Enhancing Preschoolers' Understanding of Ambiguity in Communication: A Training Study on Misunderstandings

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Understanding knowledge acquisition involves a comprehension of the relationship between a person's access to relevant information and that person's subsequent knowledge. This report investigates how preschoolers improve in their ability to evaluate the effects of two distinct types of messages—ambiguous and informative—on a listener's knowledge. Three- and four-year olds were pre- and posttested for their ability to judge message quality from a third-person perspective. Between sessions, children were assigned to one of three training conditions. In all conditions, children observed a speaker providing ambiguous messages and informative messages to a listener. In the general-feedback condition, children were informed as to whether the listener gained knowledge after each message. In the specific-feedback condition, children were informed as to whether, as well as why, the listener gained knowledge. In the no-feedback condition, children were not informed as to the listener's state of knowledge. Children in the specific-feedback condition improved their ability to judge messages, and children in the general-feedback condition showed a marginally significant improvement. No learning effects, however, were observed in a transfer task for any of the groups. Results suggest that informing preschoolers about message quality during conversational exchanges contributes to their developing understanding of how people acquire knowledge about the world.

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Developing an understanding of how people acquire knowledge about the world involves a variety of challenges for the child. One of them is to comprehend the causal relationship between access to information and a person's state of knowledge. This understanding emerges around the first birthday, when infants become able to track people's attentional states and thus react accordingly (Liszkowski, Carpenter, & Tomasello, 2008; Moll & Tomasello, 2007; Poulin-Dubois, Sodian, Metz, Tilden, & Schoeppner, 2007; Tomasello & Haberl, 2003). Another, more difficult, challenge is to realize that access to information does not guarantee knowledge; rather, the child must learn it is the quality of information that is accessed—whether or not it is informative—that plays a fundamental role in the process of knowing.

In communicative exchanges, young children are able to avoid ambiguity and to be as informative as their interlocutors require them to be (O'Neill & Topolovec, 2001), even if they do not yet appreciate that the access to good-quality information is a precondition for knowledge acquisition (Perner, 1991; Wellman, 1990). Evidence deriving from the theory-of-mind literature indicates that children's appreciation of this condition emerges at around the same time as their understanding of false belief, which is when they start to pass knowledge-attribution tasks. In addition, explanations of this developmental progression propose that particular conversational experiences may be critically important in the development of this understanding (Astington & Baird, 2005). The question that we address in this report is precisely whether the experience with a specific kind of conversational experience—namely, conversational breakdowns—contributes to this developing understanding.

By using the knowledge-attribution task, previous researchers have assessed children's appreciation of the role that information quality plays in the process of knowing. For this task, children predict the effects of exposure to ambiguous information and informative information on a person's knowledge. In its linguistic version, the child observes while a speaker places an object in one of several similar available locations; later, the speaker provides to a naïve listener either an ambiguous or an informative description of the object's location. After hearing each description, the child judges the listener's knowledge concerning the object's location (Miller, Hardin, & Montgomery, 2003; Montgomery, 1993; Sodian, 1988).

In the visual version of this task, also known as the droodles task, children evaluate the effect on an addressee's knowledge of exposure to ambiguous visual stimuli. They are asked to predict whether a naïve addressee will know the identity of an object in an image after he or she is shown partial views of that image. These views either show informative segments of the object that enable its identification or ambiguous views that hinder its identification (Gopnik & Astington, 1988; Perner & Davies, 1991; Ruffman, Olson, & Astington, 1991; Taylor, 1988). Overall, findings derived from these two tasks suggest that it is not until the age of 5 that children are capable of attributing ignorance to an addressee with access to partial, nondescript information, and knowledge to an addressee with access to partial but descriptive information.

Along with false belief, this understanding is another manifestation of the emergence of a representational understanding of mind. The reason is that, in order to be successful at these tasks, the child must be able to understand that when two different people are exposed to the same information, they might build different mental representations (Perner, 1991). With this development, knowledge no longer resides outside the person, it is no longer simply *imprinted* within the individual having access to the source of information. Instead, the person is gradually viewed as playing an active role in the construction of his or her knowledge (Gopnik & Wellman, 1992, 1994; Wellman, 1990).

Until recently, theoretical explanations concerning the mechanism underlying this developmental process were based on intraindividual factors such as conceptual revolutions (Perner, 1991; Wellman, 1990), introspection (Harris, 2000), maturation (Scholl & Leslie, 1999) or the emergence of general cognitive abilities (Frye, Zelazo, & Palfai, 1995). However, more recent accounts attribute a fundamental role to language (Astington & Baird, 2005; Lohmann & Tomasello, 2003). The specific aspect of language that might play this fundamental role is still under debate. While some consider the lexical semantics of mental-state terms as the single dimension of language that plays a role (Olson, 1988), others point to the role of the syntax of complementation accompanying mental-state verbs as the platform to master epistemic states (de Villiers, 2005; de Villiers & de Villiers, 2000). Still others highlight the role of the pragmatics of conversation, emphasizing the importance of children's experiences with disagreements and conversational breakdowns because these are instances that involve explicit, simultaneously manifested expressions of two conflicting views on the same topic (Harris, 1996, 1999, 2005; Tomasello, 1999).

This third, less explored, hypothesis is based on evidence showing that, once children begin to engage in discourse with adults, it is usual that some of these adult conversational partners, because of the linguistic formulation the children use, do not understand what is said (Golinkoff, 1986; Mannle, Barton, & Tomasello, 1991; Tomasello, Conti-Ramsden, & Ewert, 1990). In this common scenario, conversational breakdowns emerge in the form of statements of noncomprehension or in clarification requests, as adults misinterpret the child's intended meaning. In this process, Tomasello (1999) explains, the child initially formulates an utterance with a more or less coherent hypothesis of the informational needs of the listener. That hypothesis is later demonstrated to be either accurate or faulty, leading the child to try to discern the reasons why the adult did not comprehend the utterance. For Tomasello, this process constitutes a rich arena in which the child can develop a comprehension of how someone's understanding of an expressed perspective on a situation may differ from that of others; thus, the child enriches his or her understanding of the mind.

Research with preschoolers and 5-year-olds clearly demonstrates that conversational breakdown is a sufficient condition to improve their performance as speakers in a communicative exchange, leading them to be as informative as their interlocutors require them to be (Deutsch & Pechmann, 1982; Mathews, Lieven, & Tomasello, 2007; Robinson & Robinson, 1985), and as message evaluators, improving their ability to judge message quality (Robinson, 1981; Sonnenschein, 1984).

Based on these findings, the present study first tested whether the experience of conversational breakdown from a third-person perspective contributes to the young child's understanding of how people acquire knowledge about the world and, more specifically, to his or her ability to evaluate the effects of both ambiguous messages and informative messages on a listener's knowledge. Second, we also explored how much information the conversational breakdown needs to include in order for the child to progress in this ability. To do so, we implemented a training methodology with three conditions. Children in the three groups were given a knowledge-attribution task that took place in a communicative context as pretest and posttest. This task measured their awareness of how verbal messages of a different quality affect a listener's knowledge. In addition to this task, children also took a standardized language test during the pretest.

Between sessions, children were assigned to one of three training conditions. In *all conditions*, they observed while a speaker relayed ambiguous messages and informative messages to a listener about the content of a box, and the listener provided feedback to the speaker about the message. In a *general-feedback condition*, children were informed as to whether a listener gained knowledge after each message. In a *specific-feedback condition*, children were informed as to whether the listener gained knowledge after each message and why the listener did not gain knowledge if he or she had been told an ambiguous message. In a *no-feedback condition*, children were not informed as to the listener's state of knowledge after he or she had received each message. Finally, this study assessed children's performance on a transfer task to determine whether they could apply what they had learned during training to other ambiguous contexts. This transfer task, a *droodles task*, measured the child's ability to judge the knowledge of a naïve observer who had been exposed to ambiguous visual stimuli and informative visual stimuli.

Method

Participants

A total of 54 children recruited from preschools and day cares from a mid-size city in New England participated in the study. Participants were between the ages of 37 and 60 months (M = 46.9 months, SD = 5.0). The children came from diverse socioeconomic backgrounds: 42.6% of the primary caregivers of children had a high school diploma, 35.2% had a bachelor's degree, and 22.2% had a graduate degree. The children also came from diverse ethnic backgrounds: 66.7% of the children were described by their caregivers as Caucasian, 11.1% were described as African American, 1.9% were Asian American, 3.7% were Hispanic, and 16.7% were described as having a mixed ethnic background. All children used English as their primary language. Children included in the study were only those who met the pretest criteria that (a) they had not yet acquired an understanding of the implications of ambiguous information for knowledge acquisition and (b) their linguistic development fell within the norms of their age group. A total of 30 additional children did not meet one or both of these two criteria: 14 children passed the communication pretest, the language scores of 7 fell either below (6 children) or above (1 child) the normal range of their age group, and the scores of 3 fell above the normal range of their age group and they also passed the ambiguous communication pretest. An additional 6 children had to be dropped from the study because they left their programs.[1] Thus, a total of 84 children were seen.

Design

Each child participated in four sessions with one and the same experimenter within a 2-week period. Pretest and posttest took place in Session 1 and Session 4, respectively. In Session 1, children took the standardized

1. Comparisons between children who were included and children who were not showed no significant differences in maternal education and paternal education. Children who had already acquired the understanding of ambiguity were older. We found a significant difference, $t(82) = 3.03$, $p < .05$, between those children who were included (mean age in months = 46,61) and those who were not included (mean age in months = 49,95), but by only three months.

language test and the communication pretest.[2] In Session 4, children took the communication posttest and the droodles transfer task. Training was conducted in Sessions 2 and 3. The two training sessions were separated by 2–7 days. Session 1 took place between 2 and 5 days before the first training session, and Session 4 took place between 2 and 5 days after the second training session. Each session lasted 20–30 minutes and took place in a separate quiet room or corner of the preschool or day-care center. Participants were randomly assigned to one of the three groups: no-feedback group, general-feedback group, or specific-feedback group.

Materials and Procedure

Standardized language test. We used the Peabody Picture Vocabulary Test, third edition (PPVT III; Dunn & Dunn, 1997), to determine whether a given child's vocabulary development fell into the normal range. The language age was used as the final measure of the children's language ability.

Communication pretest. We used a modified version of Miller et al.'s (Experiment 3, 2003) task. First, the experimenter presented a Sesame Street pair of dolls (Ernie and Bert), the speaker and the listener for this task, and introduced the procedure as a game she wanted to play with the child and the dolls. The child was then shown the first set of three objects (e.g., a toy plate, a toy spoon, and a toy cup) and asked if he or she knew what they were.[3] The answer was either confirmed or, when necessary, provided. The experimenter went on to say, "Ernie and Bert know this is a plate, this is a spoon, and this is a cup." She brought out a box with a lid and a lock, which the child was allowed to manipulate. She then used the box to hide the stimuli. Finally, the experimenter gave these basic instructions: "We are going to play a hiding game with Ernie and Bert. Each time we play the game, I'll put either the plate, the spoon, or the cup inside this box. You and Bert will get to see while I hide something in the box, but Ernie won't get to see because we are going to put this here." The experimenter thus placed a brown screen (28 cm high and 25 cm wide) between the speaker doll and the listener doll.

The experimenter explained to the child, "Every time we play the game, Ernie has to figure out what's in the box. Each time, I'll ask you if

2. The standardized language test was administered first because it was considered a good warm-up.

3. The following were the specific objects used during the study. Pretest set 1: plate, spoon, cup; set 2: lion, crocodile, hippopotamus. Training 1 set 1: pig, horse, sheep; set 2: corn, pear, strawberry; set 3: motorcycle, car, train. Training 2 set 1: cow, elephant, tiger; set 2: banana, orange, apple; set 3: napkin, fork, knife. Posttest set 1: plain, truck, bus; set 2: ice-cream cone, watermelon, hot dog.

Ernie knows what's in the box. Sometimes he will know, some other times he won't." She then hid one of the toys inside the box while saying, "This time, I am going to hide this one in the box," without mentioning the name of the object, and put the other objects out of sight while saying, "And I am going to put these other two toys inside my bag." She next asked the control questions: "Does Bert know what's in the box?" and "Do you know what's in the box?" The order of these questions was counterbalanced between trials. If the child said he or she did not know, or Bert did not know, the experimenter showed the box contents a second time and asked the questions again. Each set of three objects was used for two adjacent trials so that only two of the three objects in the set were used and one was never used.

Four trials were conducted during the pretest: two informative and two ambiguous. The sequence for each trial was the same: The experimenter placed one of the three objects from the set in the box while the child and the speaker doll watched. The listener doll (Ernie) then returned, and the experimenter said, "Now Ernie comes back, and Bert is going to tell him what he saw." Using a high-pitched voice, the experimenter talked for the doll. The ambiguous message was "Hey Ernie, it's in the box." The informative message was "Hey Ernie, the plate is in the box."

After the message was given, the experimenter asked the child to predict the listener's knowledge about the contents of the box: "Does Ernie know what's in the box?" Depending on the child's answer to this question, the child was then asked one of the two following justification questions: "How does he know that?" or "Why doesn't he know that?" The box was always closed at the time of the question, and no feedback was given. The order of presentation of the trials was blocked within each group so that half of the children in each group received an ambiguous (A) trial first, with the other half receiving an informative (I) trial first. Two orders were then used for each of the groups: AIAI and IAIA.

Training procedure. Each training session consisted of six trials for a total of 12 trials across the two training sessions. The speaker gave ambiguous messages in eight trials and informative messages in four. The order of the trials for each training session was the same: AAIAIA. Given that most of the trials conducted during training corresponded to ambiguous trials, children could have been biased toward judging that the listener did not know about the contents of the box. The scoring procedure takes this possibility into account appropriately and rules it out (see scoring procedure as described in the "Predictions in Communication Pretest" section).

The props were different Sesame Street characters, the screen, and the box. Six new different sets of three objects each were also used. Each set was used for two adjacent trials. Training for the specific-feedback and general-feedback groups consisted of feedback and correction in a scenario similar to the one used during the pretest. For the control or no-feedback group, we used the same scenario, but no feedback was given and no corrections were made. At the beginning of each trial, we asked children in all groups to predict the listener doll's knowledge about the content of the box after the doll had heard an ambiguous message or informative message from the speaker doll. Details of the training in the different groups are presented next.

Specific-feedback condition. After predicting the listener's knowledge for each training trial, the child was told whether the listener doll did or did not know about the content of the box. For the ambiguous trials, the child was also told why the listener did not know the identity of the intended referent. For the informative trial, the listener's message was "Yes, I know what's in the box. The plate is in the box." For the ambiguous trial, the listener's message was "No, I don't know what's in the box. The speaker didn't tell me which one is in the box. Is the plate in the box? Is the spoon in the box? Or is the cup in the box?" Next, the child was asked to recall the state of knowledge of the listener doll after hearing the message. If wrong, the child was corrected. At the end of each ambiguous trial, the child helped the experimenter take the object out of the box and show it to the listener doll, which reacted with surprise.

General-feedback condition. After predicting what the listener knew, the child was told whether the listener doll did or did not know about the content of the box from the message, but she or he was not informed as to why the listener did not know the identity of the intended referent. For the informative trial, the listener gave the same message as in the specific-feedback condition: "Yes, I know what's in the box. The plate is in the box." For the ambiguous trial, the listener's message was "No, I don't know what's in the box." As in the specific-feedback training, the child was then asked to recall the state of knowledge of the listener doll after hearing the message. If wrong, the child was corrected. At the end of each ambiguous trial, the child helped the experimenter take the object out of the box and show it to the listener doll, which reacted with surprise.

No-feedback condition. After the child's response, the experimenter did not provide any correction or feedback. At the end of each trial, the child helped the experimenter take the object out of the box. The doll gave no reaction on the ambiguous trials.

Communication posttest. We used the same format of the ambiguous communication pretest for the posttest, but with different characters and sets of objects.

Droodles transfer task. The experimenter administered a modified version of Ruffman et al.'s (1991) visual ambiguity procedure to test for transfer of the training skills to other ambiguous contexts. The experimenter introduced two pictures of familiar objects (each 10 cm long and 10 cm wide) and asked the child whether he or she knew what the objects in the pictures were. The experimenter either confirmed the answer or, in few cases, provided it. She then emphasized the similarity between parts of the shapes and colors of both objects.

The experimenter initially introduced a puppet as someone who enjoyed pictures, and then presented it and showed it the full pictures. After looking at and labeling the pictures, the puppet left for a nap. During the puppet's absence, the experimenter introduced two identical cardboard covers with rectangular openings or "windows." Restricted views of the pictures were created by placing the covers on top of the pictures so that only parts of the objects in the picture were visible through the windows. In the informative trial, the covers had big windows that enabled the viewer to identify the two objects in the pictures. In the ambiguous trial, the parts of the objects visible through the windows were identical (see Figures 1 and 2).

After placing the covers on each of the pictures, the experimenter asked the control question for each picture: "Do you know where the witch/tree is?" The experimenter asked the child to predict the naïve viewer's knowledge about the identities of the objects in the pictures: "If Johnny/Sarah comes here and sees the pictures like this [pointing to pictures], will s/he know where the witch is?" Depending on the child's answer to this question, the experimenter then asked one of the two following justification questions: "How will s/he know that?" or "Why won't s/he know that?" The covers were always in place when the questions were asked, and no feedback was given. The order of presentation of the trials was blocked within each of the groups so that half

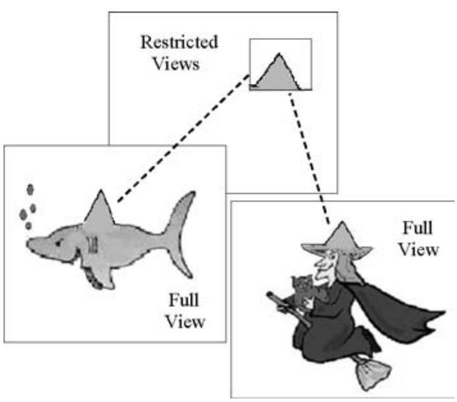

Figure 1. Ambiguous view in droodles transfer task.

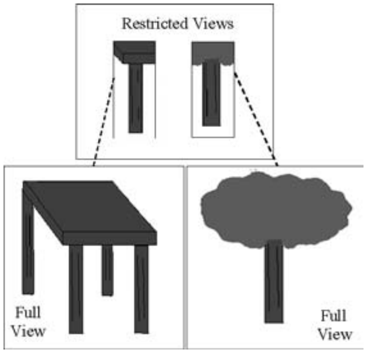

Figure 2. Informative view in droodles transfer task.

of the children in each group received the ambiguous trial first and the other half received the informative trial first.

To ensure that the informative views allowed for identification of the objects in the two pictures, and that the ambiguous views did not provide enough information to identify the objects in the pictures, we first tested the stimuli on 10 undergraduate students. They were first shown a full view of the pairs and were asked to close their eyes while the experimenter placed the covers on top of the pictures. They were then asked if, by looking at the pictures with the covers, they could identify the objects in them. All participants acknowledged their inability to recognize the identities of the objects in the ambiguous views and their ability to recognize the identities of the objects in the informative view.

Results

Relations Between Pretest Score and Posttest Performance

An initial look at the data showed that most of the children (86%) predicted the listener would gain knowledge about the content of the box after hearing the two informative messages given in pretest. These same children also predicted the listener would gain knowledge about the content of the box after hearing the two ambiguous messages given in pretest. A minority of children (14%) denied the listener's knowledge about the contents of the box after hearing the two informative messages given in pretest. This same group of children also denied the listener's knowledge about the content of the box after hearing the two ambiguous messages given in pretest. That is, children in the study either attributed or denied knowledge after all messages given in pretest.

We checked whether there was an effect of these two different kinds of replies provided in pretest on posttest scores. Fisher tests indicated that children who denied the listener's knowledge after all trials in pretest were significantly more successful in posttest than were children who attributed knowledge in pretest after all trials (Fisher's test, $p < .05$). Based on these results, the eight children who denied knowledge in the informative trials and ambiguous trials in pretest (14%) were excluded from the final sample, given that their success in posttest seemed to be determined by their pretest performance. The distribution of these excluded children was as follows: three children in the no-feedback condition (two 3-year-olds and one 4-year-old), three in the general-feedback condition (all 4-year-olds), and two in the specific-feedback condition (one 3-year-old and one 4-year-old). After these exclusions, the final sample size included in the study was $N = 46$.[4]

Equivalence of Groups: Sociodemographics

Although a random design was used in this study, it was still necessary to test for the equivalence among the training groups in relevant ways before the training began. One-way analyses of variance, the Kruskal-Wallis tests, and Fisher's exact probability test revealed that there were not significant differences in age ($F[2, 43] = 1.07$, $p = .35$), vocabulary scores ($F[2, 43)] = .48$, $p = .62$), mothers' educational level (Kruskal-Wallis = 2.91, $p = .23$), fathers' educational level (Kruskal-Wallis = 1.58, $p = .45$), and sex (2×3 Fisher's test, $p = .70$) among the groups (see Table 1).

Equivalence of Groups: Pretest Comparisons

Predictions in communication pretest. Two different prediction scores were obtained from the communication pretest. First, we obtained an *informative communication prediction score* after summing each of the participant's correct predictions during the two informative trials (0–2). Second, we obtained an *ambiguous communication prediction score* (0–2) after summing each of the participant's correct predictions during the two ambiguous trials (0–2). Calculation of this ambiguous communication prediction score was contingent upon children having successfully passed

4. For the rest of the analyses conducted here, data were treated as ordinal. Therefore, children who attained two out of two points in the informative prediction score and denied the listener's knowledge one time (out of two) when the message was ambiguous were treated differently from those children who attained two out of two points in the informative prediction score and denied the listener's knowledge two times (out of two) when the message was ambiguous.

Table 1. Means (SD) of pretest scores of participants in each condition

	Training conditions			
	All participants (N = 46)	No feedback (n = 15)	General feedback (n = 15)	Specific feedback (n = 16)
Age (37–60 months)	46.61 (5.07)	47.60 (4.48)	45.07 (4.79)	47.13 (5.76)
Vocabulary score (85–115)	101.67 (9.70)	102.47 (10.01)	102.93 (10.89)	99.75 (8.47)

the two informative trials. If children failed to attribute knowledge in the informative trials, their understanding of ambiguity cannot be inferred, since denials of knowledge in the ambiguous trials may occur because of other reasons. Responses to the justification questions were not considered when scoring this part of the communication task. Comparisons of these two predictions scores during pretest showed no significant differences among the groups (Kruskal-Wallis tests, all ps = 1; see Table 2).

Justifications in communication pretest. The children's justifications were scored independently of their answers on the prediction questions, and also independently of one another. Justifications in informative communication trials received a score of 1 when they referred to the message as the way through which the listener obtained knowledge (e.g., "Because Cookie Monster was in here, and he said 'a plate'"). Justifications in ambiguous communication trials received a score of 1 when they referred to the vagueness of the message as the reason for the lack of knowledge resulting from an ambiguous message (e.g., "Because Cookie Monster didn't tell him which one is in the box"). Two different justification scores were obtained: one for the informative trials (0–2) and one for the ambiguous trials (0–2). The first author coded all justifications given in the communication task during the pretest and posttest. Of the justifications (from 14 different participants), evenly distributed among conditions, 25% were randomly selected and coded by a second coder. There was very high agreement between coders (Cohen's k = .96). All differences were discussed and resolved. Results showed no significant differences among the three groups on the justifications given during pretest (Kruskal-Wallis tests, all ps > .40) (see Table 2).

Posttest Comparisons

Predictions in communication posttest. The informative communication prediction score and the ambiguous communication prediction score

Table 2. Frequency of pretest scores of participants in each condition

	Training conditions											
	All participants (N = 46)			No feedback (n = 15)			General feedback (n = 15)			Specific feedback (n = 16)		
Communication task	0	1	2	0	1	2	0	1	2	0	1	2
Prediction questions												
Informative score	0	0	46	0	0	15	0	0	15	0	0	16
Ambiguous score[a,b]	46	0	0	15	0	0	15	0	0	16	0	0
Justification questions												
Informative score	38	1	7	14	0	1	12	1	2	12	0	4
Ambiguous score	46	0	0	15	0	0	15	0	0	16	0	0

[a] Calculation of this score was contingent upon children's scores on the informative trials.

[b] All children included in the final sample scored 0 because they attributed knowledge in all trials, including the ambiguous ones.

were also calculated and analyzed for posttest (see Table 3). Results showed a significant difference among groups on the informative communication prediction scores (Kruskal-Wallis = 8.80, $p < .05$). Paired comparisons[5] showed significant differences between the general-feedback and the specific-feedback conditions ($p < .05$), but not between any of the other pairs of groups.

Analysis of the ambiguous communication prediction scores also showed a significant difference among conditions (Kruskal-Wallis = 9.97, $p < .01$). Paired comparisons indicated significant differences only between the no-feedback and the specific-feedback conditions ($p < .05$). These analyses demonstrated that the specific-feedback group outperformed the general-feedback group on their predictions during informative communication trials given in posttest. Similarly, the specific-feedback group outperformed the no-feedback group on their predictions during ambiguous communication trials given in posttest.

Justifications in communication posttest. We analyzed the responses to the justification questions "How will he know that?" or "Why doesn't he know that?" provided in informative trials during posttest. Results showed a significant difference among conditions (Kruskal-Wallis = 7.16, $p < .05$). Paired comparisons showed marginal significant differences between the no-feedback and the specific-feedback conditions ($p = .06$), as well as between the general-feedback and the specific-feedback conditions ($p = .06$). The comparison of responses to the justification questions provided during ambiguous trials indicated significant differences among the groups (Kruskal-Wallis = 13.98, $p < .001$). Paired comparisons revealed significant differences between the specific-feedback and the general-feedback conditions ($p < .05$), and between the specific-feedback and the no-feedback conditions ($p < .01$). As such, these results indicate that children in the specific-feedback group provided correct justifications more often than did children in the no-feedback and general-feedback groups during informative and ambiguous trials of posttest.

Change of Scores from Pretest to Posttest

Predictions in communication pretest and posttest. To determine whether the children's responses improved with training, we obtained difference scores by subtracting the prediction scores each child attained during the communication pretest from the scores they attained during the

5. Dwass-Steel-Chritchlow-Fligner pairwise comparisons for the Kruskal-Wallis test were conducted.

Table 3. Frequency of posttest scores of participants in each condition

Communication task	All participants (N = 46)			Training conditions: No feedback (*n* = 15)			General feedback (*n* = 15)			Specific feedback (*n* = 16)		
	0	1	2	0	1	2	0	1	2	0	1	2
Prediction questions												
Informative score	5	7	34	2	1	12	3	5	7	0	1	15
Ambiguous score[a]	20	3	11	11	1	0	3	1	3	6	1	8
Justification questions												
Informative score	37	1	8	14	0	1	14	0	1	9	1	6
Ambiguous score	37	2	7	15	0	0	14	0	1	8	2	6

[a] Calculation of this score was contingent upon children's scores on the informative trials. Only children who obtained two points on the informative trials were considered here.

communication posttest. Two separate scores were used: the informative communication prediction score (0–2) and the ambiguous communication prediction score (0–2). Table 4 shows the numbers of children in the three groups with difference scores of −2 to +2. Separate Wilcoxon tests for each group, comparing children's pretest and posttests scores, revealed that the number of correct predictions during informative trials decreased significantly for the general-feedback group ($Z = -2.60$, $p < .01$). No significant changes were observed for the specific-feedback ($Z = 1.00$, $p = .32$) and no-feedback ($Z = 1.63$, $p = .10$) groups. The analyses of the ambiguous communication prediction scores indicated a significant improvement for the specific-feedback group ($Z = 2.89$, $p < .01$) and a marginally significant improvement for the general-feedback group ($Z = 1.89$, $p = .06$) from pretest to posttest. That is, children in these two groups stopped attributing knowledge to the listener after all messages (informative and ambiguous), but started attributing knowledge only after informative messages and ignorance only after at least one of the ambiguous messages. We did not observe this improvement in the no-feedback group ($Z = 1.00$, $p = .32$), in which children kept attributing knowledge to the listener after both informative messages and ambiguous messages.

Justifications in communication pretest and posttest. To determine whether children's justifications improved with training, difference scores were attained by subtracting the justification score each child attained during pretest (0–2) from the justification score attained during posttest (0–2). Two separate scores were used: the informative justification score and the ambiguous justification score (see Table 4). Separate Wilcoxon tests for each group revealed that only the specific-feedback group ($Z = 2.64$, $p < .01$) improved from pretest to posttest in the justifications they gave during ambiguous trials.

Generalization in the Droodles Transfer Task

Prediction in droodles transfer task. We obtained two different prediction scores from the droodles transfer task. First, an *informative droodles prediction score* corresponded to the children's performance on the informative trial. We assigned a score of 1 when children acknowledged the viewer's knowledge in the informative view (0–1). Second, we calculated an *ambiguous droodles prediction score*. We assigned a score of 1 when children denied the viewer's knowledge about the location of the picture when the view was ambiguous (0–1). Calculation of this ambiguous droodles prediction score was contingent upon children having passed the informative trial. Again, if children failed to attribute knowledge in

Table 4. Number of children showing difference score from −2 to 2 in the communication task

	Prediction questions									
	Informative score (0–2)					Ambiguous score (0–2)				
Training conditions	−2	−1	0	1	2	−2	−1	0	1	2
No feedback (*n* = 15)	2	1	12	0	0	0	0	14	1	0
General feedback (*n* = 15)	3	5	7	0	0	0	0	11	1	3
Specific feedback (*n* = 16)	0	1	15	0	0	0	0	7	1	8
	Justification questions									
	Informative score (0–2)					Ambiguous score (0–2)				
	−2	−1	0	1	2	−2	−1	0	1	2
No feedback (*n* = 15)	0	0	15	0	0	0	0	15	0	0
General feedback (*n* = 15)	1	1	13	0	0	0	0	14	0	1
Specific feedback (*n* = 16)	0	0	13	1	2	0	0	8	2	6

the informative trial, their understanding of ambiguity cannot be inferred. Responses to the justification questions were not considered when scoring this part of the droodles transfer task. An overall 2 × 3 Fisher's test showed no significant differences for the informative scores ($p = .76$) and the ambiguous scores of this task ($p = 1$) among conditions (see Table 5).

Justification in droodles transfer task. Children's justifications were scored independently of children's answers on the prediction questions for this task and independently of one another. Justifications in the informative droodles trial received a score of 1 when they referred to the broadness of the views as the reason for the puppet's knowledge (e.g., "'Cuz these parts are sticking out," "Because she'll look on the tree right there," "Because it's still out a little bit"). Justifications in the ambiguous droodles trial received a score of 1 when they referred to the limited views of the drawings (e.g., "'Cuz see? A little bit only," "Because only the fin is showing and only the hat is showing," "Because it's hiding") as the reason for the puppet's lack of knowledge. We obtained two different scores: one for the informative trial (0–1) and one for the ambiguous trial (0–1).

The first author coded the justifications given in the droodles transfer task. Of the justifications (from 14 different participants), evenly distributed among conditions, 25% were randomly selected and coded by a second coder. There was high agreement between coders (Cohen's k = .81). All differences were discussed and resolved.

Responses to the justification question provided in the informative trial and the ambiguous trial were compared. An overall 2 × 3 Fisher's test revealed a significant difference among the groups in the ambiguous trial ($p < .05$) but not the informative trial ($p = .35$). Separate 2 × 3 Fisher's tests were conducted to analyze differences among pairs of groups (see Table 5). Three analyses were conducted (no feedback vs. general feedback, no feedback vs. specific feedback, and general feedback vs. specific feedback), for which the use of a more stringent alpha level was required.[6] Results showed that none of the comparisons reached the required alpha level (all ps > .04).

Discussion

This study sought to specify the influence of preschoolers' experience with conversational breakdown on their developing understanding of a specific aspect of the process of knowing—namely, that the quality of information being accessed matters for knowledge acquisition. Results showed that (a) when the listener informs the speaker about *whether* and *why* he or she

6. An alpha level of .02 was used because $\alpha/3$ is $.05/3 = .016$.

Table 5. Frequency of scores of participants in droodles transfer task

	Training conditions							
	All participants (N = 46)		No feedback (*n* = 15)		General feedback (*n* = 15)		Specific feedback (*n* = 16)	
Droodles task	0	1	0	1	0	1	0	1
Prediction questions								
Informative score	3	43	0	15	1	14	2	14
Ambiguous score[a]	33	10	12	3	11	3	10	4
Justification questions								
Informative score	33	13	13	2	10	5	10	6
Ambiguous score	37	9	15	0	10	5	12	4

[a] Calculation of this score was contingent upon children's scores on the informative trial. Only children who obtained one point on the informative trial were considered here.

gained knowledge after each of the speaker's messages, or (b) when the listener informs the speaker about *whether* he or she gained knowledge after each of the speaker's messages, preschoolers improved in their ability to predict the state of knowledge of a listener after hearing both ambiguous messages and informative messages. Conversely, preschoolers who observed a speaker providing ambiguous messages and informative messages to a listener who did not supply any feedback (no-feedback condition) did not display any improvements in their ability to predict the state of knowledge of a listener after hearing both ambiguous messages and informative messages.

These findings expand upon earlier research about the role of feedback in children's performance in message evaluation and blame-assignment tasks. However, the current study is the first one to demonstrate that, like older children (Robinson, 1981; Sonnenschein, 1984), preschoolers are capable of gaining an understanding of the implications of ambiguous information for knowledge acquisition. They do this by observing instances in which the listener informs the speaker of his or her state of knowledge after the speaker's messages. Children who had received feedback ceased considering all messages (ambiguous and unambiguous) as informative and began to consider unambiguous messages as informative and ambiguous messages as uninformative for the addressee of a referential communication scenario. At the same time, these findings concur with previous evidence about the role of conversational breakdown in preschoolers' communicative development. They complement the finding that young children's ability to uniquely identify a referent for an addressee improves after they have experienced conversational breakdowns from a third-person perspective (Matthews, Lieven, & Tomasello, 2007).

Within the framework of theory-of-mind research, our results support the latest body of contributions (Harris, 1996, 1999; Lohmann & Tomasello, 2003; Tomasello, 1999) that highlight the role of language for the development of children's understanding of mind. Specifically, our results support the hypothesis that communicative exchanges, where two or more people express their different perspectives on the same linguistic formulation, constitute a rich arena for young children to understand the process of knowledge acquisition. Through these exchanges, children seem to be realizing that access to information is an important but insufficient prerequisite for gaining knowledge, and that access to unambiguous information plays a fundamental role on this process.

Although children in both feedback conditions improved from pretest to posttest in their ability to make correct predictions about the listener's state of knowledge after both kinds of messages, ambiguous and informative, results indicated that those in the specific-feedback group made the greatest gains. This difference between the two training conditions expands upon earlier evidence from studies on older children regarding the type of feedback they require to improve in their performance on blame-assignment (Robinson & Robinson, 1981, 1985) and message-quality tasks (Sonnenschein, 1984). Thus, it seems that in order for conversational breakdowns to more strongly impact preschoolers' understanding that the quality of information matters for the process of knowledge acquisition, conversational interlocutors need to state explicitly the possibility that ambiguous messages can be interpreted in more than one way.

This finding is also congruent with results from training studies on false-belief understanding (Clements, Rustin, & McCallum, 2000; Lohmann & Tomasello, 2003; Slaughter & Gopnik, 1996). In a false-belief training setting, Clements and colleagues (2000) found that only those children who had received explanations of why their answers were wrong were found to improve in their false-belief understanding. Merely being informed of the correctness of their answers did not result in significant improvements. Likewise, children who made the greatest gains in the present study were those who somehow received explanations as to why their answers were incorrect (specific-feedback condition), whereas those children who were informed only about the quality of their answers were found to make improvement from pretest to posttest (general-feedback condition) at a marginally significant level.

This similarity with Clements et al.'s findings raises the question of whether it was the experience with conversational breakdown specifying the possibility that ambiguous messages could be interpreted in more than one way, or whether it was the explanation itself that improved children's knowledge in the specific-feedback condition. The data presented here do not allow us to make definite conclusions between these two possibilities, since the specific-feedback condition combined these two options and the general-feedback condition was too general. Future research should investigate whether it would be sufficient for children to hear feedback such as "I don't know which one is in the box." The level of specificity of this feedback would be somewhere in between the feedback that children heard in the specific-feedback condition (i.e., "I don't know which one is in the box. Cookie Monster did not tell me which one is in the box. Is it A? Is it B or is it C?") and in the general-feedback condition ("I don't know what's in the box") in our study. This research question would also be important to address because many would argue that this kind of feedback *without* explanation is more representative of what children normally experience in their everyday life. To our knowledge, however, even though multiple studies have described the type of extraction styles parents used in natural conversations when facing ambiguous descriptions from preverbal infants and toddlers (Golinkoff, 1986; Mannle, Barton, & Tomasello, 1991; Mannle & Tomasello, 1987; Shatz & O'Reilly, 1990; Tomasello et al., 1990), little evidence is available about the types of extraction styles parents use with their preschoolers (e.g., Robinson & Robinson, 1981; Yont, Hewitt, & Miccio, 2000).

The difference in the effect of the two training conditions also raises the question of what it is that children in the specific-feedback and general-feedback conditions learned with training. The continuous progress of children during training in the specific-feedback condition, their concluding success in making predictions, and their ability not only to make correct predictions but also to justify them suggest that they developed a full-fledged understanding of the different effects of ambiguous and informative messages on the listener's knowledge. They learned that the speaker's referring expressions, particularly the pronominal form *it*, was not informative enough for the listener; hence, this referring expression did not lead to his or her knowledge about the contents of the box. At the same time, they learned that the speaker's referring expressions, including full nouns, were informative enough for the listener and led to his or her knowledge of the box contents.

In contrast, children in the general-feedback condition found it difficult to figure out the different effects of ambiguous messages and informative messages on the listener's knowledge. The children in this group who did not pass the communication posttest showed a continuous decrease in the number of attributions of knowledge they made during informative trials. The children from this group who improved from pretest to posttest seem to have done so on the basis of some kind of partial understanding, since they improved their ability to make predictions about the listener's knowledge but were unable to justify those predictions. Overall, this evidence suggests that children in the general-feedback condition gained some understanding about ambiguity not observed in the no-feedback group, in which an improvement from pretest to posttest was not found. The understanding of the general-feedback group, however, should be differentiated from the understanding gained by children in the specific-feedback condition, who were able to improve not only at the level of prediction but also at the level of justification.

Transfer was not observed in any of the groups, since all groups were found to perform poorly on the droodles transfer task. This evidence is congruent with previous results demonstrating the limited generalization of training paradigms in referential communication (Asher & Wigfield, 1981; Matthews et al., 2007), even when the chosen transfer tasks involve exactly the same abilities and share the same level of complexity as the main task. Both of the studies aforementioned mentioned measured the improvement of children's abilities to produce spoken descriptions that uniquely described the referent; both main and transfer tasks dealt with ambiguity in verbal communication. Despite the strong similarity between training and transfer contexts, children had difficulties transferring their knowledge from the main task to the transfer task. It is reasonable to hypothesize that transfer of knowledge in the present study was even particularly harder because of the salient differences between the training communicative task and the droodles transfer task. Even though children in both tasks were asked to predict and justify the state of knowledge of an addressee who faced ambiguity, contexts used in both tasks were significantly different. Whereas the main task dealt with ambiguity in verbal messages, the transfer task dealt with ambiguity in visual stimuli. The transfer of knowledge between these two different tasks was clearly a big jump for participants as young as those in the present study who, as previously noted by other researchers, have had difficulties in transferring knowledge between closer tasks (e.g., Matthews et al., 2007).

We made no predictions about children who attributed ignorance to the listener during all messages, ambiguous and informative, during pretest. Previous studies (e.g., Miller et al., 2003; Sodian, 1988) also found in their samples a small percentage of children who attributed ignorance to the listener during the informative trials. Our study is the first one in which children with this type of response were asked to justify their predictions, thereby enabling us to better understand (a) the way these children approached the task and (b) the relationship between their responses during pretest and their performance in posttest. An overview of their justifications during pretest indicated they ignored messages as sources of knowledge and focused on the visual access of the listener as the means through which he or she could gain knowledge. (All eight children in this group justified during the pretest that the listener would not know about the contents of the box because he did not have visual access.) It seems, then, that they showed a preference for a direct modality of knowledge acquisition (i.e., seeing) over an indirect one (i.e., hearing). That is, they relied on what someone saw for himself or herself as a direct experience as opposed to relying on hearing information coming from someone else. As others have previously suggested (Robinson, 1994), linguistic statements are more indirect sources of knowledge than directly seeing, given that the former consist of comments about reality coming from and constructed by someone else's mind. Based on this distinction, these children may have started to experience the fact that minds can misrepresent reality (such as in the case of false beliefs and lies), and that is why they relied on seeing as a more direct source of knowledge. This early awareness could explain their improvement from pretest to posttest as independent of training condition.

Looking at the responses of children during pretest also raises the question of whether the majority of children in this study—who attributed knowledge after informative messages and ambiguous messages during pretest—did it simply because they replied yes to all questions or because they really were attributing knowledge to the listener after hearing all messages (ambiguous and informative). The progress of children in the specific-feedback and general-feedback conditions indicates that, with training, children made progress that could have not been possible if their responses corresponded to only a response bias. Furthermore, evidence from other studies like this one, measuring children's understanding of the implications of ambiguous information for knowledge acquisition but through alternative means such as pointing gestures, concurs with our evidence from pretest (Nilsen, Graham, Smith, & Chambers, 2008). It demonstrates that preschoolers consider both ambiguous messages and unambiguous messages as informative. Likewise, evidence from studies using the same forced-choice questions used in the present study but also including control questions suggests that preschoolers' responses to this type of task are not the result of a response bias (Montgomery, 1993).

Overall, this study has two potential implications. At a theoretical level, our results could highlight the need to consider the role of experience with conversational breakdowns for children in developing an understanding of mind. Further studies could expand upon our evidence, which derives from a very specific context, in order to explore this line of reasoning further into more generalizable contexts. At an applied level, an important implication concerns the types of feedback that are more beneficial for children. Informing caregivers of the special role of specific clarification requests and statements of noncomprehension could contribute not only to children's communicative development (as previously pointed out by Matthews, Lieven, Theakston, & Tomasello, 2006) but also to their understanding of the causal connection between the quality of information and knowledge acquisition.

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