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Preschoolers' Search for Explanatory Information Within Adult-Child Conversation

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Abstract

This research examined children's questions and the reactions to the answers they receive, in conversations with adults. If children actively seek explanatory knowledge, they should react differently depending on whether they receive a causal explanation. Study 1 examined conversations following 6 preschoolers' (ages 2-4 years) causal questions in naturalistic situations (using the CHILDES database). Children more often agreed and asked follow-up questions following adult explanations and, conversely, more often re-asked their original question and provided their own explanation following non-explanations. Study 2 replicated these patterns within an experimental task in 42 children ages 3-5 years. Children's reactions following explanatory versus non-explanatory information confirm that young children are motivated to seek causal information actively and use specific conversational strategies to obtain it.

Explanatory understanding is central to cognition, allowing us to see how the world works and to predict and interpret events in our environment (Ahn, Kim, Lassaline, & Dennis, 2000; Carey, 1985; Murphy & Medin, 1985; Rehder, 2003; Wellman & Gelman, 1998). Even young children search for causal explanations (Callanan & Oakes, 1992). Yet surprisingly little is known about young children's search for explanations, and even less is known about how they respond to the information they obtain. The current research examines young children's questions and the reactions to the answers they receive as a means for exploring the active role that children play in successfully obtaining explanatory information.

During the preschool years, children assemble explanation-rich naïve theories (Carey, 1985; Wellman & Gelman, 1998), ask many questions (Chouinard, 2007; Hickling & Wellman, 2001), and actively pursue explanatory information, a motivation that has been variously characterized as an innate “theory drive” (Gopnik, 1998), a human curiosity about the world (Simon, 2001), or a desire to resolve disequilibrium (Isaacs, 1930; Piaget, 1954), among others. It is therefore important to examine how explanatory motivations are manifested within children's everyday behavior. Hence, our central question: How does childhood explanation-seeking actually work?

In the present studies, we examined the patterns of conversational exchange between children and adults to clarify how children respond to explanatory information. We focus on situations where children actively request information from an adult and we examine how they react to the adult's answer. This strategy permits us to gain insight into whether and when children preferentially seek explanations over other types of responses. Our background assumption is that one of the most important sources of explanatory information

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potentially available to children is the knowledge they can elicit from more expert conversational partners (Rogoff, 1998).

Asking Causal Questions

To test the hypothesis that children ask causal questions with the intention of obtaining explanatory information, we must first establish whether young children appreciate specifically causal information. Early research on children's cognitive development argued that children did not have a true understanding of causality until 7 or 8 years of age (Piaget, 1930; Werner & Kaplan, 1963). Results from tasks involving physical causality suggested that young children were aware only of the temporal relationship between two events and were unable to differentiate cause from effect.

In the past 30 years, a rich literature has emerged confirming that children have an understanding of causality from a much younger age than previously suggested. Classic research, such as that by Shultz and Mendelson (1975) and Bullock and Gelman (1979), demonstrated that children as young as 3 years use covariation information and temporal order to reason about physical causality. More recently, Gopnik and colleagues have demonstrated young children's abilities to make causal inferences, using a novel toy called a blicket detector that lights up only when certain “blicket” blocks are placed on it (for a recent review of this research, see Gopnik & Schulz, 2004). This line of research has been extended to demonstrate infants' abilities to make causal inferences (Sobel & Kirkham, 2006).

However, contemporary research on children's causal reasoning abilities has rarely addressed if and how children actively seek causal information. One fundamental means for doing so is via language, and specifically, causal questions. Interest in children's questions is long-standing within developmental research, beginning with early child-language diary studies (Isaacs, 1930; Piaget, 1926; Sully, 1896) that were primarily limited to records of occasional questions voiced by individual children. Systematic study of the emergence and structure of children's questions was initially conducted from a linguistic perspective, including classic research by Klima and Bellugi (1966) and Brown (1968), who investigated developmental changes in the grammatical structure of children's questions. Further work by Tyack and Ingram (1977), Cairns and Hsu (1978), and Bloom, Merkin, and Wootten (1982) investigated the order of acquisition of different forms of children's questions (i.e., using *what*, *where*, and *who* prior to using *how*, *why*, and *when*).

Within this tradition, some researchers have examined the content of children's conversations, including their questions, as evidence for their understanding of causal relations. Hood and Bloom's (1979) analysis of longitudinal samples of speech from eight children provided early evidence that from as young as 2 ½ years, children spontaneously talk about causal intentions and motivations in the course of everyday conversations. Most importantly, children talked about causal events in systematic ways that demonstrated their understanding of the relationship between causes and effects, providing support for the idea that young children have an early understanding of and interest in causal knowledge.

More recently, Callanan and Oakes (1992) asked mothers of 3-, 4-, and 5-year-olds to keep a diary of their child's requests for explanations over a period of 2 weeks. Analysis of the diaries revealed that children as young as 3 years were asking their mothers causal “why” and “how come” questions about a variety of phenomena in their everyday lives. Children requested explanations about mechanical, natural, and social phenomena, providing evidence that children's everyday question-asking extends across several domains. The same diary methodology was replicated with higher- and lower-education Mexican-descent families with similar results (Callanan, Perez-Granados, Barajas, & Goldberg, 1999).

Additional information regarding the content of children's causal questions comes from two studies using longitudinal transcripts from the CHILDES database (Study 1 of Chouinard, 2007; Hickling & Wellman, 2001). Hickling and Wellman (2001) examined transcripts from 4 children who were recorded between the ages of 2.5 and 5 years. They searched for instances of children's use of causal terms (such as *because*, *how*, *so*) within children's statements and questions, and compared the target entity of the child's explanation (e.g., person, animal, object) to the explanatory mode the child used (e.g., psychological, biological, physical). Children were able to use multiple modes of explanation appropriately with both constraint and flexibility, providing evidence for the presence of domain-specific frameworks of knowledge (Hickling & Wellman, 2001). For instance, children described the behavior and properties of inanimate objects only in terms of physical causality, but when the target entities were persons, children appropriately used physical, biological, and psychosocial modes of causality. In other words, children did not randomly pair explanatory modes to target entities, nor did they match one mode of explanation exclusively to one type of target entity.

Study 1 of Chouinard's (2007) monograph took a different approach to examining children's questions by focusing on how children generally use questions (not just causal questions) to obtain information. Chouinard examined the transcripts of 4 preschool-aged children from the CHILDES database, tallying every question. The majority of children's questions were information-seeking (as opposed to attention-seeking, action-seeking, or asking for permission). These information-seeking questions were frequent, occurring at an average of 76 per hour, and included requests for many different types of information. At all ages, fact-based questions were more frequent, but requests for explanations increased with age. Between the ages of 2;0 and 2;5, only 4% of children's questions were explanation-based; in contrast, at age 5, an average of 30% of the children's questions were requests for explanations. Further, around age 3, each child demonstrated a relative increase in the proportion of explanation-based questions, suggesting that this may be an age when children are particularly interested in causal information. Such a result would be consistent with Hickling and Wellman's (2001) data, in which children used more causal speech at 3 years of age than at 2 or 4 years. Chouinard (2007, Study 3) also obtained similar results within a cross-sectional sample of parent-child speech.

Overall, these studies provide evidence that young children not only ask causal questions, but also have the ability to ask appropriately situated questions across a variety of domains. This early emerging and sophisticated skill is potentially a powerful tool for acquiring explanatory information. However, are children's questions actually functioning as the useful tool they have the potential to be? Examining adults' responses is an important step in addressing this question.

Adults' Responses to Children's Questions

The research from Callanan and colleagues (1992, 1999) and Chouinard (2007) also provides an initial examination of adults' responses to preschool children's questions. Within the daily diary methodology employed by Callanan and Oakes (1992), adults' provision of explanations in response to their children's questions varied with the age of the child: mothers of 3-year-olds reported responding with a causal explanation 32% of the time, whereas mothers of older children reported responding with a causal explanation 50-60% of the time. Mechanism explanations (describing intermediate steps as a way of explaining how something works) were the most frequent, followed by prior cause explanations (mentioning a prior event or state that caused the asked-about phenomenon) and consequence explanations (mentioning a purpose or an event/state that will occur after the asked-about phenomenon). No significant age effects were found for these different types of explanations, suggesting that parents provide a variety of different explanations in response

to children's questions, regardless of the age of the child. Study 1 of Chouinard (2007) found related results concerning the informative nature of mothers' responses. Within the longitudinal transcripts, children's information-seeking questions (collapsed across fact-seeking and explanation-seeking questions) received an informative reply (either immediately or eventually following the child re-asking the question) between 64-79% of the time, depending on age. Similar results were also found in Study 3 of Chouinard (2007), with adults providing informative responses between 78-86% of the time.

Children's Responses: A Key Component

The studies demonstrate that children's questions often function as an effective tool for eliciting information from adults, and that they include causal questions that prompt for explanatory information. However, prior research does not explore children's reactions beyond whether they re-ask their questions. Analyzing the nature of children's reactions in greater detail has the potential to yield critical insights. Intuitively, question-asking conversational exchanges would seem to encompass three key steps: (a) the child's initial question (e.g., “Why is he wearing a red nose?”), (b) the response the child receives (e.g., “People don't usually wear red noses like that”), and (c) the child's reaction to this response, which could range from satisfaction with the information to rejection of the response. Although these three steps are a simplification of a complex (and often much messier) process, they provide an overall framework for considering patterns in children's conversation. (For a related though distinct model, see Chouinard (2007).

The third component of these processes seems especially informative for two reasons. First, the nature of children's reactions to the response they receive critically informs us about the nature of their initial question. For instance, perhaps the function of the question from the child's point of view is simply to engage adults and keep the conversation going. In this case, any conversational response from the adult might be satisfactory, or perhaps a particularly long response might be especially satisfying. (Parents often suspect this is the child's motive at the peak of preschool-aged “why”-question asking, when it can seem that no matter what the parent says, the child repeatedly asks, “Why?” “Why?” “Why?”) Alternatively, children might be genuinely seeking explanatory information. If this is the case, then they should react differently when they receive an explanation versus some type of non-explanatory response. Information about the third step in the conversation, how children react to the answer they receive, is needed to address these possibilities.

Second, in order to gauge when adult answers are effective, one must know how the information they provide is perceived by the child who has asked the question. To begin with, is the question-asking child satisfied or dissatisfied with the answer he/she receives? Previous research has measured children's preferences by directly asking them to evaluate different types of explanations using forced-choice tasks. But it is an open question as to how this process works in everyday life and particularly in conversations initiated by the child. In this context, it is critical to examine how children react to the responses they receive from their conversational partners. When children receive answers that they consider satisfactory, we would expect them to react in systematically different ways than when they receive answers that they consider less than satisfactory.

As arguably crucial as this third component (children's reactions) appears to be, it has rarely been studied. Study 1 of Chouinard (2007) provides an initial look by examining instances when children repeated the same question multiple times in a row. This behavior was much more frequent following non-informative adult responses than following informative ones. Thus, children ask persistent questions (largely factual questions in those data) with the goal of obtaining information, rather than just to get attention or for their own enjoyment.

In the present research, we focus on children's *causal* questions and requests for explanatory information, and we look much more fully at children's reactions to the answers they receive. In Study 1, we do so using longitudinal transcripts of everyday conversation. In Study 2, we create a methodology for bringing this process into the lab to better examine, with more effective control, the relationships among children's questions, the responses they receive, and (of special interest) how they react to those responses.

Study 1

Study 1 examined adult-child conversations following preschoolers' causal *why* and *how* questions from longitudinal transcripts recorded in naturalistic situations within the CHILDES database. Although prior studies have examined the content of children's questions (causal and non-causal) using the CHILDES database (Chouinard, 2007; Hickling & Wellman, 2001), we used a larger sample and additionally focused on children's reactions to the answers they received to their *causal* questions.

We concentrated on *how* and *why* questions (although children may have also asked causal questions that did not use *why* or *how*) for several reasons: from an early age, these questions account for many of young children's causal interrogatives (Hood & Bloom, 1979), previous studies have also focused on these types of questions (Callanan & Oakes, 1992; Hood & Bloom, 1979), and *how* and *why* questions are easy to search for and easy to identify as causal. Additionally, explicitly causal questions seem best for initially examining children's reactions to parental responses, because they are the questions for which we have the clearest evidence of a causal question on the part of the children and therefore are the most interpretable. As outlined previously, we examined three steps of conversation: the initial causal *why* or *how* question asked by the child, the adult's response, and the child's reaction to the adult's response. However, our focus concerns the child's reaction to the adult's response, where we test several hypotheses.

Our primary hypotheses concern how different types of adult responses affect whether a child continues or discontinues that conversational exchange. If children actively seek explanatory knowledge using questions, one would expect them to react differently depending on whether or not they have received a causal explanation from their adult conversational partner. Specifically, if children seek explanations, they should be satisfied when adults give explanations and dissatisfied when adults give non-explanatory responses. If this is the case, we expect that children would be more likely to re-ask their questions (showing continued curiosity) or provide their own explanation (showing dissatisfaction with information provided) upon *not* receiving an explanation. Conversely, when children receive an explanation, we expect that they will be more likely to agree (showing satisfaction) or to ask an additional question that is different from the original question, but building on the same topic (showing satisfaction via further interest in the explanation).

Two alternative hypotheses deserve consideration. First, children may ask questions simply to try to extend the conversation, in which case any adult response would be satisfying and children should show a similar pattern of responses following both explanations and non-explanatory adult responses. Second, children may respond based on the length of the adult response rather than the explanatory content. If so, they should find a longer answer more satisfying than a shorter answer, and therefore ask additional questions when adult responses are brief and ask fewer additional questions when adult responses are long.

We also examined the pattern of child responses in relation to the form of the explanation that an adult gives. If children find one type of explanation more appealing or interesting than another, then they may be more likely to ask a follow-up question explicitly for that

type of explanation, in order to continue the conversation on the topic. Here we explored whether *mechanism* explanations, which have the potential to provide rich information about the process underlying a causal relationship (e.g., "The puzzle made noise because there's a little speaker that turns on when you fit the piece into the right spot"), would generate more follow-up questions than a single event mentioned in a *prior causal event* explanation (e.g., "The puzzle made noise because you put the piece in"). Prior research, with forced-choice responses from older children, suggests that children may find *mechanism* explanations particularly satisfying (Au & Romo, 1999).

Method

Participants—The initial data encompassed all conversations including child causal *how* and *why* questions from longitudinal transcripts of six children from the CHILDES database (MacWhinney & Snow, 1985, 1990). The CHILDES database consists of samples of children's conversations with parents, siblings, and occasional visitors during everyday activities in the home setting. The samples were recorded every 1-3 weeks for periods ranging from 30 minutes to two hours. The six children included were Adam, Sarah, Abe, Naomi, Mark, and Ross (Brown, 1973; Kuczaj, 1976; MacWhinney, 1995; Sachs, 1983). The age range for the transcripts initially began at ages 2 years, 3 or 4 months and continued through ages 5 years, 1 or 2 months for four of the children. Because Mark and Ross are siblings, their transcripts cover a wider age range, from 2 years, 6 months through 8 years for Ross and from 7 months to 5 years, 6 months for Mark.

These six children were selected because their data included a large number of transcripts within the ages of 2 through 4 years, and the transcripts were recorded in naturalistic settings rather than structured tasks (e.g., a researcher-prompted story book reading). While few, these 6 children vary on gender (4 boys and 2 girls), ethnicity (5 Caucasian, 1 African American), and family occupational status (4 children from academic families, 1 child from a non-academic, middle-class family, and 1 child from a working-class family).

Procedure—582 longitudinal transcripts (210 transcripts for Abe, 55 for Adam, 137 for Sarah, 93 for Naomi, and 87 for Ross/Mark) were searched for all utterances containing the target words *how* and *why*. All utterances containing *how* and *why* that were voiced by adults or voiced in statements were removed. In addition, all questions that were incomplete or included unintelligible portions were set aside. The remaining child questions were then reviewed to eliminate clear-cut instances where *how* and *why* were not being used causally. This led to the elimination of questions such as "How are you?" "How does that feel?" "How about that?" and "How much milk?" In addition, we also eliminated any questions voiced by children when they were younger or older than the age range of 2 years through 4 years, 11 months, because data outside of this range were limited. The final sample consisted of 3,162 children's causal *why* and *how* questions (948 questions for Abe, 1,202 for Adam, 358 for Sarah, 68 for Naomi, 142 for Mark, and 444 for Ross).

Coding—The coding scheme encompassed three steps of conversation: the initial causal *why* or *how* question asked by the child, the adult's response, and the child's reaction to the adult's response. When coding the adult's response and child's reaction, our focus was the two utterances immediately following the child's target question (one utterance containing the adult's response and one containing the child's reaction). If the child's reaction to the adult's response was to ask another *why* or *how* question, then this question was included as a new target question. All coding was conducted by examining the conversational sequence within the full transcript. This allowed the coders to read as much of the previous conversation as needed to gain an understanding of the context and meaning of each utterance.

Child questions: Each question that a child asked was coded as "why" or "how" and either *simple* (consisting of only one or two words, such as "Why?" or "How come?") or *complex* (including a reference to the subject of the *how* or *why* question, such as "Why not my cracker talk?").

Adult responses: The adult responses were initially coded into one of ten categories, including: providing an explanation, providing on-topic non-explanatory information, redefining or correcting assumptions underlying the child's question, confirming/agreeing with the child's question, asking a clarification question, redirecting the question to someone else, saying "I don't know," saying simply "Because" or "Because I said so" without further explanation, changing the topic, or not responding. The purpose of these extensive initial categories was to provide a comprehensive list of all possible adult responses in order to help coders distinguish between explanations and other types of responses that might include on-topic information, but were not explanatory. The analyses, however, focus exclusively on the key contrast between adults' provision of *explanations* (e.g., CHILD: "Why you put yogurt in there?" ADULT: "Yogurt's part of the ingredients") versus adults' *non-explanatory answers* (e.g., CHILD: "How do you get sick?" ADULT: "I don't know."). For these analyses, the non-explanatory answers collapse across all the other initial categories (except explanations) mentioned above. Appendix A provides additional examples of explanations and non-explanatory answers from the data.

If the adult's response was an explanation, the form of the explanation was coded into one of five categories: *mechanism* (e.g., "It doesn't fall off because it's stuck through the paper"), *prior causal event* (e.g., "I think he heard a big noise"), *consequence* (e.g., "So his feet won't get cold"), *current state of world* (e.g., "Because those are pretty colors"), or *other* (e.g., "You just don't do it that way"); see Appendix A for complete descriptions and examples. These categories were based on those used by Callanan and Oakes (1992), with one addition. We added the category *current state of the world* to deal with frequently encountered explanations that did not explicitly refer to an event occurring in the past or a future consequence, but instead focused on the state or quality of a current situation. However, if a *current state of the world* explanation included description of a mechanism, it was coded as *mechanism* explanation.

Child reactions: The child's response was coded into one of eight categories, including: (a) agrees with adult response, (b) asks a follow-up question, (c) re-asks original question, (d) provides own explanation, (e) disagrees with adult response, (f) provides additional on-topic details, (g) changes topic, and (h) no response. To give a hypothetical example, if the child's initial question was, "Why did he laugh?" an adult might respond, "He thought of a funny joke," to which the child might react in several different ways. For example, the child might say, "Oh, I think so, too," which would be coded as agreeing with the adult response. Or perhaps the child might ask, "But what made him laugh?" which would be coded as re-asking the question. If the child asked, "Why did he think of a funny joke?" this would be coded as a follow-up question. Finally, if the child said, "I think someone tickled him," this response would be coded as providing his/her own explanation. See Appendix A for more detail on these coding categories and examples from the data.

Reliability—Inter-rater reliability was established using randomly selected samples of 20% of each child's total causal questions. Two persons independently coded each of these 20% samples, and if a satisfactory level of agreement was not achieved, disagreements were discussed and an additional 20% sample was selected for reliability coding. For child questions, which were coded as simple or complex, there was 99% agreement overall (across all 6 children) and a Kappa of .99. Coding for adult responses, as explanations or non-explanatory answers, had overall (across all 6 children) 95% agreement, with a Kappa

of .90. For coding the explanation form of adults' explanatory responses (mechanism, prior cause, etc.), there was 77% agreement, with a Kappa of .68. Focally, for all the child reaction codes there was 85% agreement, with an overall Kappa of .82. Reliability was also calculated for each child response category; percent agreement for that coding ranged from 93% to 99%, with Kappas ranging from .64 to .97. Reliability was also confirmed for each individual child, with Kappas ranging from .75 to .91. All of the Kappas fall within "substantial" (.61 to .80) levels of inter-rater reliability, and 50% of them fall within "near perfect" (.81 and above) levels (Landis & Koch, 1977).

Results

The small number of children presents several analysis challenges. In order to increase the reliability of the statistical tests, data were pooled across children, making the utterance instead of the child the basic unit of analysis. With regard to the independence of such data, Bakeman and Gottman (1997) suggest that successive events (e.g., multiple utterances from the same child) measured in naturalistic settings may be regarded as independent for the purposes of statistical analysis as long as (a) observers make separate (and presumably independent) decisions when coding each event, and (b) the coding system consists of mutually exclusive and exhaustive categories. Both of these stipulations apply to our coding.

To avoid reporting findings that are driven by the results of only one child, the inferential statistical analyses followed several steps. Initially, we used an omnibus chi-square to test for differences between all the patterns of child reactions to adult responses. Whenever this chi-square was significant, it was followed up by examining proportions of responses to individual categories. Here we used *z*-scores to assess the significance of differences between paired proportions. The *z*-scores compared the relative proportions of coding categories to each other and across time. For example, for our primary hypotheses, proportions were created by dividing the frequency of each type of child reaction following an explanation by the number of explanations that children received. The same was done for child reactions following non-explanations, with the denominator being the number of non-explanations received.

For all the analyses, we adopted a conservative level of significance ($p < .01$, two tailed), to reduce the possibility of Type 1 error resulting from multiple comparisons, and because of the large numbers of utterances contributing to the proportions. In addition, to be considered significant, the comparison had to be in the same direction for at least 5 of the 6 children individually. For examples of studies that use *z*-test analyses in this manner, see Hickling and Wellman (2001) and Lagattuta and Wellman (2002).

Children's Questions and Adults' Responses—Overall, the 6 children in the sample asked simple questions (consisting of only one or two words) 31.2% of the time, and complex questions (including a reference to the subject of the *how* or *why* question) 68.8% time. The relative percentage of complex questions significantly increased over time, with 53.6% of 2-year-olds' questions being complex, increasing to 69.3% at age 3 ($z = -7.11$, $p < .001$) and to 79.2% at age 4 ($z = -5.27$, $p < .001$).

With regard to adults' provision of different types of answers, overall, adults provided an explanation 36.7% of the time, with the remaining 63.3% of adult responses being non-explanatory. The percentage of the time that children received an explanation decreased with age, with 2-year-olds receiving an explanation 40.7% of the time, 3-year-olds receiving an explanation 38.3% of the time, and 4-year-olds receiving an explanation 30.7% of the time. Only the decrease from age 3 to 4 was significant ($z = 3.81$, $p < .001$).

Do Children React Differently to Explanations Versus Non-Explanatory Answers?—To test our primary hypotheses, we compared the patterns of child responses following an adult explanation versus no explanation. Table 1 is arranged so that the child response categories where we hypothesized key contrasts are reported in the top section. Namely, we predicted that children would be more likely to agree and ask follow-up questions following explanations, whereas the responses of re-asking the original question and providing their own explanation were predicted to be more frequent following non-explanatory answers. Child response categories where we did not have predictions or that we did not expect to significantly differ between explanation and non-explanations are at the bottom of Table 1. These categories provide additional information about the other ways children react to adult responses.

The proportions in Table 1 were calculated by dividing the frequency of each type of response (following an explanation or a non-explanation) by the total number of explanations or non-explanations received. An overall chi-square analysis across the 8 categories in Table 1 confirmed a significant difference in the pattern of child responses with relation to whether or not the child received an explanation, X^2 (7, N = 3162) = 382.8, p < .001. Agreeing and follow-up questions were more frequent following adult explanations versus adult non-explanation responses (11.1% vs. 6.3%, z = 4.85, p < .001, and 18.5% vs. 4.6%, z = 12.81, p < .001, respectively). Conversely, in conversations where children did not receive an explanation (compared to those in which they did receive an explanation), they were more likely to re-ask the original question (24.0% vs. 9.4%, z = -10.20, p < .001), and to provide their own explanation (10.7% vs. 1.0%, z = -10.16, p = .001). When examined separately, all 6 children followed the same patterns in these four key categories (agreeing and follow-up questions were more frequent after explanations, and re-asking and providing own explanations were more frequent after non-explanations).

Note that these significant differences in the patterns of children's reactions following explanations versus non-explanations refute the hypothesis that children are simply trying to extend the conversation and that any adult response they get would be a satisfying one. In contrast, the presence or absence of explanatory content appears to be a key factor in how children react.

With regard to the other categories, disagreeing was relatively infrequent, but when it did occur it was more frequent following adult explanations versus non-explanatory responses (z = 3.38, p < .001). In conversations where children did not receive an explanation (compared to those in which they did receive an explanation), they were more likely to provide additional on-topic information (z = -3.21, p < .01). Children were not significantly more likely to change the topic following either an explanation or a non-explanatory answer (z = 2.38, *n.s.*). Finally, children were more likely not to respond at all following an explanation versus a non-explanation (z = 3.50, p < .001).

Are There Developmental Differences in Children's Patterns of Reactions?—Because these analyses collapsed across all child utterances, they raise the question of whether these patterns of appropriate responses might be carried solely by the oldest children. However, even for 2-year-olds, children's reactions evidenced the same patterns following explanations and non-explanations. As 2-year-olds, these children more frequently asked follow-up questions following adult explanations compared to non-explanatory adult responses (20.5% vs. 2.3%, z = 7.68, p < .001). Two-year-olds were significantly more likely to re-ask their original question following non-explanatory adult responses compared to explanatory responses (34.3% vs. 12.2%, z = -6.36, p < .001). Data for the instances when 2-year-olds responded by agreeing did not reach significance, but were in the predicted direction, with a larger proportion of agreeing following explanations compared to non-

explanations (10.6% vs. 8.1%). Two-year-olds' provision of their own explanations could not be tested due to small frequencies; however, the nine times children did provide their own explanations at this age, they followed non-explanatory responses from adults.

Besides this examination of the youngest age, we also explored age trends. An overall chi-square analysis comparing the relative proportions of child responses at each age (2, 3, and 4 years old) was significant, X^2 (14, N = 3162) = 133.3, $p < .001$. To examine this overall finding further, age patterns were examined on a child-by-child basis to determine if there were any developmental patterns upheld by at least 5 of the 6 children for the 4 key categories (agrees, follow-up question, re-asks, or provides own explanation). There was one consistent developmental pattern in the overall relative frequencies of child response types over time. Providing one's own explanation increased with age for 5 of the 6 children. Pair-wise z-scores showed a significant increase from ages 2 to 3 (1.4% vs. 6.8%, z = -5.22, $p < .001$) and from ages 3 to 4 (6.8% vs. 12.1%, z = -4.52, $p < .001$) in children's frequency of providing their own explanations.

Do Children React Differently When They Ask Simple Versus Complex Questions?—It is worth considering whether these patterns of appropriate responses might be carried solely by the situations in which children ask complex questions with fully-articulated topics. We therefore examined separately the response patterns for the conversations following children's simple, unelaborated questions (consisting of only one or two words, such as “Why?” or “How come?”). On this secondary analysis, children's reactions demonstrated the same patterns of differentiation between explanations and non-explanations as with the full set of data. Children were more likely to agree and ask follow-up questions following adult explanations (agree: 11.9% vs. 4.1%, z = 4.56, $p < .001$; follow-up question: 15.0% vs. 4.1%, z = 5.84, $p < .001$). Furthermore, following non-explanations, children were more likely to re-ask their original question (25.6% vs. 9.9%, z = -6.45, $p < .001$), and to provide their own explanation (7.9% vs. 0.2%, z-score not calculable due to only one instance following an explanation). Clearly, then, these patterns hold for children's simple as well as complex questions.

Do Children React Differently to Different Types of Explanations?—Child responses did not differ significantly based on the form of explanation (mechanism, prior causal event, consequence, current state of world, or other) voiced by the adult, X^2 (28, N = 1150) = 17.39, *n.s.* Children responded to each type of explanation with a similar pattern of responses.

Are Children's Reaction Patterns Affected by the Length of the Adult Response?—Finally, we investigated the hypothesis that children's reactions could be based on the length of the adult response. In general, adult responses ranged from 1 word to 56 words in length, with a median length of 5 words. We excluded instances when children did not receive any adult response (n = 945) from analysis. Length was confounded with the type of adult response: explanations had a longer average length (M = 7.61 words, SD = 4.81) than non-explanatory answers (M = 4.89 words, SD = 3.72). This was confirmed by a significant 2 × 2 chi-square, comparing explanations and non-explanatory answers with length, which was split into short (5 words or less) versus long (6 words or more), X^2 (1, N = 2217) = 158.8, $p < .001$.

To attempt to disentangle the effects of length and explanatory response, we compared the relative proportions of child responses following explanations and non-explanations within the short answers (5 words or less) and then separately within the long answers (6 words or more). For short adult responses, the overall chi-square was still significant, X^2 (7, N = 1146) = 158.1, $p < .001$, so we then conducted z-tests to determine if there were significant

differences in the key child response categories. Children were not significantly more likely to agree with short explanations compared to short non-explanations (12.0% vs. 11.4%, z = 0.31, *n.s.*). However, children were significantly more likely to ask a follow-up question after receiving a short explanation compared to a short non-explanation (18.8% vs. 3.3%, z = 8.80, $p < .001$). Following short non-explanations, children were significantly more likely to re-ask their original question (18.6% vs. 12.0%, z = -2.97, $p < .01$) and give their own explanation (11.4% vs. 1.3%, z = -6.33, $p < .001$) than following short explanations. Thus, even within the shortest adult responses, children still recognized the difference between an explanation and a non-explanation, responding in meaningfully different ways to these two types of responses.

A similar pattern was found for long adult responses. The overall chi-square comparing the pattern of child responses following long explanations and long non-explanatory answers was significant, X^2 (7, N = 1071) = 59.5, $p < .001$. Z-tests for the four focal categories of child reaction showed two were significant and in the expected directions. Specifically, children were significantly more likely to ask a follow-up question after receiving a long explanation compared to a long non-explanation (18.4% vs. 6.9%, z = 5.05, $p < .001$). Conversely, children were significantly more likely to give their own explanation (5.8% vs. 0.8%, z = -4.88, $p < .001$) after receiving a long non-explanation compared to a long explanation.

Discussion

The results of Study 1 confirm that children respond differently and appropriately to explanatory versus non-explanatory answers to their questions. When asking *why* and *how* questions, young children are not merely trying to extend conversation with an adult, but instead appear to be actively seeking explanatory information. Thus, when preschool-aged children receive an explanation to these questions, they appear satisfied (as evidenced by their agreement), and in some cases are motivated to pursue new information on the same topic (by asking a follow-up question). In contrast, when children do not receive an explanation, they are persistent in re-asking for this information or they suggest their own explanation. Evidence of these same response patterns was present even when these children were 2-year-olds. Length of adult response also influenced children's reactions. But explanatory content, and not simply length alone, was an important factor. Thus, within the shortest adult responses, as well as within the longest ones, children still reacted differently and appropriately to explanations and non-explanations.

Study 2 aims to replicate these patterns of child responses within an experimental context. Beyond replication, the experimental format provides the opportunity to address several challenges with the naturalistic data used in Study 1, including small sample size and the confounding issue of length of adult responses.

Study 2

The general aim of Study 2 was to examine children's responses to explanations versus non-explanatory answers within an experimental context. Although conversational sequences were revealing in the naturalistic data, numerous utterances must be available from everyday conversation to accrue enough data for analysis. In Study 1 (as well as in Study 1 of Chouinard, 2007 and Hickling & Wellman, 2001), this resulted in small sample sizes. An experimental situation can be structured to prompt children's inquiries with higher frequency. Moreover, experimental contexts allow for experimental control. In particular, we could script adult responses, allowing for more controlled contrasts of explanations versus non-explanations. Scripted adult responses with specified topics for conversation also

have the advantage of avoiding confounds of various sorts that may exist in naturalistic data where conversational partners have complete freedom over the topic of discussion.

Thus the specific aims for this study were to create items that could elicit children's question-asking and then to provide controlled adult responses to those questions. To achieve these aims, we devised a methodology inspired by Kemler Nelson, Egan, and Holt (2004). In their study, 2-, 3-, and 4-year-old children were encouraged to ask questions about unfamiliar artifacts. The procedure began with a short warm-up where a puppet modeled question-asking and then children were given opportunities to ask the researcher questions about 12 test objects. Using this methodology, on average 3-and 4-year-olds asked at least one question about 10 or 11 of the 12 objects.

Kemler Nelson et al. (2004) focused on object-situations where children were likely to ask ambiguous questions (e.g., “What is it?”). For some children these ambiguous questions were answered with the object's name and for other children they were answered with the object's function. To assess children's satisfaction with the type of answer they received, Kemler Nelson et al. (2004) measured how often children followed up their original question with additional, often more specific/directed inquiries. In their research, children were more likely to ask additional questions when given a name for the object. In contrast, children asked fewer additional questions when given a function. The researchers interpreted this reaction as meaning that the children often sought, and thus were more satisfied with, function information in comparison to name information.

In Study 2 of the present paper, incorporating similar techniques, we used a series of objects, storybooks, pictures, and short videos to elicit children's explanatory inquiries. The stimuli depicted surprising, unusual, or expectation-violating situations that had the potential to provoke requests for explanations, such as a story about a girl who pours ketchup on her ice cream or a video of a woman turning the lights off with her foot instead of her hand. Just as in Study 1, rather than being situated within a single domain (e.g., unfamiliar artifacts, biological phenomena, mechanical events), the items encompassed a variety of situations and domains (e.g., psychological motivations, physical consequences, biological phenomena). The key outcomes measured for this study, as in Study 1, concerned how the children reacted when the adult provided an explanation versus a non-explanatory response.

Study 2 also permits us to extend our focus beyond children's explicit use of “why” and “how” questions, to investigate more implicit questioning. Although direct causal questions are a clear signal that a child is asking for an explanation, there are also indirect means of indicating a request for causal information, including quizzical statements, surprised intonation, glances to the adult, and the like. In Study 1 it was not possible for us to examine such indirect requests on the part of the child, because the CHILDES database includes no systematic data on intonation or non-verbal behaviors. In contrast, the videotaped data in Study 2 allow us to expand our focus to identify other ways in which children might request explanatory information in their conversational exchanges. In pilot testing, often it seemed that children were requesting an explanation by using statements rather than articulating a specific causal question (e.g., saying, “Hey, she used her foot!” when encountering the video of the woman turning off the light switch with her foot). Pragmatically, these statements operated as requests for the adult to explain what the child noticed and commented on. We refer to these types of statements as “requestive” statements, borrowing from language used by linguists to describe the illocutionary force or intended function behind speech acts that are formally statements, yet are intended to function as requests (see Searle, 1969). This is similar to when someone asks, “Why don't you close the door?” with the intent of politely requesting someone to shut the door, rather than actually inquiring as to the reasons behind why someone has not closed the door. Rather than using a question to implicitly convey a

request, children in our study seemed to be using statements to implicitly convey requests for explanatory information. Based on this pilot testing, in the final procedure the signal for the adult to provide the explanatory or non-explanatory answer was the child's verbal acknowledgement of the unusual aspect of the stimulus, including either a causal question or an appropriate requestive statement or exclamation remarking on the oddity. However, in our analyses we do examine children's responses following their requestive statements separately from their responses following questions to confirm that they represent similar functions within the conversation.

Our predictions parallel and extend those for Study 1. If children actively seek explanatory knowledge, one would expect to find variation in the pattern of their responses based on whether or not they have received an explanation. In particular, when children did not receive an explanation, we predicted that they would show dissatisfaction by re-asking their original question or formulating their own explanation. When children did receive an explanation, we predicted that they would show signs of satisfaction by agreeing or nodding their heads. In addition, we predicted that, following explanations, children would be more likely to ask an additional question that differed from the original question, but building on the same topic (a follow-up question).

Method

Participants—Participants were 42 preschool children from a Midwestern university city. The sample was recruited from university preschools that encourage active exploration and questioning, and the community is predominantly Caucasian and well-educated. There were 21 younger children (mean age = 3 years, 11 months; *SD* = 2.76 months; 11 girls, 10 boys) ranging from 3 years, 5 months to 4 years, 3 months of age and 21 older children (mean age = 4 years, 9 months; *SD* = 3.60 months; 7 girls, 14 boys) ranging from 4 years, 4 months to 5 years, 3 months of age. An additional three children were dropped from the final sample because they did not complete the study.

Materials—Materials included 4 objects, 4 storybooks, 4 pictures, and 4 short videos designed to create surprising, question-provoking situations. The objects included a box of crayons of all the same color (e.g., all red), a puzzle with a piece that did not fit, a hat with a hole in it, and a clam-shell toy cell phone that would not open. The storybooks described a child who poured orange juice instead of milk on his cereal, a girl who poured ketchup instead of chocolate sauce on her ice cream, a boy who wore a scarf and mittens to play outside on a warm day, and a girl who went to bed with her clothes and shoes on. The pictures depicted situations with one surprising feature: a bird's nest containing two baby birds and a turtle, an unusually small door, a normally dressed man wearing a clown nose, and a bed located outside of a house on the lawn. The videos presented short segments showing a person doing puzzling activities: turning off a light with her foot, spinning while walking across a room, wearing a bucket instead of a hat, and jumping on her hat. To ensure the child was able to see everything that happened in the video, the videos were each presented three times back-to-back.

Procedure—Children were tested individually in a quiet room at their school. The interaction was videotaped either by a separate researcher seated in the room holding the video camera, or by using a video camera attached to a tripod in view of the child.

The adult began by explaining, “I brought some toys from my house to show you today. These are my toys, so if you have any questions about them, you can ask me.” Next, a short warm-up activity was used to briefly model the question-asking conversational format and engage the child. The warm-up began with the adult introducing the child to a puppet named

"Buggy." Buggy then answered two adult questions about a toy car with an unusual hook attached to it. These questions included one non-causal question, "What is that?" to which Buggy responded, "It's a car," and one causal *why* question, "Why does it have a hook on it?" to which Buggy responded, "To pull other cars with." This warm-up activity had two aims: to build rapport and to briefly model the question-asking conversational format. We included both a causal and a non-causal question to avoid modeling that a particular type of question was preferred.

Participants were then presented with the objects, storybooks, pictures, and short videos. Each item was presented individually and the items were presented in the same order for all children. The adult presented each item with a short statement introducing it, without explicitly mentioning the unusual or surprising aspect of the item. For example, "This is my brand new hat," or "Can you help me put this puzzle together?" If the child demonstrated recognition of the unusual aspect of the stimulus (including asking a causal *why* or *how* question or making a statement about the unusual aspect with a quizzical look or intonation), the researcher responded by providing either an explanation or a non-explanatory answer (alternating over trials). There was a scripted explanation and a scripted non-explanation for each item (resulting in 16 different explanations and 16 different non-explanations). The pattern of alternating explanations with non-explanations in response to children's inquires was maintained, ignoring items for which the child did not ask a causal question or make a requestive statement (to ensure that each participant would get an even mix of explanations and non-explanations across items). Seventy-six percent of children received an explanation on the first trial.

Non-explanatory answers included four different types: restatement (e.g., "You're right, there is a turtle in that bird's nest."); normative (e.g., "People don't usually wear red noses like that."); descriptive (e.g., "That looks like vanilla ice cream."); and personal reaction (e.g., "I like to put milk on my cereal."). There was one non-explanatory response for each item, with the four different types of non-explanatory answers alternated across items. The different types of non-explanatory answers were modeled on some of the non-explanatory answers adults gave in Study 1. See Appendix B for a list of explanations and non-explanatory answers used with each stimulus. Using different types of non-explanations created useful variation in that it reduced the predictability of what the adult would say in response to the child's inquiries.

As in Study 1, there are alternative possibilities for why a child might respond to explanations and non-explanations differently (other than the presence versus absence of explanatory information). One possibility is that children might respond to differences in length between these two types of answers. In Study 2, however, the explanation and non-explanation for each item were created to be equal in word length. The average word length for explanations was 9 words and the average word length for non-explanations was 8.5 words. Children might also respond to the presence of causal terms in explanations that are absent from the non-explanations. To control for this possibility, explanations were carefully worded to avoid using key causal terms such as "because" and "so" for all cases, with only one exception.

The adult paused to allow time for the child's response before moving on to the next item. In cases where the researcher had responded with a non-explanation and the child re-asked his or her original question (or continued to demonstrate curiosity about the unusual aspect of the item), the researcher provided the explanatory answer.

Children's responses to the adult's provision of an explanation versus a non-explanation were coded from the videotaped interactions, using a coding system similar to the one used in Study 1, including the key categories:

a. Agreeing with the adult, including nodding head or saying “oh”

For example: CHILD: “Why Cathy did that?” ADULT (explanation): “She thought it was chocolate syrup,” CHILD: “Oh, chocolate syrup.”

b. Asking a follow-up question

For example: CHILD: “Why does he have his bed outside like this?” ADULT (explanation): “Tommy's parents are painting his room,” CHILD: “And they—and do they want it to be a surprise?”

c. Re-asking the original question

For example: CHILD: “What were you doing?” ADULT (non-explanation): “People don't usually jump on hats,” CHILD: “Why were you doing it?”

d. Providing own explanation.

For example: CHILD: “But why she has the bucket on her head?” ADULT (non-explanation): “Well she didn't put the hat on her head,” CHILD: “Because she didn't see that hat?”

Additional categories were also included to provide additional information about the range of children's responses: e) smiles or laughs, f) disagrees with adult response, g) provides additional on-topic details, h) changes topic or asks for next item, and i) no response. Whether the child had used a statement or a question to acknowledge the unusual aspect of the stimulus was also coded.

Inter-rater reliability was established using randomly selected samples of 20% of the participants. Two persons independently coded the reliability sample and if a satisfactory level of agreement was not achieved, disagreements were discussed and an additional 20% sample was selected for reliability coding. Overall, across all 9 child response coding categories, there was 82% agreement, with a Kappa of .78. Reliability was also calculated for each child response coding category; percent agreement ranged from 93% to 98%, with Kappas ranging from .73 to .88. Because instances of children providing their own explanations were rare, reliability for this category was calculated using a separate 20% sample resulting in 99% agreement and a Kappa of .88. All of the Kappas for coding in this study fall within substantial (.61 to .80) levels of inter-rater reliability, and 44% fall within near perfect (.81 and above) levels (Landis & Koch, 1977).

Results

Children were each presented with all 16 stimuli in individual sessions lasting 15-25 minutes. Children asked an average of 4.6 questions total and made requestive statements about the unusual aspect of the stimulus an average of 7.7 times for a total of 12.3 requests for explanation. The adult researcher provided the child with an average of 6.1 explanations and 6.2 non-explanations in response to the child's requests about the unusual stimuli, in essence providing explanations and non-explanations each about 50% of the time.

Do Children Respond Differently to Explanations versus Non-Explanatory Answers?—As in Study 1, if the purpose of children's causal questions is to actively seek theory-building knowledge, one would expect to find variation in the pattern of children's responses based on whether or not they have received a causal explanation. Indeed, this variation was present as shown in Table 2, where again the key response categories are

reported in the top section. Specifically, as in Study 1, we predicted that children would more often agree and ask follow-up questions following explanations, and to re-ask the original question and provide their own explanation following non-explanatory answers. Child response categories for which we did not have predictions are in the lower portion of Table 2.

For the analyses, we calculated proportions for each child by dividing the frequency of each type of child reaction following an explanation by the number of explanations that that child received. The same was done for child reactions following non-explanations, with the denominator being the number of non-explanations received by the child. An overall ANOVA indicated a significant difference in the patterns of child responses following explanations versus non-explanations, F (8, 320) = 11.95, $p < .01$. As in Study 1, Bonferroni post-hoc comparisons showed that children were significantly more likely to agree, $p < .001$, or ask a follow-up question, $p < .001$, in response to explanations than to non-explanatory answers. Conversely, children were significantly more likely to respond by re-asking their question, $p < .001$, or by providing their own explanation, $p < .05$, following non-explanations compared to explanations.

These patterns in children's responses were consistent across a majority of children in the sample. Of the 35 children who responded at least once by agreeing or nodding their heads, 29 did so more often following an explanation than a non-explanation, $p < .001$, binomial test. Of the 24 children who asked at least one follow-up question, 21 children did so more often in response to an explanation than a non-explanation, $p < .001$, binomial test. All 20 of the children who responded at least once by re-asking their original question did so more often when they received a non-explanation than an explanation, $p < .001$, binomial test. Finally, 8 out of the 9 children who provided their own explanation at least once used this response more often following non-explanations than explanations, $p < .05$, binomial test.

Recall that most children received an explanation on their very first item. To ensure that the pattern of results was carried not only by the participants who received an explanation for the first item (and who therefore might have been more engaged in the task), we also examined the pattern of results within the subset of participants who received a non-explanation for the first item ($N = 9$). As in the full sample, these children were more likely to agree/nod their heads when they received an explanation than when they received a non-explanation, $t(8) = 3.32$, $p < .05$. There was also a trend for these children to ask a follow-up question more often in response to an explanation than a non-explanation, $t(8) = 2.10$, $p < .10$. When these children received a non-explanation, they were more likely to re-ask their question, in contrast to when they received an explanation, $t(8) = -2.70$, $p < .05$. In this smaller sub-sample, children were not significantly more likely to provide their own explanation following a non-explanation versus an explanation. Overall, then, the results hold up even when children did not receive an explanation on their first item.

In addition, these patterns held across a majority of the items. Children were more likely to agree in response to an explanation than a non-explanation for 13 of the 16 items. Children were also more likely to ask a follow-up question after receiving an explanation than a non-explanation for 14 items. In contrast, for 15 items, children were more likely to re-ask their original question following a non-explanation than an explanation. Finally, although instances of children providing their own explanations were rare and occurred with only 9 items, for 7 of these items, children provided their own explanations more often in response to non-explanations than explanations.

With regard to the further coding categories, children responded by smiling or laughing more often in response to an explanation than a non-explanation, $p < .01$. Children were also significantly more likely to disagree with non-explanations, $p < .01$.

We also compared the patterns of children's reactions following the four different types of non-explanatory answers (restatement, normative, descriptive, and personal reaction). As predicted, children's responses did not differ significantly based on the type of non-explanatory answer, F (24, 528) = 1.39, *n.s.*

Children's Use of Questions Versus Statements to Request Explanations—To confirm that children's use of requestive statements (noting the unusual aspect of an item) functioned as requests for explanations in the same way as did their questions, analyses compared children's response patterns following these two types of reactions.

For the instances in which children acknowledged the unusual characteristic with a *question*, the same patterns of child reactions following explanations versus non-explanations shown in the full sample were also demonstrated in this subset. As expected, when children asked a question initially they were more likely to agree/nod their heads, $t(41) = 2.58$, $p < .05$, and ask a follow-up question, $t(41) = 3.80$, $p < .001$, when they received an explanation than when they received a non-explanation. When children received a non-explanation in response to their question, they were more likely to re-ask their question, $t(41) = -4.32$, $p < .01$, or disagree, $t(41) = -2.41$, $p < .05$, in contrast to when they received an explanation. Children were not significantly more likely to provide their own explanation following a non-explanatory response versus an explanatory response.

Importantly, when children acknowledged the unusual aspect of the stimulus with a *requestive statement*, they were also more likely to agree/nod their heads, $t(41) = 3.19$, $p < .01$, and ask a follow-up question, $t(41) = 2.95$, $p < .01$, in response to explanations compared to non-explanations. Also (as when children voiced a question), when they used a statement to prompt an adult response they were also more likely to re-ask their question, $t(41) = -3.50$, $p < .01$, following a non-explanation than an explanation. While not significant, there was a trend for children to provide their own explanation more frequently following non-explanations compared to explanations, $t(41) = -1.88$, $p < .10$.

Are there Developmental Differences in Children's Patterns of Reactions?—There were no significant main effects or interactions involving age. But to confirm that the results hold for the younger children, separate analyses for this age group confirmed that they demonstrated the same pattern of reactions following explanations versus non-explanations. Specifically, just as in the entire data, even the 21 youngest children (M = 3;11) were more likely to agree/nod their heads, $t(20) = 2.43$, $p < .05$, and ask a follow-up question, $t(20) = 2.24$, $p < .05$, in response to an explanation than a non-explanation. Children in the younger age group were also more likely to re-ask their original question following a non-explanation than an explanation, $t(20) = -3.61$, $p < .01$. Although the younger children did not demonstrate significant differences in voicing their own explanations following explanations versus non explanations, this response did show a trend in the same direction as the general sample (with their own explanations more likely to follow non-explanations, $t(20) = -1.86$, $p < .10$).

Discussion

These results further demonstrate that when asking causal questions (or using requestive statements that point out a surprising feature) with adult conversational partners, young children were more satisfied with adult responses that provided a causal explanation compared to those that did not. In the cases when they did not receive an explanation, even

the youngest children continued to seek this causal information by re-asking their question. Additionally, in both this study and Study 1, children were significantly more likely to ask a follow-up question to their original inquiry when it was answered with an explanation than when it was not. This suggests that causal explanations may foster continued conversation and knowledge-seeking.

Study 2 also yielded a promising experimental method, useable in further research, with several specific advantages. First, this methodology provides a means of eliciting frequent, relevant child questions in a half-hour session rather than hours of transcript. Second, we were able to expand our focus beyond causal *why* and *how* questions to include other more implicit strategies that children use to seek explanations. Children's requestive statements did not use the words *why* or *how*, but still functioned in the same way as explicitly causal questions. This approach was validated by our results showing that children display the same pattern of reactions for requestive statements (based on whether the child received an explanation) as when the child asked explicit causal questions. Finally, scripting adult responses allowed for control over possible confounding factors such as length and the presence of causal vocabulary (words like “because” and “so”). Our control of these factors means that the results from Study 2 cannot be due to length or the mere presence of causal words in adult responses. Children instead appear to be responding in organized, meaningful ways based on the presence or absence of explanatory content in the adult responses they receive.

General Discussion

Examining conversational exchanges, and in particular children's reactions to the different types of information they get from adults in response to their own requests, provides several important insights. Most generally, the different patterns in children's reactions following explanatory versus non-explanatory information confirm that young children are motivated to seek causal information actively and use specific conversational strategies to obtain it. In fact, when preschool children ask “why?” questions, they are not merely trying to prolong conversation (as previously suspected by many parents and researchers alike). Upon receiving an explanation, but not otherwise, children often end their questioning and react with satisfaction.

The support for these conclusions is strong because it converges across both naturalistic conversations (Study 1) and more controlled laboratory conversations (Study 2). Our methods do not just measure the causal knowledge children already have; they assess and reveal a socially-situated process by which children seek this knowledge within their everyday lives. Conversational interchange is surely not the only way children obtain causal information (direct instruction and first-hand observation must also be at work), but children's requests within adult-child conversation are a common and useful tool for obtaining this knowledge. Child-adult exchanges prove to be similarly useful for investigators to determine what children want to find out.

These studies raise a number of important questions for future research. Two key questions are: What constitutes a satisfying explanation for children? And, does this change developmentally? The explanations (and non-explanations) scripted in Study 2 were modeled on those provided by adults in Study 1. As such, they were relatively concise and to the point. Would briefer, or more detailed, explanations be similarly satisfying? This is importantly related to Keil and colleagues' arguments about the “shallows” of ordinary explanation (Mills & Keil, 2004; Rozenblit & Keil, 2002). To what extent are children satisfied with explanations that are shallow versus deeper and more detailed? And how do such preferences change, or stay the same, from early childhood to adulthood? The

methodology created for Study 2 (including the stimuli that reliably prompt children to voice questions and make inquiries) provides a means for potentially answering these questions in future research.

In addition to examining children's relative satisfaction with different explanations, future research might also explore the impact of different types of non-explanations on children's willingness to continue the conversation. When an adult provides additional on-topic information or corrects the child's underlying assumptions, she/he may be leaving the conversation open for future discussion. In contrast, when an adult provides a more closed-ended answer such as “I don't know” or simply “Because,” these responses might be perceived by the child as discouraging further questioning. It would be interesting to know if children are sensitive to these potential pragmatic differences.

More generally, what is the developmental course of the patterns of reaction to adult explanations that we have demonstrated? Both earlier and later developments are of interest. We have explored preschool-aged children's questions and their reactions to the answers they receive, but it would be interesting to know when these patterns first emerge. The earliest data in our research are from 2-year-olds in Study 1, as they voice their first causal questions. Do children request explanatory information prior to their ability to verbalize causal questions? Study 2 of Chouinard (2007) provides some insight into this question. Over the course of a week, parents of children as young as 1;0 to 1;5 recorded instances where they appeared to be requesting information using gestures, expressions, and vocalizations. Although requests for explanatory information at this age were rare (only 3% of the time, with the rest of the requests being for fact-based information), they did exist. It would be interesting to know if, at this young age, children would persist in requesting explanatory information if it was not forthcoming.

It is also an open question as to how children's reactions and explanatory preferences might change after the age of 5. The patterns we reveal seem remarkably stable across the ages of 2 to 4 years old. Nonetheless, we did find that the frequency of adults' provision of explanations decreased in this period (Study 1), while at the same time, the frequency of children providing their own explanations increased (both studies). As children get older, they may be better able to verbalize possible explanations for the puzzling phenomena around them. As children's capabilities increase, adults' role may shift, an example of what Rogoff and colleagues describe as a “transfer of responsibility” (Rogoff, 1989). Adults may shift from providing immediate explanations in response to children's inquiries to instead providing supporting details that encourage children to come up with explanatory possibilities themselves. For example, in Study 1, when Abe asks his father about why a character on a book cover is pouring yellow paint into a can of green paint, his father responds, “I don't know, that sure isn't very smart – Why do you think he's doing that?” Providing preliminary support for this point, in Study 1, the frequency of parent responses that provided new on-topic information did increase significantly between ages 2 and 3 and showed a small increase between age 3 and 4. These and other trends are worthy of systematic research.

Interest in children's learning from adult testimony has recently blossomed (Harris & Koenig, 2006). Our data make a novel contribution to this literature by demonstrating an important mechanism whereby this learning could potentially take place. The three key steps in question-asking conversational exchanges (the child's initial question, the response the child receives, and the child's reaction to that response) could be seen as corresponding to three key steps in learning: a) an initial state, b) informational input, and c) revision of knowledge or adjustment of the system. The studies within this paper do not explicitly measure whether children are learning from the explanations they receive, but our results

support the idea that children seek adult testimony and find some forms such as causal explanations particularly motivating and satisfying.

Preschool-age children are able to recognize differences between individuals in expertise and can use this information to infer the person who is most likely to know about a particular topic (Lutz & Keil, 2002). However, not only informant status, but informant certainty is of interest. Adults may use intonational cues that (intentionally or unintentionally) signal a difference between explanations and non-explanations. Much as child-directed speech may aid children's language development, perhaps there is an “explanationese” that signals the importance of explanatory information. The present studies provide no data on this point (indeed in Study 2 we took care that the adult express the same amount of enthusiasm across both explanatory and non-explanatory answers), but future research could do so.

Finally, it will be important to consider possible cultural influences on conversational exchanges concerning causal questions. The children in Study 2 were recruited from predominantly mid- to high-income communities, where the cultural context is one that supports and encourages children to directly ask for information from the adults around them. It would be important to examine whether our findings extend to other cultural contexts where the expectations and norms for interacting with adults may differ (e.g., Heath, 1983). Rather than initiating causal inquiry through conversation, children may have different strategies for obtaining explanatory knowledge in these contexts.

Children's building of explanatory knowledge is without doubt a complicated and multi-faceted process. Nonetheless our examination of the patterns in adult-child conversational exchanges provides important information regarding a crucial mechanism by which children may construct this knowledge in their everyday lives. Children seek, and evaluate, explanations by means of causal questions.

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Appendix A: Coding Categories Used in Study 1

Form of Child's Question

1. Simple (“Why?” “How come?” “Why not?”)
2. Complex, including an articulated topic (“Why is the sky blue?”)

   Examples of questions that were not included (close imposters of causal questions):

   “Did you show Ursula how to do it?” “See how dark it is?”

Adult Response Categories

a. Explanation

Examples:

CHILD: Why you making tacos? ADULT: I thought you'd like them.

CHILD: Why you put some water in there, Mom? ADULT: To help mix all of the ingredients together.

b. Non-Explanatory Answer (includes: providing new or focusing information, redefining or correcting assumptions underlying the child's question, confirming/ agreeing with the child's question, asking a clarification question, redirecting the question to someone else, saying “I don't know,” “Because” or “Because I said so,” or not responding.

Examples:

CHILD: “How can snakes hear if they don't have ears?” ADULT: “I don't think they can hear.”

CHILD: “How do you make your voice go on?” ADULT: “I'll show you in a minute.”

Explanation Forms

1. Mechanism: Procedure-like explanations in which a step or series of steps were mentioned as a way of explaining how something works.

Example: CHILD: Why it can't turn off? ADULT: Because the springs are all wound up.

2. Prior Causal Event: Explanations that provide a single *event* that occurred prior to and caused the asked-about event.

Example: CHILD: Why my tummy so big, Mom? ADULT: Because you ate a lot.

3. Consequence: Explanations that provide a purpose for, or an event or state that will occur later in time than, the asked-about event or state. Includes teleological explanations, which assume that objects, behaviors or events occur or exist for a purpose (Kelemen, 1999).

Example: CHILD: Why does Andy go to the barber? ADULT: To get his hair cut.

4. Current State of World, Non-Mechanism: Explanations that refer to the existence of an object/entity or the state/quality of a situation that is the cause of the asked-about phenomenon; does not mention a specific mechanism.

Example: CHILD: Why not keep a light on? ADULT: Because we have the sun.

5. Other

Child Response Categories

a. Agrees with adult

Includes: agreeing with adult response, saying “yes/yeah” or “oh,” or repeating adult response

b. Asks a Follow-Up Question

Includes: asking a question that is on the same general topic as the original question, but requests different information than was requested in the original question

Example: CHILD: Why they going deep-sea diving? ADULT: (no response) CHILD: How are the people going down dere?

c. Re-asks Original Question

Includes: repeating or rephrasing the original question; requests the same information as the original question

Example: CHILD: How are the people going down dere? ADULT: (no response) CHILD: How dey going to get there?

d. Provides his/her Own Explanation

Includes: offering an alternative explanation to the one the adult has provided or providing an explanation when the adult has not given one

Example: CHILD: Do you know why he's going to live next to the mine? ADULT: How come? CHILD: Because he likes it next to the mine.

e. Disagrees with adult

f. Provides Additional On-Topic Supporting Details

Example: CHILD: Why did you give me the blue one? ADULT: (no response) CHILD: I wanted the red one.

g. Changes topic

h. No response

Includes: silence (no response) or making an unintelligible or incomplete response

Appendix B: Explanations and Non-Explanatory Answers Given in Response to Child Inquiries in Study 2

Stimuli: Objects	***Question***	***Explanation***	***Non-Explanation***
1. Animal puzzle	Why doesn't this piece fit?	I think the pieces from two puzzles got mixed up.	I think all the other pieces fit in this puzzle.
2. Red crayons	Why are all of these red?	I'll bet it's because the factory messed up.	You're right, they are all red.
3. Hat with hole	Why does this have a hole in it?	It's to put a ponytail through.	Hats don't usually have holes in them.
4. Cell phone glued shut	Why doesn't this open?	Oh, I think it was broken and somebody accidentally glued it shut.	It looks like it has some buttons on the outside.
Stimuli: Storybooks	***Question***	***Explanation***	***Non-Explanation***
1. Ice cream and ketchup	Why did she do that?	She thought it was chocolate syrup.	That looks like vanilla ice cream.
2. Clothes in bed	Why did she do that?	She was so tired that she fell asleep before putting her pajamas on.	I like to sleep under lots of covers when I go to bed.
3. Cereal and orange juice	Why did he do that?	He thought it was milk in the pitcher.	I like to put milk on my cereal.
4. Playing outside with scarf	Why did he do that?	He wanted to play a joke on his friend.	Yeah, he's wearing a scarf when it's hot outside.
Stimuli: Pictures	***Question***	***Explanation***	***Non-Explanation***

Stimuli: Objects	***Question***	***Explanation***	***Non-Explanation***
1. Nest with turtle	Why is the turtle in that nest?	You know, I think the turtle crawled in there by mistake.	You're right, there is a turtle in that bird's nest.
2. Little door	Why is that door so small?	You know, I'm pretty sure it's a fairy door.	I think doors are usually much bigger than that.
3. Clown nose	Why is he wearing a red nose?	He works as a clown and forgot to take it off.	People don't usually wear red noses like that.
4. Bed outside	Why is Tommy's bed outside?	Tommy's parents are painting his room.	I think that bed looks comfortable.
Stimuli:Videos	***Question***	***Explanation***	***Non-Explanation***
1. Light switch with foot	Why did Brandy do that?	Brandy didn't want to touch the light switch with her sticky hands.	I like the color of the shirt that Brandy's is wearing.
2. Spin in hallway	Why is Brandy doing that?	I'm pretty sure Brandy's practicing a dance move.	I like how Brandy is spinning in the hallway.
3. Bucket as hat	Why did you do that?	I'm pretending the blue bucket is a hat.	I didn't put the hat on my head.
4. Hat stomp	Why did you do that?	There was a bug in my hat.	People don't usually jump on hats.

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Table 1

Percentage of Types of Child Reactions Following Adult Explanations Versus Non-Explanatory Responses (N = 6) in Study 1

	Adult Response		
Child Reactions	**Explanation**	**Non-Explanatory Response**	**Signif.**
Agrees or says “oh”	11.6 %	6.3 %	**
Asks a follow-up question	18.5 %	4.6 %	**
Re-asks original question	9.4 %	24.0 %	**
Provides own explanation	1.0 %	10.7 %	**
Disagrees with adult response	3.4 %	1.6 %	**
Provides additional on-topic supporting details	15.3 %	19.9 %	*
Changes topic	20.7 %	17.3 %	*n.s.*
No response	20.5 %	15.5 %	**

* $p < .01$,

** $p < .001$

Table 2

Percentage of Types of Child Reactions Following Adult Explanations Versus Non-Explanatory Responses (N = 42) in Study 2

	Adult Response		
Child Reactions	**Explanation**	**Non-Explanatory Response**	**Signif.**
Agrees, nods head, or says “oh”	29.5 %	12.6 %	**
Asks a follow-up question	21.4 %	6.6 %	**
Re-asks original question	1.2 %	21.4 %	**
Provides own explanation	0.7 %	4.0 %	*
Smiles or laughs	7.0 %	0.9 %	**
Disagrees with adult response	0.7 %	5.8 %	**
Provides additional on-topic supporting details	12.4 %	18.6 %	*n.s.*
Changes topic or asks for next item	7.3 %	8.1 %	*n.s.*
No response	19.8 %	22.0 %	*n.s.*

* $p < .05$,

** $p < .01$