruction and, in turn, engaged in elaborative talk during their museum exhibit experience. Reporting of engineering content at both delay intervals was also highest for children who had received building and conversation instruction.

Discussion

Enhancing Caregiver–Child Interactions as Events Unfold

This study adapted an experimental design in order to confirm and interpret linkages that have been observed in museums and in other everyday settings between caregiver–child conversational interactions as events unfold and children's understanding and remembering of these events. The findings suggest that quite brief and simple preexhibit instructions about key exhibit-related concepts—in this case, how to engineer strong structures with cross-bracing—can enhance caregiver–child behaviors in an exhibit. Compared with those in the two groups that received no instruction and the one group that received instruction only in elaborative conversational techniques, caregivers and children in the two groups that received building instruction included more triangular cross-braces in what they built in the exhibit. Building

Table 6
Mean Number of Caregivers' and Children's Memory Comments by Condition

Memory talk	Build + talk	Build only	Talk only	Models	Control
1-day delay					
N	11	7	7	9	10
Caregivers' *wh*-questions	5.73 (2.87)	3.71_b (2.69)	4.57_d (1.99)	$8.56_{a,c}$ (2.51)	4.70_b (3.30)
Children's elaborations	10.18 (7.13)	6.86 (4.60)	10.00 (7.39)	8.33 (4.12)	9.90 (4.91)
2-week delay					
N	9	6	8	9	7
Caregivers' *wh*-questions	5.89 (3.14)	3.83 (2.56)	3.75 (2.60)	5.22 (3.77)	3.00 (2.08)
Children's elaborations	13.11_a (5.90)	7.83 (4.58)	12.37_c (3.89)	$7.11_{b,d}$ (3.82)	7.71 (4.64)

Note. Across individual rows, means with subscript *a* differ from means with subscript *b* at $p < .05$, and means with subscript *c* differ from means with subscript *d* at $p < .09$, in pairwise tests with Bonferroni adjustment for multiple comparisons. Standard deviations are in parentheses.

instruction was further linked to increased talk about engineering in the exhibit. Also, those who received both building and conversation instruction were more likely to build frame structures.

Notwithstanding the effects of the building instruction on building construction and talk about building engineering in the exhibit, just having more information about how to build strong buildings in the exhibit did not result in more elaborative exhibit conversations (cf. Fender & Crowley, 2007). Moreover, the conversation instruction enhanced the exhibit experience but in ways that were not specific to building and engineering. Caregivers' who received conversation instruction incorporated them into their conversational style and used *wh*-questions and associations in the exhibit more than caregivers in groups who did not receive such instruction. Most important, in comparison with receiving no instruction at all, and beyond the effects of building instruction alone, conversation instruction increased joint talk between caregivers and children in the exhibit. Children in both groups that received conversation instruction were responding to caregivers' *wh*-questions more so than children in the building-only instruction and control groups. Thus, instruction to use elaborative conversational techniques led caregivers to engage with their children in a form of joint verbal interaction that could be expected to enhance the children's understanding of their experience (e.g., Boland et al., 2003; Haden et al., 2001; Hedrick, San Souci, et al., 2009; Tessler & Nelson, 1994).

The selection of conversational techniques that were suggested to the caregivers and children visiting the museum was guided by previous research and an emerging perspective regarding how events are best understood and remembered. Specifically, in work focusing on mother–child conversations about previously experienced events (e.g., Fivush & Fromhoff, 1988; Haden et al., 2009; Harley & Reese, 1999), *wh*-questions have been highlighted as a key element of an elaborative reminiscing style. When talking as an event is being experienced, *wh*-questions may be particularly important for shaping understanding and encoding in that they can call attention to specific aspects of an event that are perhaps especially salient, interesting, and/or key for understanding, while at the same time helping an adult to determine what a child may or may not know (Boland et al., 2003; Haden et al., 2001; Ornstein et al., 2004). By requesting object names, descriptions, actions, explanations, and so forth during events, caregivers can help children construct a representation of an experience that may be more accessible in the future.

Questions alone, however, may not always assure understanding of a novel situation. As Tessler and Nelson (1994) observed, associative comments that relate an unfolding event to what a child already knows can also help the child make sense of what is currently being experienced. In the end, however, the potentially critical element of style for learning may not be the sheer frequency with which caregivers ask elaborative *wh*-questions or make associations but rather the extent to which these (and other) elaborative techniques are effective in promoting joint verbal engagement between the caregivers and their children. Consistent with this perspective, researchers (e.g., Hedrick, San Souci, et al., 2009; Ornstein et al., 2004) have speculated that when a caregiver's questioning is followed by the child's verbal elaboration, an enriched representation of the experience may be established. Given this, it is especially provocative that the preexhibit conversation instruction resulted in more joint verbal engagement between caregivers and children as defined by caregivers' *wh*-questions about various aspects of the exhibit experience that were responded to by the child during the event.

Impacts on Learning and Remembering

With respect to the effects on children's learning and remembering, in this study, it was the children in the two groups that received the building instruction who were best able to identify from pairs of pictures the strongest structure on the basis of the presence or absence of triangular cross-bracing. Moreover, building instruction coupled with conversation instruction was linked to the children's abilities to report engineering content, both in the immediate reunion conversation and in the 2-week delayed memory conversation, particularly when the build + talk group was compared with the control condition. The combination of building and conversation instruction also appeared to be important for the children's abilities to spontaneously report information about their experiences during the immediate reunion conversation. Finally, although the effects of the conversation instruction on the children's memory for their exhibit-related experiences were not manifest 1 day after the museum visit, the pattern of recall across groups following the 2-week delay was consistent with previous research suggesting that elaborative talk during an event can facilitate remembering (e.g., Boland et al., 2003; Haden et al., 2001; Hedrick, San Souci, et al., 2009; McGuigan & Salmon, 2006; Tessler & Nelson, 1994).

Just as adult–child conversations can be viewed as a potential mechanism for understanding, they are also an important outcome measure of learning (Callanan & Jipson, 2001; Fivush et al., 2006; Leinhardt et al., 2002; Ornstein et al., 2004). In this study, the paired-comparison picture task supplemented conversational measures of learning and remembering. Admittedly, the conclusions that can be drawn based on performance on this task are limited by the absence of pretesting and because the picture task did not tap the children's abilities to transfer their learning (e.g., Bransford & Schwartz, 1999) to different sets of materials or exemplars (e.g., identifying the X bracing of the John Hancock Center as an element that would make this structure strong). Even still, it is interesting that the picture task as implemented did illustrate some immediate gains in what the children understood about building engineering based on building instruction.

The reunion conversations were a further attempt to determine how the children made sense of their experience based on their reports immediately after building. Modeled after a common feature of family museum visits, this reunion conversation allowed for a seminaturalistic assessment of children's initial understanding and learning. These conversations were short, and across conditions, the children were providing similar amounts of information in response to the adults' probes. But in comparison with children in the control condition, the amount of information the children reported about engineering concepts, and the amount they said spontaneously, were higher for the group that had received both building and conversation instruction. Perhaps in addition to having obtained more knowledge about engineering, having experienced elaborative talk as they were building led children in this build + talk condition to construct the experience in such a way that it was more retrievable, even in a situation when they were asked to report the event to an adult who had not been present for the event.

The results of the memory conversation are also interesting because, on the one hand, they indicate that the conversational instructions to talk in an elaborative fashion during an event did not seem to transfer to caregivers' reminiscing style. Those in the groups that had been asked to engage in elaborative talk during their exhibit experience were not asking significantly more *wh*-questions during the memory conversations than caregivers in the other groups. In fact, for reasons that are not clear, at the 1-day (but not 2-week) delay, it was the caregivers in the models group who asked the most *wh*-questions. On the other hand, the findings based on the memory assessment suggest that the combination of conversation and building instructions may have led to exhibit experiences that were more accessible for reporting by the children over the long term. Despite challenges in collecting the memory data, the results of the memory conversations obtained in this study suggest that longitudinal research designs that include measurement of how exhibit experiences are discussed days, weeks, and even months after a museum visit may be fruitful. Such work may allow researchers and museums educators to glean what information is retained about an experience, as well as how initial learning can be elaborated through subsequent experiences and conversations. In this way, it might be possible to gain further leverage on how understanding of an experience is achieved beyond the time frame of the event itself (Ornstein & Haden, 2002).

Conclusions and Implications

This research is an example of how longitudinal and observational studies that identify mediators of development (e.g., elaborative conversational style) can set the stage for experimental interventions that enhance our understanding of children's development. The success in instructing caregivers in the use of techniques associated with an elaborative style is consistent with previous work in which mothers were trained to use *wh*-questions, associations, follow-ins, and evaluations when talking during events with their children (Boland et al., 2003). That the conversation instruction also increased joint talk has implications for efforts in the event memory literature to identify what it is about an elaborative conversational style that may be particularly important for child outcomes (e.g., Hedrick, San Souci, et al., 2009; Ornstein et al., 2004).

It is notable that in this study direct instruction was important for teaching both engineering concepts and the targeted elaborative talk strategies. Indeed, it was somewhat surprising that the dyads that were presented with models of strong structures and elaborative conversation did not perform significantly better on any of the measures of exhibit behaviors, or children's learning and remembering, when compared with dyads in the control condition that saw no models and received no instruction. Whereas other forms of modeling might be explored in future research, in this study, there was virtually no evidence that dyads were implicitly learning from the models presented to them absent direct instruction, other than that they may have been more prone to build four-sided structures because they were presented with one as a model building.

This study also illustrates how experiments can be done in museums in ways that may have implications for museum practice (Allen et al., 2007). For example, the results of the building instruction manipulation in this study might suggest to label writers in museums that providing short and straightforward information about core aspects of an exhibit can foster understanding. The emphasis on asking questions in the conversation instructions in this study fits with efforts being made in many museums to focus on inquiry-based, visitor-centered experiences. But museums might especially look for ways to assist visitors in generating their own open-ended questions as was done here with the conversation instruction group (Munley, Roberts, Soren, & Hayward, 2007). Future work is needed to determine the effectiveness of different delivery methods, including signage and programming to communicate instructional messages (e.g., about building and elaborative conversation) to visitors in ways that are sustainable for museums. Nevertheless, the findings from this study suggest that the impact of providing information about content—including science-, technology-, engineering-, and math-related content—and elaborative conversational techniques can be additive, with each of these influencing aspects of caregiver–child interactions and children's learning and remembering.

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