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Young Children Prefer and Remember Satisfying Explanations

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Abstract

Research with preschool children shows that explanations are important to them in that they actively seek explanations in their conversations with adults. But, what sorts of explanations do they prefer, and what, if anything, do young children learn from the explanations they receive? Following a preliminary study with adults ($N=67$) to establish materials for use with children, we addressed this question using a semi-naturalistic methodology. 4- and 5-year-olds ($N=69$) were dissatisfied when receiving non-explanations to their explanatory questions, but satisfied when receiving explanations, and their satisfaction varied appropriately across several levels of explanatory information. Moreover, using recall as a measure of learning, whereas children typically failed to recall non-explanations, their recall of explanatory information was consistently high and also varied appropriately across differing levels of information provided. These results confirm that children not only actively seek informative explanations in their everyday conversational interactions with adults, they selectively retain the answers they receive.

Keywords

explanation; conversation; information seeking; learning and memory

Causal explanatory knowledge is central to human reasoning (Carey, 1985; Keil, 2006; Murphy & Medin, 1985; Wellman, 1990, 2011). Explanations help us interpret others' actions, account for puzzling events, uncover underlying mechanisms, and discover new principles about the world. In these ways, explanations seem designed to facilitate learning (e.g., Lombrozo, 2006). But we know relatively little about how young children learn from explanations.

One important means of obtaining explanatory information, especially for young children, is through conversations. Indeed, prior research documents that preschoolers ask many causal questions (Hickling & Wellman, 2001; Hood & Bloom, 1979) and receive informative responses from adults (Callanan & Oakes, 1992; Chouinard, 2007; Kelemen, Callanan,

Casler, & Pérez-Granados, 2005). By hypothesis, children who seek explanatory information must evaluate the adequacy of the responses they receive and then retain or learn from them. Because little research addresses these processes, here we examine what children attend to and remember from answers to their everyday explanatory questions. Children are socially interactive learners engaged in processes of seeking and evaluating “testimony” from others (Callanan, 2006; Gelman, 2009; Harris, 2012; Harris & Koenig, 2006). How do children react to and learn from the testimony they receive when they ask explanatory questions?

Background

We examine young children’s reactions to explanations they have actively sought via their own causal inquiries, including their memory for those explanations as a key index of their learning. One recent study in particular helps frame the methods we employ. Frazier, Gelman, and Wellman (2009) presented preschoolers with items and materials that were unusual or unexpected, and when children spontaneously asked “Why?” (as they often did), an adult provided scripted responses--either explanatory or non-explanatory--to those inquiries. Children reacted differently and appropriately to explanations versus non-explanatory answers in response to their inquiries: When preschoolers received an explanatory response, they appropriately evidenced satisfaction by agreeing, smiling, or following up with a question that incorporated the answer they received. In contrast, when receiving a non-explanation, they insistently re-asked the original question, disagreed, or provided their own explanation. These findings confirmed that young children actively seek causal information; they use specific conversational strategies to obtain it and in this process they prefer explanations over non-explanations. But this study, and others, leave many additional questions unanswered, including (a) whether children are sensitive to variation among explanatory responses and (b) what, if anything, children learn from the answers they receive. Prior investigations have distinguished several sorts of explanations and have found that explanations influence the school-based memory and learning of older children (Siegler, 2002)., Here we examine younger children and, importantly, their learning within quasi-naturalistic conversational exchanges.

In the current research, after providing situations that provoke children to request explanatory information, just as in Frazier et al. (2009), we systematically varied the type of answer given by an adult. Primarily, we were interested in (a) children’s preferences for different “levels” of explanation and (b) what children remember of differing explanatory versus non-explanatory answers to their questions. We examined explanations that differed in both length and amount of explanatory detail. Our aim here was not to precisely define “levels of detail,” but to use variation in responses to answers--all of which were explanatory--to better illuminate young children’s reactions to and learning from the explanations they receive.

Methods for Studying Children’s Reactions to Others’ Explanations

In instructional research with older children that measures the role of explanations in learning school-based information (e.g., from textbooks; Chi, 1978), children are read or hear texts and then either do or do not hear or generate explanations of the material. Later

they are given tests for the material, tests that essentially measure memory of the critical information. Memory for the information does not exhaust the measures of learning that might be used, but it provides an important and useful measure sensitive to explanation effects. In our study, children ask for (not merely get) explanations, and hear (not generate) explanations; and this is all done in everyday conversational contexts rather than formal, instructional ones. What they remember of the explanations they receive remains a good initial measure of learning, as remembering is a form of learning in its own right, and if children do not even remember what they have been told they cannot learn further from that information.

As shown by Frazier et al. (2009), children's reaction to explanations includes their relative satisfaction or dissatisfaction with the answers they receive. Such reactions are also important to understanding their memory and learning. For example, do children best remember the explanations they prefer, or do satisfaction (preference) and memorability substantially differ from one another? Children may well prefer some explanations over others but remember different ones instead (e.g., they may prefer longer ones but better recall shorter ones).

Because so little is known about these issues, we conducted an initial study where adults rated and recalled various responses, to create and validate materials for the focal child study. Informed by these adult responses, in Study 2 we provided targeted items and a range of responses to preschool children, to study their preferences and, importantly, their recall.

Study 1

Adults saw pictures that depicted expectation-violating situations and read target *why*-questions asking about the unusual aspect of the situation. Participants rated answers to the target *why*-questions then attempted to recall the answers they had received. There were four possible types of answers for each target *why*-question: one non-explanatory answer and three different explanations. Explanations included: (a) short explanations containing minimal causal information, (b) longer explanations with an intermediate level of information, and (c) elaborated explanations that were longest and provided the most information.

Explanations can differ in a variety of ways, including their depth and thus level of detail (Keil, 2006), their adequacy and probability (Lombrozo, 2012), and their empirical accuracy, scope, consistency, simplicity, and plausibility (Bonawitz & Lombrozo, 2012; Read & Marcus-Newhall 1993; Thagard, 2008). We did not attempt to distinguish these different factors. Instead, we began by intuitively devising three arguably different levels of explanations that might straightforwardly be related to children's memory and preferences, using adults' rating to help us in this process. Level-1 explanations were meant to provide minimal information, but were still explanatory. For example, given the question: "Why did she pour ketchup on her ice cream?" a level-1 explanation was, "It was a mistake." Level-2 explanations added more information, such as, "It was a mistake because she thought it was chocolate in the bottle." Level-3 explanations were still more elaborated, such as, "It was a

mistake because she thought it was chocolate in the bottle, because the ketchup bottle and the chocolate bottle look the same.”

We did not comprehensively define or vary the amount of information, nor did we precisely vary the length of each answer. But even imperfectly varying these factors can inform us about how children react to and remember a variety of explanations they might receive. Indeed, the conversational explanations analyzed by Frazier et al. (2009) suggested that young children do receive explanations that vary in these ways.

Method

Participants—Participants were 67 adult (mean age = 18.72 years, $SD = 0.92$, 31 females, 36 males) undergraduates at a Midwestern university. No personal information was collected from them..

Materials—Adults received a packet with color photographs of 16 unusual, question-provoking objects or situations. The items are listed in the Appendix (outlined via the parallel items used with children). Short written descriptions were included with each picture or set of pictures. Following each description was a specific *why* question that targeted the unusual aspect of each object/situation depicted, and one of four scripted answers.

For example, participants saw a photo of a hat with a hole cut in it. Written below this picture was the description, “This hat has a hole in it” and the target question, “Why does this have a hole in it?” Below that participants saw one of four answers:

Explanation Level-1: “The owner wanted it that way.” (short, minimal explanation)

Explanation Level-2: “The owner wanted it that way so her ponytail could fit through the hole.” (medium-length explanation)

Explanation Level-3: “The owner wanted it that way so her ponytail could fit through the hole, so she cut a hole in it with her scissors.” (longest, elaborate explanation)

Non-Explanation: “Hats don’t usually have holes in them.”

Participants saw one answer per item, but across their 16 items, participants saw four of each type of answer (level-1, level-2, and level-3 explanations, and non-explanations).

Presentation orders were scrambled so that types of answers were mixed across items for different participants, and not presented in any predictable order.

Procedure

Ratings: Adults went through the packet of stimuli three times to rate each answer on three separate scales (in this order): their satisfaction with each answer (on a scale of 1–6, ranging from “not at all satisfying” to “very satisfying”), whether or not the answer provided an explanation to the question (“yes” or “no”), and (with only a single answer visible at a time) their estimation of the length of that answer (on a scale of 1–6, ranging from “short” to “long”).

Recall: Following the ratings, participants completed a distractor task (a page of multi-digit multiplication problems) for 4–5 minutes, and then were given a packet with copies of all the picture stimuli (including the descriptions and target questions) and instructed to “recall the answers that were provided earlier as accurately as possible,” in writing. Recall presented items in a single order different from that of any participant's original stimuli.

Recall responses were scored based on how much they matched the content of the four different types of scripted answers. Answers were broken into segments based on the content added at each level of explanation, as shown in the Appendix. Thus, for the hat with the hole, three separable segments that were scored as present or absent for any participant's recall:

Segment-1: “The owner wanted it that way”

Segment-2: “So her ponytail could fit through the hole”

Segment-3: “So she cut a hole in it with her scissors.”

Level-1 explanations had only segment-1, level-2 contained segments-1 and –2, and level-3 contained segments-1, –2, and –3. Non-explanations were counted as having a single (non-explanatory) segment. Each segment was scored as recalled (1) or not (0). To get a 1, participants did not need to recall the segment verbatim, just the gist. Inter-rater reliability for coding recall of each different segment type on 20% of the data (segments-1, –2, –3, and NE) ranged from 95% to 98% agreement, with Kappas from .64 to .84.

Results and Discussion

Adults recognized differences in length among explanations, $F(3,198) = 809.59$, $p < .001$, $\eta^2 = .93$. Bonferroni comparisons showed that ratings of length significantly differed for each answer type ($p < .001$): level-1 explanations ($M=1.75$ on the 1–6 rating scale), non-explanations ($M= 2.56$), level-2 explanations ($M=3.85$), and level-3 explanations ($M=5.26$). The actual number of words for these levels averaged 4.3, 7.0, 11.1, and 20.0 respectively.

Identifying Explanations and Ratings of Satisfaction—Confirming our intuitions, 92.5% of the time, participants rated the *explanatory* answers as providing an explanation, but did so only 4.1% of the time for *non-explanatory* answers. Bonferroni comparisons showed that, adults rated level-1 ($p < .001$), level-2 ($p < .001$), and level-3 explanations ($p < .001$) as substantially more explanatory than non-explanations. Adults made no significant distinction between the explanatory value of level-2 and level-3 answers; both were rated as more explanatory than level-1 answers ($ps < .01$) but did not differ from each other. The same pattern occurred for adults' ratings of satisfaction with the answers.

Recall: Table 1 presents the percentage of the time adults recalled the explanatory segments and non-explanations. The table is organized with the different levels of explanation in the rows and the segments that make up each level of explanation in the first three columns.

Not surprisingly, adults often remembered the answers they received; even non-explanations were remembered correctly over 90% of the time. Nonetheless, adults remembered explanations better than non-explanations. Even the minimally explanatory segment-1

segments when heard in Level-1 explanations were recalled better than the non-explanations ($p < .05$). However, intriguingly, when the same segment-1s occurred as part of both level-2 and level-3 explanations, they were recalled significantly *worse* than the non-explanations, $ps < .01$. Instead, it was segment-2 segments within level-2 explanations that were recalled better than the non-explanations ($p < .05$). Moreover, segment-2 segments were recalled significantly better than segment-1s within both level-2 and level-3 explanations, $ps < .001$, as can be seen by comparing across the third and fourth rows in Table 1.

Selection of Items for Study 2—Given our materials, the modal adult ratings showed that (a) all three types of explanations were more satisfying than the non-explanations, (b) satisfaction increased from level-1 to level-2 explanations, but (c) ratings of satisfaction between level-2 and level-3 explanations did not differ. Ten of the 16 items conformed exactly to these patterns and 2 others did so closely. To create consistent materials for children, we exploited this feature: as shown in the Appendix, we used the 12 items that fit the modal pattern closely to create our explanatory items. The other four items became those for which children received non-explanatory answers

Establishing adult patterns of responses across items allows us to address several key questions with children. As two examples: Is even a “minimal” causal explanation that is quite brief (e.g., “Because she wanted to”) distinguished from a non-explanation, in children’s judgments or recall? And, to what extent are more expanded explanations most preferred and/or better remembered by children (as level-2 explanations were for adults)?

Study 2

In this focal study we presented preschool children stimuli that prompted them to ask questions, and then provided scripted adult responses to those inquiries. Following Frazier et al. (2009), our method rested on the finding that children’s satisfaction with different answers would be reflected in their conversational reactions to these answers. Thus, we expected that when children were dissatisfied with a response, they should be more likely to re-ask their original question or to provide their own explanation. In contrast, when children were satisfied, they should be more likely to agree with the answer or to continue the conversation with a new follow-up question based on the original answer.

Beyond Frazier et al. (2009), our focus also included children’s recall of the answers they received. Recall data provide an opportunity to measure whether explanatory information is better retained than non-explanatory information, and potentially which parts of extended explanations were most remembered. Recall of non-explanatory answers presented an opportunity to see if children would construct an explanation in place of the non-explanatory information they were given, perhaps demonstrating constructive memory processes (Signorella & Liben, 1984) where children’s drive for explanation further shape their memories.

Method

Participants—Sixty-nine 4-year-olds ($N = 36$; M age = 54.82 months, $SD = 3.57$ months; 17 girls, 19 boys) and 5-year-olds ($N = 33$; M age = 63.32 months, $SD = 2.93$ months; 12

girls, 21 boys) participated. They were recruited from preschools in a Midwestern university city and a smaller west-coast town. The preschools all encouraged active exploration and questioning. The communities were predominantly European-American, with mid- to high-level SES.

Materials—Materials were the same as those used in Study 1, but presented in an interactive, rather than paper-and-pencil format. To sustain children’s interest, four items were presented as real objects (e.g., a box of crayons of all the same color, a hat with a hole in it), four were presented in storybook format (e.g., a story about a child who poured orange juice instead of milk on his cereal), four were photos (e.g., depicting a bird’s nest containing two baby birds and a turtle, a normally dressed man wearing a clown nose), and four were short videos (e.g., a woman turning off a light with her foot, a different woman jumping on her hat). All items are detailed in the Appendix. To ensure full processing of the videos, each was repeated three times.

Procedure—Children were tested and videorecorded individually by an adult interviewer in a quiet room at their school. After explaining, “I brought some toys from my house to show you today,” the experimenter used a short warm-up activity 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 of the adult’s questions about a toy car with an unusual hook attached to it. These questions included one non-causal question, “What is that?” and one causal *why* question, “Why does it have a hook on it?”

Participants were then presented with the objects, storybooks, pictures, and short videos, in the same scrambled order for all children. Each item began with a short introductory statement, with no mention of the unusual aspect of the item. For example, “This is my brand new hat,” or “Can you help me put this puzzle together?” When the child demonstrated recognition of the unusual aspect of the item, the researcher responded by giving one of three types of explanations or a non-explanatory answer (see Appendix). The adult responded to children’s direct causal questions, as well as to implicit strategies that children used to request explanations, such as voicing a statement with a quizzical or surprised intonation, accompanied by glances to the adult (e.g., saying, “Hey, she used her foot!” when encountering the video of the woman turning off the light switch with her foot). We term this second type of child response “requestive” statements; they operate pragmatically as requests for the adult to explain what the child commented on, as validated empirically in Frazier et al. (2009).

If the child did not at first explicitly ask for an explanation (via a question or requestive), the adult mildly prompted with, “Is there anything funny about this?” The adult provided an explanatory response only if the child asked for one via a question or a requestive; if not, the adult moved to the next item. Thus, not all children received adult responses to every item.

As derived from Study 1, explanations reflected three different levels, which were varied across 12 of the 16 items using a repeated sequence that varied across children (e.g., level-3, then level-1, then level-2; or level-1, then level-3, then level-2; etc.), such that the order of

levels was roughly counterbalanced over participants. For the other four items, the adult provided a non-explanation. Non-explanations were given for the fourth, eighth, twelfth, and sixteenth items (given that the child asked for explanation for that item). The non-explanatory answers included restatements (e.g., “All the other pieces fit in this puzzle”), normative descriptions (e.g., “Hats don’t usually have holes in them”), or descriptive details (e.g., “That bed is very comfortable”). After giving their response, the adult paused to allow time for the child’s reaction..

To allow recall of non-explanations at the end of the study, when the child received a non-explanation and re-asked their original question (or continued to demonstrate curiosity about the unusual aspect of the item), the researcher provided no additional information instead saying, “That’s a good question. Let’s see the next thing I brought?”

After all items were presented, children engaged in a 4-minute distractor task looking for objects (none the test items) hidden in pictures. Then the child saw eight small color pictures each depicting an item from earlier and heard a reminder of its unusual aspect (e.g., “Remember these crayons were all orange.”). Children were asked to recall the answer given for that item (e.g., “Do you remember what I said about why they were all orange?”). So that the recall task would not be too long or demanding, recall was tested for eight items per child, two items of each type of explanation and two non-explanations. Where possible, recall tested items for which the child had asked a question initially, rather than had used a requestive statement.

Coding

Coding child reactions: The videorecorded conversation between the child and researcher was transcribed and children’s reactions were coded into one of nine categories, as outlined below. Focally, in accord with children’s responses in Frazier et al. (2009), we expected that children would be more likely to re-ask their questions (showing continued curiosity) or provide their own explanation (showing dissatisfaction with the information provided) upon receiving an answer they were not satisfied with. Conversely, if children were given a response they found satisfying, we expected that they would be more likely to agree or to ask an additional question that was different from the original question, but building on the same topic (showing satisfaction via further interest in the explanation). Thus these four types of responses constitute our key coding categories (listed below with examples):

1. *Agreeing with the adult*, including nodding head or saying “oh”
CHILD: “She turning off the lights with, with her foot,” ADULT (level-2 explanation): “She didn’t want to use her hands because they were sticky,”
CHILD: “Oh.”
2. Asking a follow-up question
CHILD: “Does this open?” ADULT (level-1 explanation): “It’s stuck,” CHILD: “How’d it get stuck?”
3. Re-asking the original question

CHILD: “Why’s his bed outside?” ADULT (non-explanation): “That bed is very comfortable,” CHILD: “But why is it outside?”

4. Providing own explanation

CHILD: “Why’d she do that?” ADULT (non-explanation): “People don’t usually jump on hats,” CHILD: “Maybe she didn’t like that hat.”

Additional categories were also included to provide information about the range of children’s reactions: 5) smiles or laughs, 6) disagrees with adult response, 7) provides additional on-topic details, 8) changes topic or asks for next item, and 9) no response. Use of a question or a requestive statement to acknowledge the unusual aspect of the stimulus was also coded.

For a sample of 20% of the responses, across all nine child reaction coding categories, there was 86% agreement between two independent coders, with a Kappa of .80. Reliability for each child reaction coding category ranged from 93% to 99%. Kappas for all individual categories were at least “substantial” (.61 to .80), and 33% were “almost perfect” (.81 and above, according to descriptive levels of Landis and Koch, 1977).

Recall coding: Children’s answers were coded for the presence/absence of different segments provided by the researcher, using the same coding scheme as in Study 1. Two persons independently coded a randomly selected sample of 20% of the data, with 95% inter-rater agreement, Kappa = .80. Reliability for segments-1, -2, -3, and NE ranged from 96% to 100%, with Kappas ranging from .78 to 1.00.

Results

Across the 16 items, children asked an average of 3.88 questions and made requestive statements an average of 11.75 times, for a total average of 15.63 requests for explanation. The adult provided the child with an average of 3.94 level-1 explanations, 3.87 level-2 explanations, 3.93 level-3 explanations, and 3.90 non-explanations in response to the child’s requests, thus providing the four different answers each about 25% of the time.

Do Children React Differently to Explanations versus Non-Explanatory

Answers?—Because children asked for explanations for differing numbers of items, we calculated proportions for each child’s reactions by dividing the frequency of each type of child reaction by the number of explanations (or non-explanations) that that child received for the relevant item type. Recall, our predictions were that children would more likely re-ask their questions or provide their own explanations upon *not* receiving an explanation, whereas they would more likely to agree or to ask a follow-up question building on the same topic after receiving an explanation. Indeed, Bonferroni comparisons ($ps < .05$) showed they did so. These patterns in children’s reactions were consistent across a majority of children. Of the 47 children who reacted at least once by agreeing or nodding their heads, 32 did so relatively more often following an explanation than following a non-explanation ($p < .05$, binomial test). For the 41 children who asked at least one follow-up question, 37 did this relatively more often in response to an explanation than in response to a non-explanation ($p < .001$). Conversely, for children who reacted at least once by re-asking their original

question, 31 out of 33 did so relatively more often when they received a non-explanation ($p < .001$); 13 out of the 16 children who provided their own explanation did so relatively more often following non-explanations ($p < .05$). The same patterns held whether children initially asked a question or whether they made a requestive statement.

Children's Reactions to Explanations that Vary in Amount of Detail—The above results replicate Frazier et al. (2009). Going beyond that, we examined whether children reacted differently to different levels of explanatory detail. For this analysis, we calculated proportions for each child by dividing the frequency of child reactions following a given explanation type by the number of explanations of that type that the child had received (e.g., the frequency of each type of child reaction following level-1 explanations divided by the number of level-1 explanations the child received) as shown in Table 2.

Child reactions following the four types of adult responses differed, $F(24, 1608) = 7.43$, $p < .001$, $\eta^2 = .10$. All levels of explanation were typically preferred over non-explanations. As shown in Table 2, there are 12 potential comparisons between explanations (the 3 levels times the 4 responses) and non-explanations—9 of those 12 are significant. Level-2 explanations in particular were favored over non-explanations for each of the four key reaction categories. Moreover, Bonferroni comparisons revealed that children were significantly more likely to agree with level-2 and level-3 explanations than with level-1 explanations, $ps < .05$, and the same pattern appeared for smiling or laughing in response to a level-2 or level-3 explanation compared to a level-1 explanation or a non-explanation ($ps < .05$). Thus, like adults, children's satisfaction (demonstrated by agreement and smiling) increased up to a point (level-2 explanations), at which providing additional information did not increase satisfaction further.

Children's Recall—Table 3 presents child recall in a manner comparable to adult recall in Study 1. Non-explanatory responses were poorly (18.8%) recalled, and explanations were recalled considerably better. In particular, as shown in Table 3, children remembered segment-1s from level-1 explanations, segment-2s from level-2 explanations, and both segment-2s and segment-3s from level-3 explanations, significantly better than the non-explanatory answers, $ps < .05$.

Child recall of the different explanatory segments varied systematically, as revealed in a series of planned comparisons. Recall of segment-2s was significantly better than recall of segment-1s within both level-2 and level-3 explanations, $ps < .001$ (see the third and fourth rows of Table 3). Within level-3 explanations, child recall of segment-2s was also significantly better than recall of segments-3s, $t(48) = 3.66$, $p < .01$. Thus, children's good recall of segment-2s in the level-2 explanations is not just because that segment was the last part heard (i.e., even when the segment-2s were in the middle of the level-3 explanations, they were frequently recalled most). In sum, children did not simply recall explanatory over non-explanatory responses, they found certain explanations more compelling and memorable than others.

Altering the non-explanations to be explanatory: On 40.3% of trials children misremembered the non-explanation as if it were an explanation (adding "because" 7.2% of

the time and/or coming up with an actual explanatory account 33.1% of the time). For example, given the item where a boy puts on a hat, scarf, and gloves to go outside on a hot day, and the non-explanation, “He’s wearing all his winter clothes,” several children recalled this response as “Cause he thought it was winter.” Children seemed to expect an explanation, and so tended to mis-recall the experimenter’s non-explanation as if it were explanatory.

Discussion

Confirming the results from Frazier et al. (2009), children reacted differently and appropriately to explanations versus non-explanations, in terms of satisfaction with the answers they received. Going further, even the short, less-detailed level-1 explanations were recognized by children to be explanations. In comparison to non-explanations, these level-1 explanations inspired significantly more follow-up questions and fewer re-asks of the original question. Note that this result provides strong evidence that children do not merely prefer longer answers to shorter ones, because the level-1 explanations were actually shorter on average than the non-explanations. Of course, children do not just prefer shorter answers either, because they typically agreed most with the long level-2 and -3 explanations they received. This confirmation that children genuinely prefer explanations in response to their apparent everyday explanation-seeking, as found by Frazier et al. (2009), is of note, given the increased recognition within psychology of the value of replication.

Importantly, explanatory information was not just more satisfying than non-explanatory information, but also better remembered. Not only level-1 explanations but also level-2 and -3 explanations (that consisted of many more words than the non-explanations) were far better remembered than non-explanations. Using recall as a measure, these data show that children learn from the explanations they receive; given an explanation, they are likely to recall it (as seen in absolute levels of recall of up to 60–70% in some of the cells of Table 3).

Children’s inaccurate recall of non-explanations as explanatory adds further support to the idea that children are specifically motivated to seek explanations. In these explanatory intrusions, children apparently expected to receive an explanation, because even when they did not, they misremembered the adult’s response as if it were explanatory. Actually receiving an explanation importantly influenced memory, however. Although the recall question implied that an explanatory response had been given (e.g., “Do you remember what I said about *why* the puzzle piece did not fit?”), children who received a non-explanatory answer for an item typically responded by saying that the researcher had not told them this information.

Comparing different levels of explanation, children (like adults) showed a non-linear relationship between satisfaction and the amount of detail provided in the explanations, and between the amount of detail and what was remembered. Moderate length explanations (level-2) were more satisfying than shorter explanations (level-1), yet including more information (level-3) produced no additional satisfaction. Correspondingly, segment-2 segments within the level-2 *and* level-3 explanations seemed to be especially memorable. Of course, because we chose explanation “levels” that evidenced this pattern in the adult data, we cannot determine the generalizability of these results. However, the items themselves do

not force such a pattern: for example, children could have preferred the longest explanations, and could have better remembered the shortest explanations.

General Discussion

Our data, coupled with those of Frazier et al. (2009), confirm that preschool children actively seek explanatory information within conversations with adults. In response to their inquiries, preschoolers showed satisfaction when they received explanations, and continued inquiry when they received non-explanatory answers, and sometimes also showed a preference for explanations by reconstructively recalling non-explanatory responses as explanatory.

Going further than Frazier et al. (2009), we now show that preschoolers not only seek explanatory information, they learn from it in the sense that they recall that information later. Explanatory value shaped their recall beyond sheer volume of the information provided: They recalled explanations considerably better than non-explanations--whether those explanations were longer or shorter than the non-explanations.

Our study adds to a small set of recent findings exploring how children learn from explanations (Legare & Lombrozo, 2014; Walker; Lombrozo, Legare & Gopnik, 2014). Two notable aspects of our procedure are that children themselves initiated the provision of explanatory information, and the data reflect their genuine, unprompted reactions to the information provided by the adult. Lombrozo, Legare and their colleagues instead had children explain a novel mechanical toy, and this self-explanation affected their subsequent recall and inferences. Our methods and results provide insight into how children process and potentially learn from the information they receive from adults in their everyday lives. Moreover, our semi-naturalistic method, using a variety of items children encounter in their ordinary lives—stories, pictures, objects, and the like—allowed us to examine how adult explanations influence children’s learning in more everyday circumstances than allowed by a focus on single, contrived machine-like devices.

Additionally, varying the explanations as we did provided initial evidence that children do not treat all explanations as equivalent, but find some explanations more satisfying and memorable than others. Specifically, these preschoolers preferred level-2 explanations, which were intermediate in both length and amount of information. Because the different levels were intuitively generated, they do not reflect any precise analysis of “amount of information” or of “levels of detail,” explanatory depth, scope, or the like. Moreover, we cannot rule out the possibility that these levels are conflated with other factors unrelated to explanatory detail (e.g., the extent to which they invoke explanatory mechanisms or motivations). However, given these provocative results, an important question for future research is what factors might underlie the apparent special value and memorability of the level-2 explanations, for children?

One possible factor is that level-2 explanations merely represent an optimal *length* of response (neither too short nor too long). However, our results tentatively argue against response length as the sole or primary account. The non-explanations were longer than the

level-1 explanations, and closer in length to level-2 explanations, yet were less satisfying and remembered less well. Moreover, in an informal inspection of children's responses, items with longer level-1 explanations (with lengths closer to the range for level-2 explanations) were not systematically preferred or remembered better than the shorter level-1 explanations.

A possible alternative interpretation would instead focus on something special about the nature of the information or content provided in the level-2 explanations and their segment-2 segments. For example, when we more closely scrutinized the explanations (see those in the Appendix) in a post hoc fashion, it seemed to us that the segment-1s, although functioning as explanations when presented alone in level-1 explanations, typically served merely to situate the explanation within a domain or framework. For example, "I wanted it that way" and "She didn't mean to" signal psychological causes, whereas "It's stuck" and "Regular doors are too big for Julia" signal physical causes. If this is a sensible interpretation of many of our segment-1 segments (that they establish a general frame), then within the framework they outline, those segments also seem to prompt a further question of *why* "it's stuck" or *why* "I wanted it that way." The segment-2 segments might then tend to provide a more specifiable answer to such questions, by presenting information about the underlying "purpose," "rationale," or "cause." In contrast (and here length might play an important role) the additional details provided in the E3 segments might just overtax children's memories.

These speculations prompt future research to further understand how children process and learn from the variety of explanations they receive, explanations that inevitably differ in length, detail, and content. But that open agenda should not detract from our primary results, including that children learn from the explanations they receive, at least in the minimal but important sense that they recall them. Moreover, children's recall tends to closely follow their explanatory preferences. They are more satisfied with explanations than non-explanations, and they recall explanations better as well. They tend to prefer explanations that are moderate in length and level of information (within the variations we provided) and they tend to remember those explanations better as well. This is an intriguing finding, with or without a firm conceptual analysis of levels of explanation, because children could easily find one sort of explanation most satisfying when they hear it (e.g., prefer longer explanations or those that seem packed with details) but better recall quite different ones (e.g., better recall short explanations with minimal detail). Instead we demonstrate that young children tend to better recall the explanations that they find more satisfying, and vice versa.

A limitation of our recall data, of course, is that recall was tested after a single, relatively brief interval (approximately 5 to 20 minutes, depending on when (early or late) an item was first presented in the child's procedure). Future studies should examine how children remember and learn from the explanations they receive over longer delays. A further limitation is that the participants were recruited from predominantly European-American, mid- to high-income communities, where the cultural context is one that supports and encourages children to ask questions and initiate conversations with the adults around them. In other cultural contexts where the expectations and norms for interacting with adults are different (e.g., Heath, 1983), children may use different strategies for obtaining explanatory

knowledge, such as keenly observing the behaviors or others, or requesting information from peers. Nonetheless, children from the backgrounds we studied not only asked causal questions, they cared about the answers they received. Thus, they preferred even brief, non-specific explanations over non-explanations. These systematic preferences influenced children's causal learning, evident in their differential recall of the information they heard. Through their questions and explanatory preferences, children not only seek and receive explanations, they acquire information about the world.

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Appendix

Items for both Studies and Coding Scheme for Recalled Answers

	Segment-1: Explanation with low level of detail ^a	Segment-2: Explanation segment added to provide medium level of detail ^a	Segment-3: Explanation segment added to further provide high level of detail ^a	Non-explanatory answer
1. crayons Box of crayons that are all one color	It was a <u>mistake</u> ^b Also: didn't mean to, goof, error, shouldn't, accident, got mixed up	in <u>packaging</u> at the crayon <u>factory</u>	the <u>machine</u> put all the <u>same</u> <u>color crayons into one</u> <u>box</u> Must include mention of machine OR all the same color ending up in one container	They are all the same color.
2. hat Hat with a hole in it	I <u>wanted</u> it that way Also: need	so my <u>ponytail</u> <u>could fit</u> <u>through the hole</u> Give credit for “for your ponytail”	so I <u>cut</u> a hole in it with <u>my</u> <u>scissors</u> Also: ripped it, anything about how hole was put there	Hats don't usually have holes in them.
3. phone Clam-shell cell phone	It's <u>stuck</u>	because <u>somebody</u> <u>spilled glue</u> on it	the <u>glue ran into the</u> <u>crack</u> and <u>pasted it together</u>	It looks like a young girl's cell phone.

that will not open		Also: it was glued	Must include something about where the glue went OR information about how it was stuck together; "in it" alone is not enough.	
4. puzzle Puzzle with piece that does not fit *				All the other pieces fit in this puzzle.
5. ketchup Story about a girl who puts ketchup on her ice cream	It was a <u>mistake</u> Also: didn't mean to, goof, error, shouldn't, accident, didn't know	because she <u>thought it was chocolate</u> in the bottle Also: didn't know	because the ketchup bottle and the chocolate bottle look the same	That looks like vanilla ice cream.
6. clothes in bed Story about a girl who goes to sleep with her clothes and shoes on	She <u>didn't mean to</u> Also: mistake, goof, error, shouldn't, forgot, didn't want to	but she was <u>really tired</u> so she fell asleep without <u>changing</u> Any of the three parts is enough for credit. Also: didn't change	into her <u>pajamas</u>	Some people sleep under lots of covers when they go to bed.
7. orange juice Story about a boy who puts orange juice on his cereal	He <u>wanted</u> orange juice Also: need	because milk <u>makes him sick</u> Also: doesn't taste good, doesn't like milk, allergic, tummy ache	so he <u>has to</u> have his cereal with <u>juice</u> instead	Most people put milk on their cereal.
8. winter clothes Story about a boy who wears hat, scarf and gloves in hot weather *				He's wearing all his <u>winter clothes</u> .
9. turtle/nest Picture of a turtle in a bird's nest	He <u>crawled in</u> there Also: crawled up, climbed in, went in	because he was looking for <u>something to eat</u> Also: hungry, wanted to eat, food	he <u>couldn't see</u> what was in the nest Also: didn't know what was in there	He is in a bird's nest.
10. door Picture of a miniature door	Regular doors are <u>too big</u> for Julia Should include mention of Julia's size, "she's little" OK.	because she's a <u>mouse</u> Also: rat	she <u>can't reach</u> the doorknob on a big door	Doors are usually much bigger than that.
11. nose Picture of a normally dressed man wearing a red nose	He works as a <u>clown</u>	he forgot to <u>take it off</u> Also: left it on, still on, didn't take off	because he didn't <u>look in the mirror</u>	People don't usually wear red noses like that.
12. bed Picture of a bed outside a house *				That bed is very <u>comfortable</u> .
13. light switch Video of a girl who turns off a light	She didn't <u>want to use her hands</u>	because they were <u>sticky</u>	because some <u>jellysquished</u> out of her sandwich	She's wearing a pretty blue shirt.

switch with her foot	Also: didn't feel like using her hands		Should include the cause of the sticky hands, any food is fine.	
14. spin Video of a girl who spins while walking down a hallway	She's practicing Also: training, getting ready	so she will be ready for her danceclass Also: to be a dancer, dance moves, for dance, dance routine, for a dance, ballet, recital	because when she practices she gets better	She looks like she's going fast.
15. bucket Video of a girl who puts a bucket on her head instead of a hat	She's pretending Also: thinking, wanted, trying, to act as	the blue bucket was a fairy crown Also: bucket as a hat	so she could be a beautiful fairy princess Give credit for "to be a fairy"	She didn't put the hat on her head.
16. hat stomp Video of a girl who takes off her hat and jumps on it *				People don't usually jump on hats.

^aLevel-1 explanations had only segment-1, level-2 contained segments-1 and -2, level-3 contained segments-1, -2, and -3. Participants never heard segments-2 or -3 alone; those separated segments were only considered in assessing recall.

^bUnderlines show the crucial information for assessing gist recall. The additional unbolded comments show further considerations for assessing gist recall.

* Children received only the non-explanations, as shown, for the four items marked with an *. Adults heard one of four different types of answer for these items, just as for all other items.

Table 1

Percentage of Times Adults (N = 67) Recalled Each Answer Segment in Study 1

	E1 Segment	E2 Segment	E3 Segment	NE Segment
Non-Explanations (NE)	-	-	-	90.3 (0.15)
Low Detail Explanations (Level-1)	98.0 * (0.07)	-	-	-
Medium Detail Explanations (Level-2)	79.1 * (0.19)	96.9 * (0.10)	-	-
High Detail Explanations (Level-3)	68.9 * (0.26)	89.8 (0.13)	82.7 (0.21)	-

SDs are in parentheses.* Significant differences between recall of the explanatory segments and recall of the non-explanation, $p < .05$.

Table 2

Percentage of Child (N = 69) Reactions Following Adult Explanations versus Non-Explanatory Responses in Study 2

Child Reaction	Adult Response			
	Low Detail Explanation (Level-1)	Medium Detail Explanation (Level-2)	High Detail Explanation (Level-3)	Non-Explanatory Response (NE)
Agrees, nods head, or says “oh”	10.9 ^a (0.21)	19.9 ^{b *} (0.27)	18.2 ^b (0.24)	10.2 (0.17)
Asks a follow-up question	16.9 [*] (0.24)	11.6 [*] (0.19)	12.3 [*] (0.21)	2.9 (0.09)
Re-asks original question	1.9 [*] (0.08)	1.1 [*] (0.07)	0.3 [*] (0.03)	18.0 (0.25)
Provides own explanation	1.8 (0.07)	0 [*] (0.0)	0.7 [*] (0.04)	4.9 (0.10)
No response	40.6 (0.34)	37.0 (0.32)	34.4 (0.31)	39.0 (0.31)

SDs are in parentheses.

Contrasting superscripts (a, b) *within a row* indicate significant differences between the three different explanation types, $p < .05$.

^{*} Significant differences between an explanation type and the non-explanatory responses, $p < .05$.

Table 3

Percentage of Times Children (N = 69) Recalled Each Answer Segment in Study 2

	E1 Segment	E2 Segment	E3 Segment	NE Segment
Non-Explanations (NE)	-	-	-	18.8 (0.30)
Low Detail Explanations (Level-1)	67.8 ^a (0.35)	-	-	-
Medium Detail Explanations (Level-2)	29.0 ^a (0.30)	71.7 ^{b, *} (0.35)	-	-
High Detail Explanations (Level-3)	27.1 ^a (0.31)	57.7 ^{b, *} (0.36)	32.4 ^{a, *} (0.36)	-

SDs are in parentheses.

Contrasting superscripts (a, b) indicate significantly different pairwise comparisons *within a row*, $p < .05$.

* Significant differences between recall of the explanatory segments and recall of the non-explanation, $p < .05$.