Little Pitchers Use Their Big Ears: Preschoolers Solve Problems by Listening to Others Ask Questions

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Children ask questions and learn from the responses they receive; however, little is known about how children learn from listening to others ask questions. Five experiments examined preschoolers' (N = 179) ability to solve simple problems using information gathered from listening to question-and-answer exchanges between 2 parties present in the same room. Overall, the ability to efficiently use information gathered from overheard exchanges improved between ages 3 and 5. Critically, however, across ages children solved the majority of problems correctly, suggesting preschoolers are capable of learning from others' questions. Moreover, children learned from others' questions without explicit instruction and when engaged in another activity. Implications for the development of problem-solving skills are discussed.

As adults, we sometimes rely on others to ask questions in order to obtain information. For example, as voters, we rely on our representatives to ask meaningful questions to candidates during presidential debates, and the information that we learn has the potential to influence our voting decisions. As jurors, we rely on attorneys to ask witnesses questions that reveal evidence regarding a suspect's guilt. Indeed, in many situations, we learn from listening to others garner information through questions. Whether we are relying on others because we do not have access to the sources we wish to question, because we lack the expertise to formulate appropriate questions, or because we do not even know that there is a question that should be asked, it is clear that adults are adept at obtaining information from the answers to other people's questions. Although children face similar situations, such as listening to a sibling question a parent or a classmate question a teacher, it is unclear when young children begin to detect the utility in the information that they gather incidentally. How successful are preschoolers at learning from the responses to questions asked by others?

At the minimum, young children frequently ask questions themselves. Even children as young as 26 months use questions with the words *where* and *what* in conversations to obtain specific information, and this could be considered a form of problem solving (Bloom, Merkin, & Wootten, 1982). For instance, a child might want to find her teddy bear, and so she might ask, “Where is teddy?” Children’s initial questions are often modeled from adults (e.g., “What dat”; Brown, 1968), and perhaps in part due to recognizing the utility of their questions, they begin to expand their use of question words. In fact, by age 3, children have typically added who, how, and why questions to their repertoire (e.g., Bloom et al., 1982; Brown, 1968; Hood & Bloom, 1979; Tyack & Ingram, 1977).

Although preschoolers’ questions may serve many purposes, such as to get attention or to continue an interaction, they often ask questions to seek information (Callanan & Oakes, 1992; Frazier,
Gelman, & Wellman, 2009; Greif, Kemler Nelson, Keil, & Gutierrez, 2006; Hickling & Wellman, 2001; Kemler Nelson & O'Neil, 2005). For instance, 4- and 5-year-olds can use questions as a tool to determine which of two objects is inside a box (Chouinard, 2007). Five-year-olds can also direct questions to appropriate informants to solve simple problems (Mills, Legare, Bills, & Mejias, 2010; Mills, Legare, Grant, & Landrum, 2011). However, preschoolers are not always successful in their questioning; younger preschoolers in particular sometimes have difficulty using questions to help them solve problems. Mills and colleagues found that although 3- and 4-year-olds can sometimes decide which of two informants to query for a given problem, they often struggle to generate suitable questions for solving the problem. For instance, they ask questions that are not relevant to the topic at hand or that do not narrow down the possible solutions (e.g., Mills et al., 2010). Still, even though preschoolers sometimes struggle to identify and ask suitable questions, they may be able to learn effectively from sources that are skilled at asking questions and extracting useful information.

So how much do children learn from listening to third-party exchanges? Many have argued that children benefit from "listening in" on the interactions and activities of others (Rogoff, Paradise, Mejia-Arauz, Correa-Chavez, & Angelillo, 2003). For instance, children learn some concepts from modeled examples without explanations (like how to play certain games; Zimmerman & Rosenthal, 1974), and under certain conditions they can learn new vocabulary words (Rice & Woodsmall, 1988) and new skills (Strouse & Troseth, 2008) from watching people on television or video. Two-year-olds, and sometimes 18-month-olds, can learn object labels and actions for engaging objects by observing others (Akhtar, 2005; Akhtar, Jipson, & Callanan, 2001; Floor & Akhtar, 2006). In fact, 2-year-olds are able to learn words through overhearing an interaction even in the presence of a potentially distracting activity or in situations lacking key social cues, such as child-directed speech (Akhtar, 2005; Shimpi, Akhtar, & Moore, 2009). That said, learning from overhearing may not always be easy for 2-year-olds; past studies have typically involved children overhearing one word label used as many as nine times in association with an object, and it is unclear how successful they would be at learning from fewer repetitions.

It is clear that in some circumstances, preschoolers can learn new words and actions from watching the interactions of others, but what about learning from question-and-answer exchanges? Much of the research related to children’s learning from listening to questions has focused on school-aged children. Children do ask questions in the classroom, but their questions are often simple; for instance, questions by younger elementary school-aged children focus mostly on clarifying procedures and getting attention from the teacher as opposed to obtaining causal explanations or obtaining deeper information for problem solving (Good, Slavings, Harel, & Emerson, 1987). When children and adults do not have the knowledge or ability to ask effective questions on their own, they may benefit from hearing others ask questions. For instance, there is evidence that hearing questions asked by others helps school-aged children and adults recognize the gaps that exist in their own knowledge (Chin & Brown, 2002; Choi, Land, & Turgeon, 2005; Mills & Keil, 2004; Rozenblit & Keil, 2002). In addition, research supports that even college students who are novice learners in a particular domain benefit from witnessing others ask questions (Choi et al., 2005).

Although learning from hearing others ask questions and receive answers may be useful to children, it is also possible that this kind of learning is quite difficult for them. In general, both adults and children have been shown to learn and remember self-generated information better than other generated information (e.g., Foley, Johnson, & Raye, 1983; Greenwald & Banaji, 1989; Howe, 2006; Symons & Johnson, 1997). Memory traces may also be stronger and more cohesive when one has generated information on one’s own (e.g., Howe, 2006; Raye, Johnson, & Taylor, 1980). In fact, Ross and Killey (1977) found that third and fourth graders remember answers to their own questions better than answers to someone else’s questions. Consequently, it is possible that information obtained from question-and-answer exchanges that are not produced by the child may be more difficult for the child to remember and learn from than information obtained from self-generated questions.

Indeed, the act of learning from listening may present children with multiple challenges. When learning from overhearing others name objects, children must associate spoken word labels with the objects to which they refer. This requires children to shift attention when a novel label is presented to determine the referent. Learning from question-and-answer exchanges may be more complicated. The child must keep track of the question asked, infer the correct answer from the response, and potentially act on the correct answer. Each step of the process is likely to take considerable cognitive and attentional resources. For instance, children must
focus on what the questioner was asking and the response, while disregarding what they themselves might have asked or be thinking. This may be particularly difficult for a question that receives a response of “no.” In these situations, children must encode the question, and then later recode this information as they gather evidence about the veridicality and usefulness of the question. Even if the “no” response helps eliminate or narrow down alternatives to come toward a correct answer, it may be more difficult to put aside the content of the original question. Indeed, in other tasks involving contrasts between positive and negative tests of information (e.g., positive and negative diagnostic tests), children have more difficulty with negative tests than positive tests (Samuels & McDonald, 2002).

Although learning from listening to others is a critical component of obtaining information, little is known about how this ability develops. Given that the quality of preschool-aged children’s questions is sometimes poor and of limited value for obtaining information (see Mills et al., 2010), and that children are likely to be exposed to more effective questions posed by adults and peers, it is essential that we understand how young children process and learn from the questions and answers they overhear.

To better understand children’s learning from hearing others ask and answer questions, the current research used a focused problem-solving task. Five experiments examined 3- to 5-year-old children’s ability to listen to a question-and-answer exchange between two parties and infer the correct answer to simple problems. The experiments varied with respect to the phrasing and specificity of the questions, the answers given (e.g., “yes” or “no”), and the degree of instruction children received to pay attention to the third-party exchange (ranging from explicit instruction to none at all).

Overall, we expected developmental improvements in children’s ability to use question and answers to solve problems for two main reasons. First, 3-year-olds sometimes struggle to generate effective questions themselves in problem-solving tasks (Mills et al., 2010; Mills et al., 2011), which suggests that they may also have trouble recognizing good questions and applying the overheard information. Second, 3-year-olds may lack the cognitive resources required to successfully integrate and apply overheard information into problemsolving behaviors. That said, we also predicted that while there would be developmental improvements, preschool children overall would frequently be able to learn from listening to others ask questions, again for two main reasons. First, even 2-year-olds can learn word labels from overhearing them repeated multiple times (e.g., Akhtar, 2005). Second, though learning from question-and-answer exchanges is more demanding than learning word labels, the cognitive requirements of this task were still fairly low in that children were not required to generate questions. Finally, we predicted that question type would potentially influence children’s ability to apply overheard information, given that preschool-aged children may learn to integrate and encode positive evidence earlier and more effectively than negative evidence (e.g., Samuels & McDonald, 2002). Thus, we expected children to find the questions with “yes” responses more informative and straightforward and consequently apply those answers to solving the problem more often than questions with “no” responses, as they require an additional inferential step.

**Experiment 1**

In Experiment 1, children were presented with a game focused on identifying the contents of special boxes, and they were told to listen to the confederate ask questions to learn what was inside each box. During the task, children listened to the confederate ask direct questions stating one of the two options for each box (e.g., “Is it the pig?”). The experimenter responded to each question with a puppet by stating “yes” or “no.” Puppets were used in the following experiments to keep children engaged in the tasks.

**Method**

**Participants.** Sixteen 3-year-olds ($M = 3.40$ years; six females) and sixteen 4-year-olds ($M = 4.51$ years; seven females) were recruited from preschools in a suburban area in Texas to participate in this study. The sample reflected the distribution of ethnic groups in the community: approximately 82% Caucasian, 12% African American, and 6% Other. Children were primarily middle to upper class. Children were tested in a quiet room; each session took 10–15 min and was digitally recorded. Two additional children participated but were dropped from the final sample due to attention difficulties and being unable to complete the study because of missing eyeglasses.

**Materials.** There was one training pair of stimuli (a pig and a banana), and eight test pairs. All pairs were presented as $2 \times 3$ in. colored drawings. The
pairs included a bird and a block, a tree and a cup, a car and a butterfly, an apple and a truck, a bottle and a flower, a ball and a cat, a dog and a hat, and a horse and a spoon. The stimuli were designed to be maximally distinguishable. Each pair included two visually dissimilar and conceptually diverse objects (i.e., each pair consisted of a natural kind and an artifact). An identical copy of one picture from each pair was inside each box.

Training. Each experimental session consisted of a training phase and a test phase. After several minutes of rapport building, the experimenter told the participants they would be playing the question game. The experimenter explained that the purpose of the game was to figure out what was inside some special boxes. All the boxes were placed on the table and out of the child’s reach. Then, the child heard a short conversation between an experimenter, a puppet (“Giraffe”) controlled by the experimenter, and a female adult confederate (always referred to as “Sally”). During the conversation, children were told that the boxes on the table belonged to the puppet, who knew all the items contained in them. Children were also told that the confederate would be asking the puppet questions to learn about the items in the boxes. Finally, children were instructed that it would be their job to listen to the confederate’s questions and decide what was inside the boxes based upon the puppet’s answer.

Next, the experimenter pulled two pictures from the envelope attached to the training box (a different color from the other eight boxes), and placed the box and pictures (a pig and a banana) directly in front of the child. Children were asked to identify each picture by pointing in response to the experimenter’s questions: “Which one’s the pig?” and “Which one’s the banana?” Then, children were told that one of those things, the pig or the banana, was inside the box. Finally, children were reminded that Giraffe knew the contents of the box.

Children were then told that they were going to listen to a question about a practice box. Sally said, “I’m going to ask a question. Giraffe, is it the pig?” The puppet responded by nodding and saying, “Yes.” The experimenter then asked the child, “Which one do you think is inside the box?” If children provided no verbal response, the experimenter said, “Can you point to the picture of the thing that’s in the box?” If children still provided no response, the experimenter said, “One of these pictures [while pointing at each picture] is inside this box. Is it the pig or the banana?” After the child’s response, the experimenter pushed the chosen card closer to the box. The experimenter then opened the box to reveal the pig inside, stating, “Look, you said a [child’s choice] was inside. Let’s see what’s in here. It’s a pig.” Children who chose incorrectly did not receive any explicit correction or opportunity to try again.

Test trials. There were eight test trials total. The experimenter began the test trials by placing a box and two pictures in front of the child and reminding the child, “One of these things is inside the box and Giraffe knows which picture is inside.”

For each trial, the experimenter placed the pictures on the table and asked the child to point to each object by name (e.g., “Which one’s the cat?” and “Which one’s the ball?”). This ensured that the child was familiar with each object. If children could not identify the picture accurately, they were corrected by the experimenter. For each box, the confederate asked one question to distinguish between the two objects by label (e.g., “Is it the car?”). For half of the questions, the puppet verbally responded “yes,” and for the other half, the puppet responded “no.” The puppet also nodded yes or shook his head no to accompany the verbal response.

At the end of each trial the confederate recorded the child’s response. The experimenter did not verbally label the child’s responses as right or wrong or give the child any specific reward for accurate responses. At the end of each trial, the experimenter simply opened the box and said, “Look, you said a [child’s choice] was inside. Let’s see what’s in here? It’s a [contents of box]! Okay, let’s try the next one.”

Four pseudorandom orders were created to meet several requirements. First, test items were counterbalanced so that each item in a pair was in the box for 50% of children. Second, all orders contained four “yes” questions and four “no” questions, and the items that received “yes” or “no” responses were counterbalanced between participants. Third, the questions were in pseudorandom order, with no more than two of the same question type (“yes” or “no”) in a row.

Results

One 3-year-old did not correctly point to the pig during the training session, but the child was able to identify all other pictures. All other children correctly identified all target cards at the beginning of the trials. In addition, there were no developmental differences in performance on the first trial of the task, $\chi^2(2, N = 32) = 0.0, p = 1.0$. Eighty-eight percent of 3-year-olds and 88% of 4-year-olds answered correctly on the first trial, indicating high
performance for both age groups upon initial engagement with the task.

For each age group, the number of problems solved correctly for “yes” questions and “no” questions were calculated (each of four; see Table 1). A 2 (question type) × 2 (age group) repeated measures analysis of variance (ANOVA) revealed no main effect of question type: Children responded correctly equally often regardless of whether the questions received “yes” or “no” answers, F(1, 30) = 0, p = 1.0. There was a significant effect of age group: Three-year-olds solved fewer problems correctly than 4-year-olds, F(1, 30) = 5.976, p = .021, η² = .166. There was no interaction between question type and age group, F(1, 30) = 0, p = 1.0.

We examined whether children solved more than two of the four problems correctly for each question type, finding that both 3-year-olds and 4-year-olds did so (all ts > 6.214, all ps < .001). Fourteen of sixteen 3-year-olds were correct for more than half of the items for both “yes” and “no” questions, while all sixteen 4-year-olds were correct for more than half of the items.

To examine whether children performed better as the task progressed, we compared performance on the first four items to performance on the last four items. A 2 (item set: first four items or last four items) × 2 (age group) repeated measures ANOVA revealed no difference in performance between the first four items and the last four items, F(1, 30) = 1.216, p = .279, η² = .039, and no interaction with age group, F(1, 30) = 1.216, p = .279, η² = .039.

Still, from conducting the study, it was clear that there were some individual differences in children’s patterns of responses. To better understand these differences, we divided children into three categories based on their performance in the task: those who did equally well on the first four and last four items, those who improved and obtained more correct answers on the second half of the items than the first, and those who performed more poorly over time and obtained less correct answers on the second half of the items than the first. Only two 3-year-olds and two 4-year-olds performed worse as the study progressed. The majority of the children—seven 3-year-olds and twelve 4-year-olds—performed consistently. Seven 3-year-olds and two 4-year-olds actually improved as the study progressed.

**Discussion**

Consistent with our predictions, children effectively used information gathered from listening to a third-party conversation to solve problems. Children were also unexpectedly adept at integrating both “yes” and “no” answers into their solutions. These results suggest that children effectively use information gathered from listening to third-party conversations to solve simple problems. There is also some evidence that this competency improves over the preschool years: Four-year-olds obtained more correct answers than 3-year-olds, and while 4-year-olds performed consistently in the first half and the second half of the task, 3-year-olds were more likely to show improvement in the second half of the task. However, it may be difficult to generalize from these findings because of the simplicity of the task: The information that children overheard was literally the solution to a problem that they would subsequently solve. When children overhear real question-and-answer exchanges, the people that they are observing rarely provide information that directly addresses the problems that they face.

**Experiment 2**

Experiment 2 addresses the previous issue by employing indirect questions. In Experiment 2, the confederate’s questions involved features of the objects instead of labels for the objects as a whole (e.g., “Is it something that has wheels?” instead of “Is it the car?”). Thus, children needed to make additional inferences in order to connect overheard facts to test items. If children do well on this task, it

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*Note. Standard deviations are in parentheses.*
suggests that they can take relevant information asked in a question, even if the response does not provide an explicit answer, and apply it to solving a problem. Because the task was expected to be more difficult, 5-year-olds were also included in this study. We predicted that preschool children would be able to learn from listening to others’ question-and-answer exchanges but that inferring the identity of the hidden item based on a question about features would be somewhat more difficult than drawing inferences based on a direct label.

Method

Participants. Sixteen 3-year-olds (M = 3.35 years; eight females), sixteen 4-year-olds (M = 4.50 years; nine females), and sixteen 5-year-olds (M = 5.31 years; six females) were recruited from preschools in the same suburban area as in Experiment 1 to participate in this study. Three additional children participated but were dropped from the final sample due to either attention difficulties or experimenter error. The ethnic distribution of the sample was similar to Experiment 1. Children were tested in a quiet room; each session took 10–15 min.

Materials and procedure. The materials and procedure employed in Experiment 2 were similar to those used in Experiment 1 with one important change. Rather than answering questions about the label of the contents of the boxes (e.g., “Is it the car?”), the confederate asked questions about the features of target items (e.g., for the car and butterfly pair, the confederate asked, “Is it something that has wheels?”).

Results

One 3-year-old did not correctly identify the pictures during the first trial; however, the child went on to accurately choose the picture inside the box. All other children correctly identified all target cards at the beginning of the trials. Like in Experiment 1, there were no significant differences between age groups in performance on the first trial of the task, $\chi^2(2, N = 48) = 1.20$, $p = .55$. Seventy-five percent of 3-year-olds, 88% of 4-year-olds, and 88% of 5-year-olds obtained a correct answer on the first trial. Thus, across age groups, children are frequently successful at learning from overhearing even on the first trial of the task.

For each age group, the number of accurate answers was calculated as in Experiment 1 (see Table 1). A 2 (question type) × 3 (age group) repeated measures ANOVA revealed a main effect of question type: children solved more “yes” questions correctly than “no” questions, $F(1, 45) = 6.235$, $p = .016$, $\eta^2 = .122$. However, there was no main effect of age, $F(2, 45) = 0.480$, $p = .956$, $\eta^2 = .002$, and there was no interaction between question type and age, $F(2, 45) = 0.409$, $p = .605$, $\eta^2 = .022$.

Likewise, children of all three age groups solved problems correctly more often than chance for both “yes” and “no” questions (all ts > 3.437, all $p$ < .005). For the “yes” questions, all sixteen 3-year-olds, fourteen of sixteen 4-year-olds, and all sixteen 5-year-olds were correct for more than half of the items. For the “no” questions, thirteen of sixteen children from each age group were correct for more than half of the items. This suggests that, despite the increased difficulty of the task, children in all age groups were able to use indirect questions to generate correct inferences about the contents of the box. Although children were not at ceiling with their performance, a number of children did obtain correct answers for all eight items (five of sixteen 3-year-olds, eight of sixteen 4-year-olds, and ten of sixteen 5-year-olds).

To examine whether children performed better as the task progressed, we compared their performance on the first four items with their performance on the last four items. A 2 (item set) × 3 (age group) repeated measures ANOVA revealed no difference in the performance between the first four items and the last four items, $F(1, 45) = 2.246$, $p = .141$, $\eta^2 = .048$, and no interaction with age group, $F(2, 45) = 0.998$, $p = .377$, $\eta^2 = .042$.

To better understand differences in patterns of performance across development, we divided children into three categories based on their performance in the task using the same criteria from Experiment 1 (see above). Six 3-year-olds, eight 4-year-olds, and twelve 5-year-olds performed consistently. Only three 3-year-olds and four 4-year-olds performed worse as the study progressed. In contrast, seven 3-year-olds, four 4-year-olds, and four 5-year-olds improved as the study progressed.

To compare children’s performance between Experiments 1 and 2, a Mann–Whitney $U$ test was conducted, finding that the two distributions of performance for the two studies were not statistically different, $U = 713,500$, $p = .563$, suggesting that less direct questions do not pose a significant additional challenge for young children.

Discussion

Despite the increased difficulty of the task, children were able to take the information heard in a
question-and-answer exchange and use it to draw inferences about the content of the box. In fact, 3-year-olds obtained just as many correct answers as 5-year-olds. Unlike Experiment 1, children obtained more correct answers for “yes” questions than “no” questions. We will return to this finding in the General Discussion.

It is important to note that in both Experiments 1 and 2, children were explicitly instructed to listen to the confederate’s questions to learn information needed to solve the problems. It is possible that children only attended to the confederate’s questions because they were directed to do so by the experimenter. In many real-life situations, however, children are not instructed to attend to a third-party’s conversation, yet that information may still be useful to them later on. Consequently, Experiment 3 examined the robustness of children’s ability to learn from hearing others ask questions without being told to do so.

### Experiment 3

Unlike the earlier experiments, in Experiment 3, children were not instructed to listen to the confederate’s questions. Instead, the experimenter said they would be playing a game with the child and Sally to figure out what was inside the box, and Sally asked questions. We predicted that younger children would find this task more difficult, as it might be unclear to them that the question-and-answer exchange is relevant to solving the problem.

### Method

**Participants.** Sixteen 3-year-olds ($M = 3.57$ years; eleven females), sixteen 4-year-olds ($M = 4.47$ years; ten females), and sixteen 5-year-olds ($M = 5.57$ years; nine females) were recruited from preschools in the same suburban area as in Experiment 1 to participate in the study. The ethnic distribution of the sample was similar to Experiment 1. Two additional children were dropped from the final sample: one due to attention difficulties and one due to difficulty understanding English.

**Materials and procedure.** The materials and procedure were similar to Experiment 2 except for the instructions regarding the confederate (Sally). In Experiments 1 and 2, participants were told that their friend Sally would be asking questions to a puppet friend about what might be in the boxes, and they were instructed to listen to the questions so that they could guess the contents of the box. In contrast, in Experiment 3, children were never explicitly instructed to listen to Sally. Instead, Sally stated that she wanted to figure out what was inside the boxes and then asked questions. After Sally asked her question and the question was answered, children were then asked which of the two objects was inside the box.

### Results and Discussion

All children correctly identified all target cards at the beginning of the trials. Like in Experiments 1 and 2, we examined first trial performance to see if there were developmental differences in children’s success at learning from overhearing question-and-answer exchanges at the beginning of the task. This was particularly relevant in this experiment, given that unlike the previous two experiments, children did not receive explicit instructions to listen to the question-and-answer exchanges. Unlike the first two experiments, there were developmental differences in first trial performance, $\chi^2(2, N = 48) = 10.67, p < .01$. Fifty-six percent of 3-year-olds, 88% of 4-year-olds, and 100% of 5-year-olds obtained a correct answer on the first trial. Thus, 3-year-olds were more likely than older children to miss the first trial, suggesting that the lack of instruction to attend to the confederate’s questions impeded children’s ability to think about the utility of the question-and-answer exchanges.

A 2 (question type) × 3 (age group) repeated measures ANOVA revealed no main effect of question type, $F(1, 45) = 0, p = 1.0$. Thus, the difference in performance based on question type was not seen in this study. There was, however, a main effect of age, $F(2, 45) = 7.081, p = .002, \eta^2 = .239$. To further examine this effect of age, we conducted an orthogonal polynomial test of the linear trend, finding the trend to be significant, $F(1, 45) = 14.140, p < .001$. Thus, over development, children performed increasingly better on the task. There was no interaction between question type and age, $F(2, 45) = 1.250, p = .296, \eta^2 = .053$.

Although there had been a significant difference in accuracy for “yes” and “no” questions in Experiments 2 and 3, all three age groups solved more problems correctly better than chance for both “yes” and “no” questions (all $t$s > 2.798, ps < .05).

While all sixteen 5-year-olds answered all eight questions correctly, there were some differences in performance among the 3- and 4-year-olds. For the “yes” questions, eleven of sixteen 3-year-olds and fourteen of sixteen 4-year-olds were correct for more than half of the items. For the “no” questions,
thirteen of sixteen 3-year-olds and twelve of sixteen 4-year-olds were correct for more than half of the items. Overall, only six of sixteen 3-year-olds but eleven of sixteen 4-year-olds solved all eight problems correctly. Thus, although children in all age groups were capable of using the questions and answers to solve problems without instruction to do so, there was a marked improvement in this ability between ages 3 and 5, culminating with the 5-year-olds showing mastery of this task.

To examine whether children’s performance improved as the task progressed, we compared their performance on the first four items with their performance on the last four items. As in the previous experiments, a 2 (item set) × 3 (age group) repeated measures ANOVA revealed no difference in the performance between the first four items and the last four items, \( F(1, 45) = 1.905, p = .174, \eta^2 = .041 \), and no interaction with age group, \( F(2, 45) = 0.883, p = .441, \eta^2 = .036 \). One 3-year-old and one 4-year-old performed worse as the study progressed. However, the majority of the children—eight 3-year-olds, twelve 4-year-olds, and sixteen 5-year-olds—performed consistently. Seven 3-year-olds and three 4-year-olds improved as the study progressed.

To compare the performance between Experiments 2 and 3, a Mann–Whitney \( U \) test was conducted, finding that the two distributions of performance for the two studies were not statistically different, \( U = 986.000, p = .173 \). Thus, even without explicit instructions to listen to the question-and-answer exchange, children still performed generally just as well as they did in the previous experiment. However, it is interesting to note that only two of sixteen 3-year-olds obtained five or fewer correct answers in Experiment 2, while seven children did so in Experiment 3. This suggests that 3-year-old children may still find it more difficult to apply others’ questions to solving problems when they are not instructed to do so. In contrast, all sixteen 5-year-olds performed at ceiling in Experiment 3, suggesting that older children are much less impeded by the lack of specific instructions.

**Experiment 4**

In the previous experiments, children’s strong performance may have been due to them following a leading element in the environment. Perhaps children were merely drawing a simple association between the puppet’s responses and their choice of objects instead of recognizing the utility of the questions asked and the answers received. If children’s choices were driven by simple associations, children should make their decisions about the item inside the box based on what they overhear, regardless of its relevance to the task at hand. In order to test this possibility, the current experiment mirrored Experiment 1 through Experiment 3 except that instead of children overhearing a question-and-answer exchange between the confederate and the puppet, the children only heard the puppet make a general descriptive statement about one of the two items that did not provide information about which item was in the box. For example, the statement “A pig is something that is an animal” does not indicate if a pig or a banana is inside the box. If children were responding by following something leading in the environment, then they should now make their choices based on the statement the puppet provides, even though the statement has no relevance to what is inside the box. In contrast, if, as we predicted, children were responding based on the relevance of the information that is provided to solving the problem, then they should not base their decisions on the puppet’s statements at greater than chance levels.

**Method**

**Participants.** Sixteen 3-year-olds (\( M = 3.61 \) years; six females), seventeen 4-year-olds (\( M = 4.53 \) years; eleven females), and eighteen 5-year-olds (\( M = 5.29 \) years; ten females) were recruited from preschools in the same suburban area as in Experiment 1 to participate in the study. The ethnic distribution of the sample was similar to Experiment 1.

**Materials and procedure.** Prior to beginning this experiment, children participated in the task described in Experiment 5.

The materials and procedure for Experiment 4 were similar to Experiment 3, except for the interaction between the confederate and the puppet. During each trial presented in Experiment 4, the experimenter reminded the child that one of the things was inside the box and the confederate stated, “Giraffe, you look like you want to say something.” The puppet (controlled by the experimenter) responded with a statement about one of the pictures based on the questions asked in the previous studies. For instance, in Experiment 3, the confederate asked, “Is it something that has wheels?” to determine whether a car or a butterfly was inside the box and the puppet responded with the accurate answer: yes or no. In this experiment, the puppet simply made a descriptive statement similar to the original question: “A car is something that has
wheels.” Thus, children heard the same information as in Experiments 2 and 3 about one of the items, but this time the comments were not meant to be in response to a question about what was inside the boxes. After hearing Giraffe’s statement, the confederate responded, “Oh, that’s neat.” The experimenter then prompted the child to identify what was inside the box. Critically, while in the previous studies Giraffe provided accurate responses to the confederate’s questions about the contents of the box, Giraffe’s statements for this task were descriptive of the actual contents of the box for only half the trials. Whereas Giraffe’s responses were part of a question-and-answer exchange identifying the contents of the box in the previous experiments, Giraffe’s responses in the current experiment were not meant to provide a solution to the problem.

Results and Discussion

All children correctly identified all target cards at the beginning of the trials. A one-way ANOVA compared the number of times that the child chose the object described in the puppet’s descriptive statements (of eight responses) between the three age groups. There were no developmental differences, \(F(2, 48) = 1.663, p = .200\). Three-year-olds made choices that matched the descriptive statement 5.19 times of 8 \((SD = 1.940)\), 4-year-olds matched the descriptive statement 4.12 times of 8 \((SD = 2.058)\), and 5-year-olds matched the descriptive statement 4.83 times of 8 \((SD = 1.043)\). To examine whether children followed Giraffe at above-chance levels, the number of times children made choices that matched the descriptive statement was compared with chance (a score of four) for each age group. As expected, 4-year-olds responded at greater than chance levels, \(t(16) = 0.236, p = .817\). In contrast, 3-year-olds and 5-year-olds made choices matching the descriptive statement at greater than chance levels, \(t(15) = 2.449, p = .027\) and \(t(17) = 3.389, p = .003\), respectively.

Why were both 3-year-olds and 5-year-olds making choices that matched the provided statements at greater than chance levels? One possible explanation for these developmental differences may relate to how children thought about the statements that were provided. According to Grice’s (1989) conversational maxims, when speakers provide information, they usually do so for a reason. Older children might initially assume that the puppet is trying to provide hints with the statements, even if the statements seem irrelevant. Through experience recognizing that the statements are not relevant to the problems at hand, children should stop paying attention to the statements. To examine this possibility, we compared the number of times children chose the item that matched Giraffe’s statements to chance (two of four) separately for the first half of the items and the second half of the items for each age group. Three-year-olds responded at chance for the first half of the items, \(t(15) = 1.385, p = .186\), but they responded with the descriptive statements at greater than chance levels for the second half of the items, \(t(15) = 3.223, p = .006\). Thus, like in Experiments 1 and 3, 3-year-olds were more likely to use information from overheard exchanges in the second half of the study compared to the first (albeit measured in slightly different ways). These findings may suggest it takes time for 3-year-olds to integrate cues from the environment into their problem-solving strategies. Four-year-olds responded at chance for both the first half and the second half of the items, \(t(16) = 1.383, p = .186\) and \(t(16) = 1.000, p = .332\), respectively. In contrast, 5-year-olds responded at greater than chance levels for the first half of the items, \(t(17) = 2.297, p = .035\), and at chance levels for the second half of the items, \(t(17) = 1.190, p = .250\). This suggests that 5-year-olds initially believed that the provided statements would be informative (drawing from Gricean principles of relevance), but they realized as the experiment went on that the statements were not predictive of the contents of the box and stopped relying on them.

Finally, we wanted to see if children were more likely to pay attention to the information overheard when it was provided as part of a question-and-answer exchange as in Experiment 3 than when it was provided as nonpredictive descriptive statements in Experiment 4. To examine this, we calculated the number of times in each experiment that children’s responses matched the heard information, whether it was from question-and-answer exchanges or from irrelevant statements. Using a Mann–Whitney \(U\) test, the two distributions of performance for the two studies were found to differ significantly, \(U = 371,000, p < .001\). Separate Mann–Whitney \(U\) tests were conducted to compare the performance for each age group. For the 3-year-olds, performance on the two tasks did not differ significantly, \(U = 94,000, p = .210\). In contrast, both 4-year-olds and 5-year-olds were more likely to follow Giraffe’s statements in Experiment 3 than Experiment 4, \(U = 29,000, p < .001\) and \(U = .00, p < .001\), respectively. Thus, in general, older children applied information from the question-and-answer exchange to solving problems at rates...
higher than when they simply heard statements involving one of the objects in the box, suggesting that children viewed the question-and-answer exchange as more meaningful.

**Experiment 5**

In Experiment 3, children were not instructed to listen to the confederate’s questions, and although there were improvements with development, children in all three age groups performed at better than chance levels. However, in all of the studies described above, children were presumably paying full attention to the interaction between the confederate and the puppet as there was nothing else to distract them. In reality, though, children often overhear conversations while they are engaged in other activities, and this splitting of attention may have an important effect on how much information they obtain from third-party exchanges. The current experiment presents a situation closer to true overhearing, in which children were working on another task while the confederate and experimenter engaged in conversation. In this conversation, a question-and-answer exchange involving the location of a hidden prize was embedded. After this exchange, children were recruited to help figure out where the prize was hidden. We predicted that younger children would struggle more with this task because their attention was also engaged in a separate task but that overall, children would still learn from overhearing question-and-answer exchanges at greater than chance levels.

**Method**

**Participants.** The same participants who were in Experiment 4 also participated in this experiment. Experiment 5 was conducted before Experiment 4 within the same testing session in order to avoid the possibility that children would be primed to listen for questions.

**Materials.** Four translucent drawers (approximately 16 cm wide × 10 cm tall × 21 cm deep for each drawer) were stacked vertically for this study. Each drawer was lined on the inside and outside with construction paper in a different color (red, blue, yellow, orange). A Fisher-Price Doodle Pro toy, aimed at children ages 3–7, was used as a distracter.

**Procedure.** Children entered the test setting to see a table with piles of papers stacked in front of the experimenter and the confederate. The drawers were at the opposite side of the table between the confederate and experimenter, facing the child. Importantly, the drawers were out of reach so the child could not easily open any drawer from where he or she was sitting. The experimenter introduced the confederate and indicated that they were going to be playing some games with the child and that the child might be able to win a prize at the end. The experimenter then remarked, “Oh goodness. We forgot to finish setting everything up.” She then asked the child to sit quietly and play with the distracter toy for a moment.

While the child was playing with the toy, the experimenter and confederate went through a scripted exchange. The experimenter stated that she was going to set up, and the confederate responded that she needed to set up, too. After waiting 10 s, the confederate stated that she had to read a chapter for her Cognitive Development class, and the experimenter asked her how it was. The confederate responded that it was fun and that it was about sociocultural theories. The scripted exchange began with this brief dialogue so that children would not be prompted to attend to the conversation. Afterward, the confederate stated that she was going to check to make sure the prize was ready. Then she said, “Oh, wait, I don’t remember which drawer has the prize in it. Is it the ___ drawer?” The experimenter responded, “Yes, it’s the ___ one.” Thus, the exchange between the experimenter and confederate regarding the prize was embedded in the dialogue. The confederate then said thank you and went back to shuffling papers for approximately 10 more seconds.

At that point, the experimenter thanked the child for waiting patiently and said that it was time to get started. After cleaning up Sally’s materials and putting the distracter toy away, which took approximately 10 s, the experimenter asked the confederate if she could get the prize out while she (the experimenter) did one last thing and turned to her papers to write something. The confederate then stated, “Oh, I can’t remember which drawer the prize is in.” Turning to the child, she asked, “Which drawer should I open?” If the child didn’t respond with a specific color, she asked the child to point toward a drawer. If the first guess was incorrect, the confederate asked, “Which drawer should I open now?” This continued until they determined where the prize was hidden. The color of the drawer that the toy was in was counterbalanced between participants. Also, during this interaction, the confederate observed whether the child was engaged in the distracter activity and recorded the child’s responses.
Results and Discussion

All children were engaged in playing with the distracter toy. In fact, children often wanted to make sure to finish what they were working on and erase their work before giving the toy back to the experimenter.

A binomial test was used to compare the number of children who chose the correct drawer on the first try to the number who did not. Above-chance performance measured by a binomial test (with chance probability = .25) required that at least 19 of 51 children choose the correct item the first time. Overall, 33 of 51 children chose the correct item in the first try, a number significantly different from what one would be expected by chance ($p < .001$). Eleven of sixteen 3-year-olds, ten of seventeen 4-year-olds, and twelve of eighteen 5-year-olds all chose the correct item in the first try ($p < .01$ for all age groups). A chi-square goodness-of-fit test revealed no age group differences, $\chi^2(2, N = 51) = 0.40, p = .82$. Thus, across all age groups, children were able to apply information overheard from a third-party question-and-answer exchange that took place while their attention was engaged in another task and with no prior instruction to do so.

General Discussion

Despite the fact that young preschoolers sometimes struggle to produce questions that facilitate problem solving, they are capable of learning from listening to others ask questions. In Experiment 1 through Experiment 3, preschoolers used information obtained by listening to question-and-answer exchanges to determine the correct solutions to simple problems. Children could not solve these problems just by pointing at the picture that matched the words mentioned in the questions; instead, they had to connect the question with the answer and use the information they gathered to inform their problem solving. For Experiment 1 through Experiment 3, children performed well overall: Each age group for each experiment solved more problems correctly than chance for both “yes” and “no” questions.

Preschoolers’ ability to learn from overhearing question-and-answer exchanges does not seem to be due to merely following leading information in the environment. The results of Experiment 4 indicate that although children may sometimes try to apply information provided in statements toward problem solving, they apply the information gleaned from question-and-answer exchanges much more frequently. In other words, children recognize that questions have utility that unrelated statements do not.

It may be that children used information from overhead question-and-answer exchanges more frequently than irrelevant statements because the information gleaned from the question-and-answer exchanges always led to the right answer for problem solving while the information from the irrelevant statements did not. If this were true, one might expect that children were learning that question-and-answer exchanges were relevant during the course of the experimental session. This explanation, however, is unlikely considering children’s performance in Experiment 1 through Experiment 3: On average, they did equally well on the first four trials as they did on the last four trials. Thus, children in all age groups recognized the utility of question-and-answer exchanges, and we suggest that this recognition extends beyond simple associative relations between statements and test items.

That said, this understanding of the utility of question-and-answer exchanges seems to be still developing during the preschool years. Indeed, 3-year-olds performed differently from older children in several ways. First, 3-year-olds did not perform as well in Experiment 3 (with no explicit instructions to listen to the questions) as they did in Experiments 1 and 2: They were less accurate overall on the first item, and their performance was more variable. Second, 3-year-olds were more likely than older children to perform better in the second half than the first half of Experiments 1, 2, and 3, suggesting that they better understood the importance of listening to the questions as the task progressed. Third, unlike older children, 3-year-olds responded with the overhead information at equal rates for Experiment 3 (question-and-answer exchanges with no explicit instructions to listen) and Experiment 4 (irrelevant statements), and they grew more likely to apply the irrelevant statements in Experiment 4 to the problem as the trials progressed. Their behavior in Experiment 4 suggests that they were not successfully evaluating how much the overhead irrelevant statements were helping them with problem solving as they progressed through the trials. Overall, these developmental differences may suggest that while older children understand the utility of question-and-answer exchanges without explicit instruction and without much experience with a task, 3-year-olds’ understanding is much more fragile. They may need additional experience and instruction to effectively use information from exchanges between other people to solve problems.
Preschoolers’ ability to learn from overhearing question-and-answer exchanges is also not limited to situations that explicitly command their undivided attention. In Experiment 1 through Experiment 3, in order to allow for multiple trials, the interaction between the two people was staged directly in front of the child. There is no doubt that children experience similar situations in everyday life, such as in a classroom setting in which a student asks a teacher a question, while everyone else is dutifully listening. However, there are many other ways children may overhear an interaction. For instance, a child might be playing with an exhibit at a museum when an unfamiliar parent and child come over to engage in the same exhibit. Experiment 5 involved a more naturalistic task in which children played with a toy while two adults were engaging in a separate activity. In the process, children overheard a question-and-answer exchange. When asked later to solve a simple problem that related to the overheard exchange, the majority of the children were able to do so on their first try.

Although we had anticipated that children would be better at learning from “yes” questions than from “no” questions, this hypothesis was only partially supported. Only in Experiment 2 did children perform better for “yes” questions than “no” questions, and this was found with all three age groups. Even when the “no” questions were more difficult, as in Experiment 2, children still performed well overall: Each age group for each experiment solved more problems correctly better than chance for each question type. Thus, it seems that for these simple problems, children were generally able to piece together the question and answers to determine the best way to solve the problem. For more complicated problems, however, it remains possible that young children have difficulty coordinating information from multiple question-and-answer exchanges involving “no” questions to solve problems. This is an issue for future research.

Given how often children ask questions as well as how often adults and other children talk over the heads of young children, it is easy to assume that young children ignore or overlook secondhand or indirect information. However, building on earlier research, the present study demonstrates that even very young children obtain information indirectly and can effectively use this information in their problem-solving behaviors. This finding has important implications for theories of education. Some researchers have lauded “discovery learning”—the process of learning through constructing knowledge on one’s own—as often being superior to direct instruction (e.g., Stohr-Hunt, 1996). Yet there is also evidence that in some cases, direct instruction leads to deeper learning and retention (e.g., Klahr & Nigam, 2004). In some discovery learning situations, children may not know how to direct their attention or what kinds of questions to ask; consequently, they learn less. Although the current experiments did not compare children’s capacities for learning directly and indirectly, previous research using similar tasks has found that 3-year-olds often have trouble generating questions that effectively help them narrow down possible responses to one answer (e.g., Mills et al., 2010; Mills et al., 2011). Our findings suggest that when children are unable to construct good questions of their own, they may benefit from listening to others ask appropriate questions.

At the same time, however, it is important to note that younger preschoolers may not automatically benefit from observing others ask questions. Although in the current research, children overall did not seem to be learning across trials to use the information provided in the question-and-answer exchanges, there were some interesting patterns of individual differences across age groups. For example, almost half of the 3-year-olds in Experiment 3 experienced several trials before they recognized the relevance of the overheard question-and-answer exchanges. Explicit instructions may help very young children to identify the valuable information seeded in other people’s questions. Without instruction, some young children may require repeated exposure to question-and-answer exchanges before they realize their value for solving a problem. In other words, because young children themselves are not asking the questions, it may take experience and attention to recognize the value in the questions of others. Future research should examine the role of explicit instructions and repeated exposure in helping young children learn from the question-and-answer exchanges of others. Finally, it may be valuable to examine how children observe or overhear interactions to determine what other factors (e.g., qualities of the speakers, environment, subject matter) influence children’s ability to learn from the questions of others. Given the wide range of situations where children and adults must rely on third-party exchanges to obtain information, it is important to understand the origins and development of the ability to learn from listening to others. Our results demonstrate that the ability to use others’ questions to solve problems emerges early but that young children may require more support in order to do so effectively.