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Parents' science talk to their children in Mexican-descent families residing in the USA

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Everyday parent–child conversations may support children's scientific understanding. The types and frequency of parent–child science talk may vary with the cultural and schooling background of the participants, and yet most research in the USA focuses on highly schooled European-American families. This study investigated 40 Mexican-descent parents' science talk with their children (mean age = 5 years 7 months, range = 2 years 10 months to 8 years 6 months). Parents were divided between a higher schooling group who had completed secondary school, and a basic schooling group who had fewer than 12 years of formal schooling. Parents and children were videotaped engaging with science exhibits at a children's museum and at home. Conversations were coded in terms of parents' explanatory talk. In both contexts, Mexican-descent parents engaged children in explanatory science talk. At the museum, parents in the higher schooling group used more causal explanations, scientific principles explanations, and encouraging predictions types of explanations than did parents in the basic schooling group. By contrast, the only difference at home was that parents in the higher schooling group used more encouraging predictions talk than parents in the basic schooling group. Parents who had been to museums used more explanations than parents who had never visited a museum. The results suggest that while explanatory speech differed somewhat in two groups of Mexican-descent parents varying in formal schooling, all of these children from Mexican-descent families experienced some conversations that were relevant for their developing science literacy.

Keywords: conversation; Mexican descent; parent–child; science talk; socio-economic status

A growing body of research suggests that children's conversations with parents may support the early development of scientific learning. Everyday parent–child conversations are a rich source of information that may help children learn about the physical, natural, and psychological world (Beals, 2001; Callanan & Jipson, 2001; Crowley et al., 2001; Crowley & Jacobs, 2002; Ochs, Taylor, Rudolph, & Smith, 1992; Snow & Kurland, 1996). For example, when young European-American children ask "why" questions about the world around them, parents often respond in ways that may help children delineate science domains and begin to understand causal information about science (Callanan & Oakes, 1992). Explanatory talk about science topics has been found in parent–child conversations in museums, homes, and naturalistic lab activities. Thus, everyday conversations that arise during mundane activities may offer some guidance to children as they develop and revise intuitive theories about the world around them (Callanan & Jipson, 2001).

If these family conversations are important for children's early science understanding, then it would follow that children's understanding of science may vary depending on their experiences. Research on parent–child interactions in families from different cultural backgrounds suggests that explanatory conversations about science may not be typical occurrences for all children (Heath, 1986; Rogoff, 2003; Tizard & Hughes, 1984). Other research indicates cultural variations in parents' encouragement of their children's questions. For example, Goody (1978) argued that children's questions are not valued equally in all cultures.

The present study focuses on explanatory talk in Mexican-descent families residing in the USA while they were engaged in science-related activities. This study compares parents from different schooling backgrounds, focusing on variation within the Mexican-descent U.S. population, which is increasing in size and yet underrepresented in research. By "Mexican-descent" we mean people who are either immigrants from Mexico residing in the USA or U.S. citizens born in the USA whose parents emigrated from Mexico. Individuals of Mexican descent constitute the largest cultural group of Latinos/as in the USA (United States Census Bureau, 2000). Latinos/as

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presently constitute 13% of the U.S. population. Latinos/as are the largest growing ethnic minority in the USA with an increase of 58% in population between 1990 and 2000 (compared with a 13% increase in the total U.S. population; United States Census Bureau, 2000). Despite the numerical significance of Mexican-descent families, developmental research often excludes Mexican-descent families or treats families of Mexican heritage as a homogenous group. Even more troubling is when researchers treat Latinos/as as a homogenous group. Indeed, many have conflated ethnicity and education level in Mexican-descent families (see Perez-Granados & Cervantes, 2002, for a discussion), ignoring the importance of variations in experience, such as experience with schooling, as a component of culture. Parents in this study interacted with several science exhibits at a children's museum and completed two museum-like science tasks at home. We compared explanatory talk in two groups of Mexican-descent families varying in formal schooling.

Formal schooling comprises merely one factor along which variations exist in the heterogeneous Mexican-descent community and it is likely to be correlated with immigration status, language spoken at home, and other factors. For example, mother–child conversations about emotion vary with immigration status, with Mexican-American mothers using more emotion labels to describe behavior than Mexican-immigrant mothers (Cervantes, 2002). Other factors are often found to be linked tightly to the amount of formal schooling mothers have attained. For example, European-American and African-American mothers' years of formal schooling predict their occupation, income, and employment status (Hart & Risley, 1995; Leventhal, Graber, & Brooks-Gunn, 2001). Similar relations are likely to exist in the Mexican-descent community. Given that these factors do not occur in isolation from one another and cannot be independently assessed, the two groups of families in the current study necessarily differed from one another on a host of factors related to parents' years of formal schooling. In fact, formal schooling is perhaps best seen as an indicator of a constellation of factors that help to identify distinctive cultural communities, rather than as a variable in itself.

Schooling and cross-cultural variations in parent–child interaction

Parent–child conversations are embedded within and reflect larger cultural contexts (Moreno, 2002; Perez-Granados, 2002). For instance, Rogoff (2003) reports that Guatemalan Mayan children's interactions with their parents are characterized by close attention to everyday adult activities, and that children's "intent participation" in these activities is an important source of learning. Further, Rogoff and her colleagues (Rogoff, 2003; Rogoff, Paradise, Arauz, Correa-Chavez, & Angelillo, 2003) suggest that engaging in verbal explanatory talk may be an interactional style that contrasts with the intent participation style, and report that this verbal style may be more likely for parents who have had extensive experience in formal schooling settings (Rogoff, Mistry, Goncu, & Mosier, 1993).

Investigations of European, Asian, Latin American, and North American mothers find that maternal talk to children varies with mothers' educational attainment and socioeconomic status (SES) (Hart & Risley, 1995; Hoff, 2003; Hoff-Ginsberg, 1991; McGillicuddy-DeLisi, 1982; Tizard & Hughes, 1984). For example, middle-class (as defined by parents' education and occupation) parents from the USA, Estonia, Russia, and Korea were more likely to engage their children in academic lessons and conversations than were working-class parents from these nations (Tudge et al., 1999). Hoff-Ginsberg (1991) found that European-American mothers who had attained more years of formal schooling used a greater amount of contingent speech and fewer directives than did mothers who had attained fewer years of formal schooling.

Mothers' schooling and SES also predict their childrearing attitudes (Kohn, 1977). For example, mothers with higher levels of schooling and SES from the USA, Estonia, Russia, and Korea were more likely to endorse self-reliance for their children than mothers with basic levels of education (Tudge et al., 1999). Differences in parents' beliefs were greater based on social class than on nation state. Other studies conducted with European-American families have similarly found that maternal education is correlated with mothers' endorsement of children's self-direction (Luster, Rhoades, & Haas, 1989).

In contrast to the focus on self-reliance in families from middle-class backgrounds, Miller and her colleagues (Burger & Miller, 1999; Wiley, Rose, Burger, & Miller, 1998) have suggested that European-American families from working-class backgrounds (as defined by education and occupation) focus on developing cooperation in their young children. Similarly, Guatemalan Mayan mothers with fewer years of formal schooling were more collaborative and less directive with their children than mothers with more years of formal schooling while completing a puzzle (Chavajay & Rogoff, 2002). In sum, it appears that parents with fewer years of formal schooling may be more collaborative than parents with more years of formal schooling.

Schooling and variations in Mexican-descent parent–child conversations

Findings regarding whether formal schooling is related to maternal talk in Mexican-descent families have been mixed. On the one hand, several studies suggest systematic variations based on family background. Delgado-Gaitan (1994) compared family talk in Mexican-immigrant and first-generation Mexican-American families. Although both groups engaged in causal conversations with their children, first-generation Mexican-American parents provided more explanations and asked more questions than did Mexican-immigrant parents. Delgado-Gaitan also noted that the immigrant parents who had attained a high school education tended to use more causal language than did immigrant families with fewer years of formal schooling. Thus, when families had more years of formal schooling, their conversations involved more of the directive inquiry and explanation style that is typical of classroom discourse. Similarly, Laosa (1980) studied how Mexican-descent mothers[1] taught their children to construct a Tinkertoy model of a robot. He found that Mexican-descent mothers with higher levels of formal schooling used more inquiry with their children than did mothers with lower levels of formal schooling. An examination of maternal distancing

[1] Laosa's sample combined mothers born in Mexico residing in the USA, mothers born in the USA whose parents and ancestors immigrated from Mexico, and mothers whose ancestors resided in Mexican lands who became U.S. citizens when the borders shifted.

behavior (i.e., inquiry and explanatory talk that engages children in representational thought; see Sigel, 1981; Sigel, Stinson, & Flaugher, 1991) in a structured school-like (block building) and a structured home-like (baking) task revealed effects of education in Mexican-American mothers born in the USA (Eisenberg, 2002). In both tasks, Mexican-American mothers who had completed more years of formal schooling used more complex language than did mothers who had completed fewer years of formal schooling.

Contrasting with these differences in conversations related to formal schooling, many other researchers have not found differences in parent–child interactions in Mexican-descent families based on parental education. For example, Callanan, Perez-Granados, Barajas, and Goldberg (2005) found that Mexican-descent children asked many "why" questions and that mothers with differing levels of formal education responded to their children's questions with equivalent levels of causal explanations. After attending a family science workshop, Mexican-descent parents who had not completed high school provided as much explanatory talk in response to their children's questions as parents who had completed high school (Tenenbaum, Callanan, Alba-Speyer, & Sandoval, 2002). Moreno (1991) reports that while teaching their children to tie shoes, Mexican American mothers used as many conceptual questions as did European-American mothers.

Task demands of the activity and the situational context

How parents construct the situational context may partially account for whether differences are found between families with higher and basic levels of formal schooling. Depending on their experience and comfort level with a particular task, parents may employ different teaching styles (Moreno, 1991). Accordingly, Moreno (1991) has proposed that differences between ethnic groups in teaching behaviors are minimized when the familiarity of the task is taken into account. He posits that parents who have completed fewer years of formal schooling are uncomfortable being videotaped in the presence of an experimenter because of class differences and the unfamiliarity of the university laboratory environment. Talking with their children in more naturalistic settings, Mexican-descent parents may use more explanatory and inquiry-based talk than when the tasks are unfamiliar. Supporting this view, two ethnographic studies of Mexican-immigrant parents with low levels of formal schooling found that parents engaged their children in explanatory and inquiry-based conversations during everyday activities such as entertaining visitors and eating dinner (Vasquez, Pease-Alvarez, & Shannon, 1994; Villanueva, 1991).

In sum, research within the Mexican-descent community suggests that formal schooling as well as task familiarity contribute to differences in how mothers talk to their children. When families are less familiar with specific contexts, they may engage children in fewer explanatory interactions. One problem with this conclusion, however, is that participants' familiarity with a particular context has often been confounded with the types of interactions that may occur during the different contexts (e.g., baking versus assembling a puzzle).

Everyday scientific discourse

Parents may engage in a variety of discourse strategies that may result in conversations about science. The present study focused on four of these possible types of talk: using prior knowledge, causal explanations, scientific principle explanations, and encouraging predictions. The first category of explanation, *using prior knowledge*, encourages the listener to draw links between the present situation and previous occurrences. Such talk may aid learning by contextualizing new information (Tharp, 1997). For example, a parent could report, "the bees are making honey, like you eat at home." Indeed, even close analogies facilitate scientific discovery in microbiology laboratories (Dunbar, 1995). The second type, *causal explanation*, provides a cause–effect description for an event. For example, in response to a query about why a plant died, a causal explanation might be "The plant died because it wasn't watered." Causal explanations have been linked to increased conceptual understanding especially in the domain of science (Chi, de Leeuw, Chiu, & La Vancher, 1994). Also, mothers' use of these types of explanations predicts children's future science literacy (Tenenbaum, Snow, Roach, & Kurland, 2005). The third type of scientific discourse, *scientific principle explanations*, provide children with domain-specific scientific information (Klahr, 2000). When a parent informs a child, "all living things need water," children learn a principle that can be generalized beyond the immediate situation.

Differing from the first three types of science talk, the fourth type – *encouraging predictions* – encourages children to generate information on their own. A large body of work attests that people learn many types of information when they generate explanations (Coleman, Brown, & Rivkin, 1997; Pillow, Mash, Aloian, & Hill, 2002). Likewise, Sigel (1982) hypothesizes that generating predictions is cognitively stimulating because it leads the responder to reconstruct knowledge and thereby become engaged in representational thought (Sigel, 1982; Sigel et al., 1991). The frequency of parental conceptual questions with preschoolers has been shown to correlate with children's later advanced scholastic skills in domains such as reasoning and mathematics (Sigel et al., 1991). Inclusion of all four types of explanations enables us to explore the patterns of these different kinds of talk that appear in the everyday parent–child conversations we studied.

The present study

The present study differs from previous research on Mexican-descent families in its specific focus on everyday science talk at a museum and at home. Our goal was to study explanatory parent–child conversations in contexts that promote children's developing ideas about the physical and natural world. We examined parent–child talk in two science contexts: during a visit to a children's science museum, and at home engaging in two science activities. We examined whether two groups of parents with varying levels of formal schooling differed in their explanatory talk in these contexts. To understand how task familiarity specifically relates to parent–child interactions, we investigated parents' prior experiences with museums as a possible mediator of their explanatory talk in the museum. Examination of the complex relations among formal education and the activity setting could enable a deeper understanding of the diversity in Mexican-descent parents' use of science explanations with children.

Based on previous research, the main hypotheses were: within the context of the museum, parents in the higher schooling group were hypothesized to use a higher frequency of explanatory talk with their children than were parents in the

basic schooling group. By contrast, within the context of the home, we did not expect a difference in the frequency of explanatory talk between the two groups of parents. Thus, we predicted an interaction between formal schooling and situational context. We predicted this interaction because Mexican-descent families with basic schooling have been found to be less familiar with museums than families with higher levels of schooling (Tenenbaum et al., 2002). In addition, we also expected that families who had not been to a museum prior to the visit in the present study would use fewer explanations with their children while at the museum than families who had been to a museum previously.

Method

Participants

The participants were 40 Mexican-descent families living in the central coast area of California. The primary caregiver in each family had either been born in Mexico or their parents had been born in Mexico. The central coast consists mainly of small cities and farming towns ranging in size from 20,000 to 50,000 people, as well as rural farming areas. Families tended to live in downtown areas that were within a short drive of farms employing agricultural laborers. Parents in each group had either been employed as agricultural laborers or their parents had been. Families were divided into two groups based on whether the primary caregiver had completed secondary school (higher schooling) or had fewer than 12 years of formal schooling (basic schooling). In 39 families, mothers served as the primary caregivers. In one family with higher schooling, we included a father because he was the sole caregiver after a divorce. Inspection of his data suggested that he was not an outlier. Data from one primary caregiver in each family are included in analyses.

A target child was selected from each family. Target children were divided into two age groups. The younger group ranged from 2 years 10 months to 5 years 0 months, with a mean age of 4 years 2 months. The older group ranged from 5 years 3 months to 8 years 6 months, with a mean age of 6 years 11 months. There were equal numbers of female and male target children in each schooling group.

Table 1 gives information about the families. All data except family income pertain to the primary caregiver alone. Family income includes as many parents as lived in the household. Parents in the higher schooling group ranged from having completed high school to having completed college. The average was 1 year beyond high school (13.32 years of formal schooling, *SD* = 1.34). Seventeen of these parents reported that they were bilingual, two were monolingual Spanish speakers, and one was a monolingual English speaker. Of the 11 families reporting their income, families' income ranged from $15,000 to $60,000 with a mean of $28,636 (*SD* = $15,501). Four of these parents were born in Mexico.

Parents in the basic schooling group ranged from having completed third grade to eleventh grade with a mean of 7.65 years of formal schooling (*SD* = 2.37). Three parents reported that they were bilingual and 17 reported that they were monolingual Spanish speakers. Of the 11 families reporting their income, families' income ranged from $5000 to $40,000 with a mean of $21,818 (*SD* = $8739). All 20 of these mothers were born in Mexico.

Table 1
Demographic characteristics of parents in basic and higher schooling groups

	Schooling group	
	Basic schooling (n = *20*)	*Higher schooling* (n = *20*)
Years of formal schooling*	7.65 (2.37)	13.32 (1.34)
Family income ($)	21,818 (8,739)	28,636 (15,015)
Number born in Mexico*	20	4
Years in USA*	10.45 (6.30)	19.89 (11.07)
Language (as reported by parent)*		
Spanish only	17	2
English only	0	1
Spanish and English	3	17

Note. Standard deviations appear in parentheses. In each group, 11 families chose to report their income. All other data in this table are based on data from 20 families in each group.

*Indicates significant differences at the $p < .05$ level between the two groups.

Participants were recruited from a variety of sources. Flyers were distributed to local preschools known to serve Mexican-immigrant and Mexican-American populations. Researchers also recruited from a neighborhood with a large Mexican-descent population by talking to parents at community festivals and information sessions. Finally, parents who had participated in the study often recommended friends and relatives to participate. Given that parents were uniformly positive and enthusiastic about their experiences (e.g., one mother likened the museum to Disney World), they often volunteered to contact other families.

Procedure

Museum visit. A bilingual researcher accompanied each family to Children's Discovery Museum (San Jose, California). Children's Discovery Museum is geared to children younger than 12, and museum exhibits are interactive. Examples of exhibits include a time-lapse photography exhibit where one can view videos of growing and dying plants, a trolley powered by an electric crank, a full-sized fire truck that children can climb on, and a programmable traffic light. Prior to their arrival at the museum, parents completed a demographic form. Bilingual researchers spoke to the parents in the language that was most comfortable for them. In addition, all instructions were given in the parents' preferred language. Parents were invited to bring all their children to the museum and to participate in the home visit. The researchers decided not to limit the study to dyadic parent–child interactions to increase the ecological validity of the results. The number of children participating in the activities is listed in Table 2. The difference in the number of family members between the higher schooling and basic schooling groups was not significant. Upon arrival at the museum, researchers provided families with a map in Spanish and a brief tour of the museum in the language the parent preferred. The map was the only resource available

Table 2
Characteristics of parents and siblings during the museum and home activities

	Schooling group	
	Basic schooling (n = *20*)	*Higher schooling* (n = *20*)
Language spoken by parent during the museum activities*		
Spanish only	16	8
English only	1	4
Spanish and English	3	8
Language spoken by parent during the home activities		
Spanish only	14	9
English only	0	4
Spanish and English	6	7
Number of children present during the museum activities	2.15 (1.09)	1.75 (.79)
Number of Children present during the home activities	2.20 (1.11)	1.88 (.70)

Note. Standard deviations appear in parentheses.
*Differences at the $p < .05$ level between the two groups.

to Spanish speakers. Researchers did not accompany families throughout the museum. Instead, the families roamed freely by themselves. Families were encouraged to visit the exhibits that were being taped that day at their leisure. Families could stay as long as they liked at different exhibits. They were always taped at the time-lapse photography exhibit and at two other exhibits that varied. Typically, the latter included a zoetrope and a train exhibit. The researcher treated the family to lunch at the museum snack bar and talked to them about their visit. When the family members were ready to leave, the researcher drove them home.

Interviews. Within a week of the visit, the same researcher called the parents to ask several open-ended questions about their visit. Interviews were conducted in the language the parent preferred. Relevant to the present study, parents were asked if they had ever been to a museum prior to the visit with the researchers, and about their goals for the family visit to the museum.

Home visits. The family's visit to the museum was expected to serve as a naturalistic context for parent–child talk about science. Examination of parents' answers to whether they had visited museums prior to participation in the present study revealed that many parents had never been to a museum previously. To assess parental behavior in a more comfortable but controlled setting, a home visit, where they engaged in hands-on museum-like tasks was added to the study. Because the museum visits gauged less structured behavior compared with the home visits, it was decided that the museum should precede the home visits. Had the home visit occurred prior to the museum visit, the families' spontaneous behavior in the museum may have been altered. Thus, the task order was not counterbalanced. Instead, after their visit to the museum (M = 2.80 months between the museum and home visits, SD = 2.41), families were visited in their homes. Families engaged in two tasks at home, the order of which was counterbalanced. The tasks included playing a water game and watching a time-lapse video. In two cases, a sibling who did not attend the museum activity was present during the home activities.

The time-lapse video displayed five changing objects. There was a popsicle that melted on a burner, a piece of cheese that melted, two plants that grew, and a video of one of the growing plants played backwards. Between each episode, the screen displayed, "¿Qué pasó?" and "What happened?" for 30 seconds and a voice said the words on the screen in English and Spanish. Families were instructed to talk as much as they liked during and after the film. Instructions were given in the language in which the family was conversing. Once researchers explained the task to the families, the researchers turned on the video camera and left the family members by themselves.

During the water game, families were asked to decide together whether 20 different objects (e.g., empty bottle, wooden block, plastic sea animal, plastic bracelet) would sink or float. They were also asked to discuss reasons for why they predicted that the objects would sink or float. Using a large bucket, family members were told that they could test their predictions. After explaining the water game, the researchers turned on the video camera and left the family members alone.

Coding explanations

Only utterances spoken by the primary caregiver of the family were coded. Four types of explanations were coded. The first type, *Using Prior Knowledge*, was coded when a parent made a comparison from the exhibit or activity to something that was not immediately present in the situation. This type of explanation included analogies. For example, while watching the time-lapse photography exhibit, a parent asked, "Do you remember that movie we saw with the hurricanes? This is like it." The second type of explanatory talk, *Causal Explanations*, occurred when parents used causal language to link together two related events or actions. While interacting with the time-lapse photography exhibit, a parent said, "The cheese melted because it was hot." The third type of explanatory talk, *Scientific Principle Explanations*, occurred when parents used a more general principle to explain something. After watching a plastic seal sink, a parent explained to her children, "The ones that sink to the bottom are usually heavier." The final type of explanatory talk, *Encouraging Predictions*, was coded when a parent encouraged a child to make a prediction or explain a reason for an occurrence. For example, while watching a plant die in the home video a parent asked her child, "¿por qué cambiaron de color?" ("Why did the leaves change color?"). Questions were not differentiated from statements. Utterances were coded only once; repetitions were not coded.

All transcripts were coded in the original language. The majority of the basic schooling parents spoke in Spanish. The higher schooling parents tended to speak Spanish or both Spanish and English. Table 2 gives the exact numbers of parents speaking in each language during each task. Parents typically conversed primarily in one language or another and used a few utterances in the second language. In fact, no participant used more than five utterances in total in the second language in the entire conversation. Children primarily

answered parents in the language that parents addressed to them.[2]

A native speaker of the language the family members spoke transcribed the conversations. Another native speaker checked the transcripts for accuracy. Disagreements were resolved through discussion. Rather than translating the Spanish conversations into English, the researchers coded and obtained reliability in the language spoken by the participants. Some of these conversations were later translated so they could be used as examples. Because we were interested in explanations only, which tend to be a relatively low frequency occurrence (Crowley et al., 2001), we used the event sampling method to identify the sections of transcripts that contained explanations, and coded only those sections (Bakeman & Gottman, 1997).

The first author trained a native speaker of Spanish (who is also a fluent speaker of English) on the coding scheme for the museum transcripts. To test for inter-coder reliability, the first author and this coder independently coded 20% of the data set using the transcripts while watching the videotapes. Half of the transcripts used in achieving reliability were in English and half were in Spanish. Intercoder reliability was good with an overall kappa of .74 for the museum transcripts. Next, for the home transcripts, the procedure was repeated with a different bilingual native Spanish speaker trained on the transcripts. The first author and the new coder separately coded 20% of the data set. Intercoder reliability again was good with a kappa of .70 for the home visit transcripts. Fleiss (1981) considers kappas between .60 and .75 as good and kappas over .75 as excellent. Disagreements were resolved through discussion. After reliability was achieved, the first author coded the remainder of the home and museum transcripts in both languages using the transcripts and videotapes.

Study variables and data analysis plan

Similar to many psychological studies based on everyday conversations (for examples, see Dickinson & Tabors, 2001; Gelman, Taylor, & Nguyen, 2004, see also Bakeman & Gottman, 1997), the number of statements falling into the four different codes was tabulated for the primary caregiver in each family. Thus, each parent received a score for each category of explanatory talk they spoke at home and at the museum. Recall these categories were using prior knowledge, causal explanations, scientific principle explanations, and encouraging predictions talk. These frequency counts served as the dependent variables in all analyses. Parents' educational level and prior museum attendance served as predictors of parents' frequency of explanatory talk.

An analysis of covariance (ANCOVA) was used to test whether parents in the higher schooling group used more explanatory talk compared with parents in the basic schooling group at the museum or at home. In addition, we carried out follow-up comparisons to examine all interactions involving schooling group, setting, and type of explanation. Using a chi-square test, we examined whether parents in the two groups differed in whether they had been to a museum prior to the visit with the researchers. Second, to test whether prior museum visits would mediate the number of explanations parents used in the museum, we conducted regression analyses designed to test for the influence of a mediational model (Baron & Kenny, 1986). Comparisons were two-tailed using an alpha level of .05.

Results

Significant main effects and significant interaction effects pertinent to the hypotheses are described below. In addition, eta^2 estimates are presented. Eta^2 is the measure of the proportion of variance accounted for by a predictor. Eta^2 values between .01 and .09 indicate a small effect size, values between .09 and .24 indicate a medium effect, and values greater than .25 indicate a large effect (Cohen, 1988).

Descriptive statistics

Preliminary analyses showed no significant main or interaction effects in the frequency of parents' explanations related to age of their child (all F values < 1) so the two age groups were collapsed to increase statistical power.[3] Specifically, the correlation between age group and explanation was $r(38) = .02$ and between child's age in months and parents' explanation was $r(38) = .03$. In addition, parents who spoke primarily Spanish did not differ significantly from parents who spoke primarily English in the number of explanations they provided their children, $F(1,39) < 1$.

Parents from the basic schooling group used a mean of 19.70 (SD = 13.27) explanations at home and a mean of 1.05 (SD = 1.43) explanations at the museum. The minimum number of explanations used by parents from the basic schooling group in both settings combined was 2 and the maximum was 55. More specifically, in the museum, ten parents (50%) from the basic schooling group did not use an explanation, five (25%) used one explanation, one (5%) used two explanations, three (15%) gave three explanations, and one (5%) gave five explanations. In contrast, at home, every parent provided at least one explanation to their children. One parent (5%) from the basic schooling group used one explanation and three (15%) used two explanations; all other families from the basic schooling group provided their children with ten or more explanations. Parents from the higher schooling group used a mean of 29.70 (SD = 11.73) explanations at home and a mean of 4.56 (SD = 5.11) explanations at the museum. The minimum number of explanations used by a parent in both settings combined from the higher schooling group was 10 and the maximum was 61. More specifically, in the museum five parents from the higher schooling group (25%) did not use an explanation, four (20%) used one explanation, one (5%) used two explanations, and the remaining 10 (50%) used between 3 and 17 explanations. Parents in the higher schooling group provided children with a minimum of 10 explanations at home.

Table 3 displays the correlations between parents' schooling,

[2] Six children at the museum and seven children at home addressed some utterances to their parents in English after being addressed in Spanish. None of these children, however, spoke more than three utterances in English in total.

[3] First, we conducted an Age (younger, older) × Setting (Museum, Home) × Type of Explanation (Using Prior Knowledge, Causal Explanations, Scientific Principle Explanations, Encouraging Predictions) ANOVA. The results showed no significant main effect of Child Age, nor any significant interactions with age (all F values < 1). Second, we carried out an Age (younger, older) × Schooling (Higher, Basic) × Setting (Museum, Home) × Type of Explanation (Using Prior Knowledge, Causal Explanations, Scientific Principle Explanations, Encouraging Predictions) ANOVA with all F values < 1.

Table 3

Relations among maternal education, years in the USA, income, prior museum experience, and language

	1	*2*	*3*	*4*	*5*	*6*
1. Parents' schooling (Basic schooling = 1; Higher schooling = 2)	—	.48** (n = 39)	.28 (n = 22)	.32* (n = 38)	.73** (n = 40)	–.35* (n = 39)
2. Years residing in the USA	—	—	.45* (n = 22)	.38* (n = 37)	.62** (n = 39)	–.61** (n = 39)
3. Family income	—	—	—	.25 (n = 22)	.24 (n = 22)	–.25 (n = 22)
4. Prior museum visits (No = 0; Yes = 1)	—	—	—	—	.46** (n = 38)	–.23 (n = .18)
5. Language reported spoken (Spanish = 1; English = 2; bilingual = 3)	—	—	—	—	—	–.26 (n = .11)
6. Parents' country of birth (US = 1; Mexico = 2)						—

Note. Pearson correlations were conducted.
*Significant correlations at the $p < .05$ level; **significant correlations at the $p < .01$ level.

the amount of years that parents lived in the USA, family income, whether parents had been to a museum prior to participation in the research study, the language that parents reported speaking, and their country of birth. Whether parents were from the higher or basic schooling group was significantly and moderately correlated with their years residing in the USA, $r(37) = .48$, $p < .01$, and with whether parents had been to a museum prior to participation in the research study, $r(36) = .32$, $p < .05$. As might be expected, parents' schooling group was significantly and highly correlated with the language that they reported speaking, $r(38) = .73$, $p < .01$.[4] Finally, parents' schooling group was related to being born in the USA, with more parents in the higher schooling group born in the USA than parents in the basic schooling group, $r(37) = –.35$, $p < .5$.

The first hypothesis was that parents in the higher schooling group would use a higher frequency of explanations than parents in the basic schooling group at the museum. In contrast, it was expected that parents in the higher schooling group would use a similar frequency of explanations compared with parents in the basic schooling group in their homes. Thus, we predicted an interaction effect. To test this hypothesis, a 2 × 2 × 4 mixed-design ANCOVA was conducted with Schooling (High, Basic) as a between-participants variable, and Setting (Museum, Home) and Type of Explanation (Using Prior Knowledge, Causal Explanations, Scientific Principle Explanations, Encouraging Predictions) as within-participants factors. Total time spent on the tasks, language (English, Spanish, bilingual) that parents reported speaking, and years in the USA served as covariates in the first analysis. Prior to conducting the ANCOVA, we assessed whether homogeneity of slopes existed. Custom factorial tests revealed that the interactions between the covariates, total time spent on the tasks, language spoken, years in the USA, and the predictor, schooling, were not significant, all $F(1,36) < 1$, indicating homogeneity of slopes. Neither years in the USA, $F(1,34) = 1.20$, nor language, $F(1,34) < 1$, were significant covariates. To increase statistical power, language and years in the USA were therefore dropped from the analyses.[5] Time spent at the museum and at home was significantly associated with the number of explanations parents provided their children, $F(1,37) = 7.52$, $p < .01$, eta^2 = .17. (Not surprisingly, the longer the interactions that the families had at the museum and home combined, the more explanations that parents provided their children.) Thus, time spent was included in the ANCOVA model. Results indicated a main effect of schooling after controlling for time spent during the conversations, such that parents in the higher schooling group ($M = 34.25$, $SD = 14.14$) were more apt to use explanations than were parents in the basic schooling group ($M = 20.75$, $SD = 14.06$), $F(1,37) = 5.96$, $p < .05$, eta^2 = .14. Second, parents provided more explanations overall at home ($M = 24.70$, $SD = 13.36$) than at the museum ($M = 2.80$, $SD = 4.11$), $F(1,37) = 4.52$, $p < .05$, eta^2 = .10.

The main effect for schooling was qualified by a significant 2-way Type of Explanation × Schooling interaction effect, $F(3,111) = 7.28$, $p < .001$, eta^2 = .16. Follow-up t-tests indicated that parents in the higher schooling group were more likely than parents in the basic schooling group to use scientific principle explanations, $t(38) = 2.40$, $p < .05$, and to encourage predictions, $t(38) = 3.68$, $p < .01$. There was no difference between parents in the two schooling groups on their use of prior knowledge or causal explanations.

In addition, a significant 3-way Type of Explanation × Schooling × Setting interaction effect emerged, $F(3,111) = 7.39$, $p < .001$, eta^2 = .17. Follow-up t-tests indicated that, while visiting the museum, parents in the higher schooling group were more likely than parents in the basic schooling group to use causal explanations, $t(38) = 2.38$, $p < .05$, scientific principle explanations, $t(38) = 2.56$, $p < .05$, and encouraging predictions talk, $t(38) = 2.26$, $p < .05$. There was also a nonsignificant trend in which parents in the higher schooling group were more prone to engage in use of prior knowledge explanations at the museum than parents in the basic schooling group, $t(38) = 1.96$, $p = .06$. In contrast, at home, the only significant contrast was that parents in the higher schooling group used more encouraging predictions talk than did parents in the basic schooling group, $t(38) = 3.51$, $p < .01$. Mean

[4] According to Tabachik and Fidell (1996), multicollinearity is only a serious concern when the correlations between two predictor variables in a multiple regression exceed .80. Therefore the strength of the relation between schooling group and prior museum in the present study ($r = .32$) does not constitute a problem.

[5] Mediational analyses, using regression models and Sobels' z, similarly indicated that neither years spent in the USA nor language spoken served as significant mediators of the relation between maternal education and use of explanation.

Table 4
Mean frequency of parents' type of explanatory talk by schooling and setting

	Type of talk			
Setting	*Using prior knowledge*	*Causal explanation*	*Scientific principle explanation*	*Encouraging predictions*
Museum				
Basic schooling	.30 (.57)	.55 (.83)	.10 (.45)	.10 (.31)
Estimated marginal means	.39	.79	.24	.15
Higher schooling	1.00 (1.49)	1.90 (2.40)	1.05 (1.61)	.60 (.94)
Estimated marginal means	.91	1.66	.91	.55
Home				
Basic schooling	1.80 (2.38)	6.00 (6.04)	1.95 (2.67)	9.95 (6.69)
Estimated marginal means	1.96	6.36	2.04	10.36
Higher schooling	2.45 (2.28)	5.15 (4.16)	3.25 (2.57)	18.85 (9.17)
Estimated marginal means	2.29	4.79	3.16	18.44

frequency and the corresponding estimated marginal means of each type of explanation by parents' schooling background may be found in Table 4.[6] Thus, the overall prediction, that schooling level would be more important in the museum setting than in the home setting, was partially supported.

Prior museum experiences

A chi-square test revealed that parents in the higher schooling group (17 of 20 reporting) were more likely to have been to a museum previously than parents in the basic schooling group (8 of 18 reporting), $\chi^2(1, n = 40) = 3.99$, $p < .05$.

In addition, a 2 × 4 mixed-design ANCOVA was conducted with Experience (Previous Museum Visit, No Previous Museum Visit) as a between-participants variable, and Type of Explanation (Use of Prior Knowledge, Causal Explanations, Scientific Principle Explanations, Encouraging Predictions) at the museum only as a within-participants factor. A custom factorial test revealed that the interaction between the covariate, total time spent at the museum exhibits, and the predictor, prior museum experience, was not significant, $F(1,36) < 1$, indicating homogeneity of slopes. Total time spent at the exhibits served as a covariate. The covariate was significantly associated with type of explanations, $F(1,37) = 7.52$, $p < .01$, $\text{eta}^2 = .17$, indicating that parents who spent more time at the museum exhibits provided more explanations to their children. After controlling for the amount of time families spent at the museum, parents who had been to a museum previously ($M = 3.63$, $SD = 4.68$) provided more explanations than parents who had never been to a museum previously ($M = .91$, $SD = 1.64$), $F(1,35) = 5.69$, $p < .05$, $\text{eta}^2 = .14$.

Regression analyses were conducted to identify whether prior museum experience served as a mediator of the number of explanations parents used with their children in the museum. To test for a mediational model, Baron and Kenny (1986) specify that the following regressions must be conducted: first, the effect of the independent variable on the mediator is tested (first regression). Second, the effect of the independent variable on the dependent variable is tested (second regression). Finally, the effect of both the independent variable and the mediator on the dependent variable is estimated (third regression). For evidence of a mediational model, all three equations must be significant, the effect of the independent variable must be smaller in the third equation than in the second equation, and the mediator must contribute significantly to the model when the independent variable is also included in the model. Schooling level predicted prior museum experiences, $F(1,36) = 4.23$, $p < .05$, $R^2 = .11$ (first regression). Schooling predicted explanations at the museum, $F(1,38) = 8.69$, $p < .01$, $R^2 = .19$ (second regression). Finally, when schooling and prior museum experiences were both entered into the regression, the model was statistically significant, $F(2,35) = 4.81$, $p < .05$, $R^2 = .22$ (third regression). However, as indicated in Table 5, prior experiences in the museum did not contribute significantly to the prediction of the number of explanations parents provided to children when schooling was included in the model. Moreover, results of the Sobel test (Sobel, 1982) were not significant, $z = .97$, *ns*. Thus, prior experiences did not mediate the effect of the completion of high school on parents' explanations in the museum.

Table 5
Summary of mediational analysis predicting parents' explanations in the museum (n = *37)*

Variable	*B*	*SE B*	*β*
Step 1			
Education predicting prior museum	.29*	.14	.32
Step 2			
Education predicting museum explanations	3.50**	1.19	.43
Step 3			
Education predicting museum explanations	3.13*	1.32	.37
Prior museum predicting museum explanations	1.60	1.45	.18

Note. $R^2 = .11$; $R^2 = .19$ for Step 2; $R^2 = .22$ for Step 3.

[6] Analyses were also conducted using the rate of explanation per minute, rather than frequency of explanation, as the dependent variable. The patterns of results were identical.

Discussion

This study examined the ways that Mexican-descent parents' formal schooling experiences were related to their explanatory talk in a museum and at home. Parents in two schooling groups used explanatory talk with their children during their visit to a science museum and at home. Parents in the higher schooling group used more explanations overall in the museum and at home than did those in the basic schooling group, even after controlling for the length of the interactions. However, two significant interaction effects qualified the effect. First, the patterns varied for different types of talk. Parents in the higher schooling group used more scientific principle explanations and encouraging predictions talk than did parents in the basic schooling group. In the museum, in particular, parents in the higher schooling group were more likely to use causal explanations, scientific principle explanations, and encouraging predictions talk than were parents in the basic schooling group. In contrast, in the home setting, only encouraging predictions talk that differed by schooling, with parents in the higher schooling group using more of this talk than parents in the basic schooling group. As expected, differences in the amount of explanations used by the two groups of parents were minimized in the home compared with the museum context.

Also, parents who had been to a museum prior to the present study used more explanations in the museum than did parents who had not been to a museum previously. Because the parents with basic schooling had less experience with museums, this may partially explain the schooling result. However, previous museum visits did not directly mediate the relation between parental schooling and the numbers of explanations parents provided to children within the context of the museum. Thus, formal schooling may be serving as a proxy variable for the different experiences that parents have, which could influence the way that parents speak to their children.

Relations between formal schooling and parents' use of explanations

It is important to emphasize that parents in both schooling groups used explanations with their children during their visit to the science museum and at home. Parents from both schooling groups engaged children in science conversations. In fact, there was no difference in using prior knowledge in either setting. Parents' use of this type of explanation may help children to contextualize new knowledge, which has been shown to contribute to their understanding (Tharp, 1997). Moreover, that both groups used explanatory talk underscores recent research showing that Mexican-American parents are involved actively in their children's learning (Valencia & Black, 2002).

Why might there have been a more pronounced difference between the two groups of parents in their explanatory talk at the museum than at home? Given the consistent order across the two tasks, one could argue that the parents with basic schooling used more scientific principle explanations and causal explanations in their homes than at the museum because of an order effect. Second, parents may have used more explanations at home because they were more comfortable with the researchers given that this was the second time that they spent time together. Third, families may have been more focused on the tasks at home than at the museum. Exploring a museum, visitors' attention is often drawn to other exhibits, whereas there might be fewer distractions in one's home. Fourth, parents were given an explicit prompt at the end of each segment of the video ("What happened?"), which in itself might have increased the amount of time that parents conversed with their children. The reason the home activity was included in the study was to help clarify whether the parents from the basic schooling group might use more explanations under some conditions other than the museum setting. Our hypothesis was that these parents may have been uncomfortable in the unfamiliar museum setting, and would be more comfortable with similar activities at home. Regardless of which elements of the situation were most important, the results show that the parents in the basic schooling group will sometimes use explanations more frequently than they did in the museum, and under some circumstances equivalently to higher schooling parents.

A different explanation for this result would be suggested by the work of Rogoff (2003) and her colleagues, namely that the highly structured home task may have led parents to use a communication style that they think of as "school-like" or "teacher-like," and that this may not be a communication style that they would normally use. In other words, even a few years of familiarity with formal schooling may contribute to the ways in which adults interact with children in school-like contexts. Past research has similarly revealed few differences between low and middle-income European-American mothers during more structured book reading tasks (Hoff-Ginsberg, 1991). Perhaps book reading was understood by both groups of parents as "school-like" thereby influencing parents' behavior. Nevertheless, our findings underscore the need to examine families in more than one context to gauge how context relates to their behavior. Future research should expand on the range of everyday contexts to explore variations in the kinds of explanations that parents provide their children in different activities and environments.

That parents in the higher schooling group used more scientific principle explanations and encouraging predictions talk than did parents in the basic schooling group across the two contexts, but equal levels of causal explanations and use of prior knowledge talk, is noteworthy. Learning to understand causal relations is necessary for the development of children's theories about many domains (Kuhn, Garcia-Mila, Zohar, & Andersen, 1995). Consider, moreover, that much of scientific thinking rests on cause–effect relations (Klahr, 2000). Explaining a biological or physical event causally may contribute to children's understanding of the physical and natural world (Callanan & Jipson, 2001). Thus, we would argue that both groups of parents were potentially aiding their children's conceptual developmental.

Despite the similarities between the two groups of families, our findings partially confirm a tradition of work suggesting that some differences in parental talk may be attributed to formal schooling in European-American (Hart & Risley, 1995) and Mexican-American families (Laosa, 1980). In formal schooling environments, teachers frequently employ a question and answer strategy (Rogoff, 2003). Parents in the higher schooling group may have more experience with this specific discourse style than parents in the basic schooling group. Indeed, parents in the higher schooling group were more likely to encourage predictions in both contexts than parents in the basic schooling group. This type of discourse, encouraging predictions, more frequently occurs in question than in statement form.

Relations between prior museum experiences and parents' use of explanations

In addition to schooling, experience in the museum environment was related to the frequency of parents' explanations while visiting the museum. As Moreno (1991) suggests, parents' teaching styles may vary depending on their experience and comfort level with a particular task. Perhaps the parents who had not been to museums prior to participation in this study did not feel as comfortable engaging with the exhibits as parents with more experience. The fact that the parents without prior museum experience were represented disproportionately in the basic schooling group emphasizes the fact that schooling correlates with many other life experiences that may influence maternal behavior. For example, the parents in the basic schooling group had also lived in the USA fewer years than those in the higher schooling group. However, neither the amount of time nor the language spoken by parents was a significant predictor of parents' use of explanations. Of course there are other life experiences that may differ with parents' educational background, which this study did not capture, such as parents' daily stress levels.

Whereas parents with prior museum experience used more explanations with their children while at the museum, prior experiences did not directly mediate the relation between parents' formal schooling and the amount of parents' explanations. Thus, formal schooling is perhaps a stronger predictor of the parents' behavior than is their past experience with museums. Understanding both the correlates of formal schooling and of past experiences will enable researchers to develop a more comprehensive view of how different life experiences are related to parent–child conversations. Focused on formal schooling, context, and prior experiences, the present study did not examine other possible influences on parents' behavior within their homes and the museum. For example, the way that participants interpret situations influences their behavior (Gallimore, Goldenberg, & Weisner, 1993).

Although some researchers may argue that the inability to tease apart the independent effects of language, years of formal schooling, years residing in the USA, and income is a limitation, these are not variables that can be independently manipulated. For example, the Mexican-descent parents with basic schooling in our sample were less likely to speak English than parents with higher schooling. Factors such as formal schooling and family income do not occur randomly and in fact, are associated with each other, making it difficult to systematically test the independent effects of these variables.

Children's age and parents' talk

Parents did not vary in the number of explanations they used with older or younger children. Past work examining whether mothers speak differently to younger or older children about science has been mixed. While playing with magnets, low-income European-American mothers used a higher proportion of explanatory and pretend play talk when their children were 9 years old than 4 years previously when their children were 5 years old (Tenenbaum et al., 2005). In contrast, cross-sectional studies conducted with European-Americans families have not found differences in the amount of explanations mothers provide to children of different ages (Jipson & Callanan, 2003; Tenenbaum & Leaper, 2003). Perhaps because there is so much individual variability in these measures, the differences may be so subtle as to only be observed in longitudinal studies.

Also, we did not examine children's talk. In our past work at the museum, children rarely asked a question. For example, children asked a question less that 8% of the time in the 10 seconds leading up to a parents' explanation (Crowley, Callanan, Tenenbaum, & Allen, 2001). Nonetheless, future work should examine children's as well as parents' talk.

Other considerations

There are four important limitations to the present study worth noting. First, in such a small sample, it is impossible to control for the host of factors (e.g., years residing in the USA) that covary with education. We might expect that parents' schooling group, the amount of time that they have time resided in the USA, and their language would be related. Given that mothers within a schooling group may share many similar life experiences, we would caution readers not to attribute parents' explanatory talk as caused by one factor alone, such as schooling. Instead, we suggest that a combination of parents' life experiences influences how they converse with their children. Perhaps, in a larger sample, there would be more variability in parents' life experiences within a particular schooling group and these factors could begin to be teased apart. Second, as previously mentioned, we added the home task to help untangle how parents' behavior might vary in more structured (i.e., home) compared to less structured tasks (i.e., museum). Not wanting parents' behavior to become proscribed in the museum, we chose not to counterbalance order. However, counterbalancing the order of the tasks would have enabled a better test of why the differences were minimized in the home visits. Third, another problem is that parents engaged in the more structured tasks in their home only. Thus, we cannot differentiate whether the increase in explanatory talk at home resulted from the specific task or the change in setting. We can only demonstrate that in some situations under specific conditions, parents in the basic schooling group will engage their children in as much explanatory talk as parents in the higher schooling group. Fourth, one could argue that the types of tasks that families were asked to do in their home may have been more familiar to them (e.g., watching a video together) than visiting a museum and thus, there was conflation of context and type of task. Research needs to be conducted examining how Mexican-descent parents talk to their children about science topics in a variety of contexts.

Conclusion

Different theoretical traditions posit that children learn through participation with more advanced members of their community (Bandura, 1997; Callanan & Jipson, 2001; Rogoff, 2003; Vygotsky, 1978). Involvement in explanatory conversations about science may provide guidance for children who are learning about the scientific world. Although parents from the higher schooling group used a higher frequency of causal explanations, scientific principle explanations, and encouraging predictions types of explanations at the museum and more encouraging of predictions at home than parents in the basic schooling group, there was no difference in using prior knowledge between the two groups. Moreover, every child in this study heard at least two explanations from their parents. While there are differences related to parents' formal schooling and prior experiences, the present findings suggest that

Mexican-descent families engage their children in conversations that serve as a rich context for the development of children's scientific literacy in some contexts.

The findings suggest that causal explanations and other explanatory talk are part of Mexican-descent children's family experience. Teachers should perhaps build on these experiences by incorporating similar types of talk in the classroom. Such talk would enable teachers to build on children's funds of knowledge (González, Andrade, Civil, & Moll, 2001) and enable children to build links between their home and school experiences.

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