Seventeen-month-olds appeal to false beliefs to interpret others' referential communication

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Abstract

Recent studies have demonstrated infants' pragmatic abilities for resolving the referential ambiguity of non-verbal communicative gestures, and for inferring the intended meaning of a communicator's utterances. These abilities are difficult to reconcile with the view that it is not until around four years that children can reason about the internal mental states of others. In the current study, we tested whether 17-month-old infants are able to track the status of a communicator's epistemic state and use this to infer what she intends to refer to. Our results show that manipulating whether or not a communicator has a false belief leads infants to different interpretations of the same communicative act, and demonstrate early mental state attribution in a pragmatic context.

Introduction

Speakers' utterances vastly underdetermine their intended meaning (Grice, 1989), and non-verbal forms of communication may be even more equivocal. For example, deictic gestures, like pointing or gazing, cannot unambiguously specify what a recipient should attend to (Liebal, Colombi, Rogers, Warneken, & Tomasello, 2008; Tomasello, 2008; Tomasello, Carpenter, & Liszkowski, 2007). Uncovering the intended referent of (verbal or non-verbal) communicative acts thus requires the capacity to enrich their meaning—an inferential process dependent on the underlying *pragmatic* competence of the recipient.

Such pragmatic competence may be especially important for young preverbal children who need to acquire a vast amount of information from referentially ambiguous communicative signals. In fact, children take into account a variety of pragmatic cues, which are readily available for identifying the intended referent of communication. For example, toddlers use the direction of a speaker's gaze in order to assign reference (Baldwin, 1993; Bloom, 2000; Koenig & Echols, 2003). When the direction of gaze is ambiguous, infants rely on other strategies. For example, they assume that if someone uses a novel label, it does not refer to an object they already have a label for (Diesendruck & Markson, 2001).

Whether the use of such pragmatic inferences requires consideration of the mental states of the communicator is debated (Breheny, 2006; Ganea & Saylor, 2007). For example, assuming that objects have only one label may be a lexical, rather than a pragmatic, constraint (Woodward & Markman, 1998). Similarly, reference assignment could be achieved by monitoring the physical co-presence of objects and

people, without the need to think about what people know (O'Neill, 2005). However, recent studies suggest that, at around the same age as children demonstrate pragmatic inferences, they are also capable of taking into account the epistemic states of others. For example, 15-month-olds show 'surprise' when someone searches in a container where her toy was moved to in her absence (Onishi & Baillargeon, 2005). This suggests that infants understand that the person did not know that her toy had been moved. In another study, 25-month-olds were able to correctly anticipate that someone who did not see her toy being moved would incorrectly search in the location where she last saw it (Southgate, Senju, & Csibra, 2007), suggesting that young children can track the content of others' epistemic states, and take into account their false belief when predicting their actions.

These recent findings raise the possibility that mental state reasoning may also be available to infants for pragmatic inference. As communicators are not always competent, the ability to consider that someone's communication is based on a belief that is false may be important in preventing recipients from misinterpreting what a communicator intends to refer to (Sperber, 1994). Previous research suggests that older children are able to monitor a speaker's ignorance (Nurmsoo & Bloom, 2008) and track a speaker's false beliefs in order to assign reference (Carpenter, Call, & Tomasello, 2002; Happé & Loth, 2002). However, whether younger children can use their demonstrated epistemic state attribution abilities in order to interpret referentially ambiguous communicative acts is unknown. More specifically, at an age where infants are reported to demonstrate considerable pragmatic

competence, can they assign reference correctly in a situation where a speaker has a false belief about the object she intends to refer to?

The studies reported here were designed to investigate this question. We presented seventeen-month-old infants with a paradigm combining elements of a number of studies that have demonstrated older children's abilities to attribute false beliefs in order to resolve reference (Carpenter, Call, & Tomasello, 2002; Happé & Loth, 2002; Mitchell, Robinson, & Thompson, 1999). An experimenter placed two novel unnamed objects in two separate boxes and left the room. A second experimenter then appeared and switched the objects so that they were each now in opposite boxes. In the critical false-belief condition, the original experimenter returned to the room, apparently ignorant of the fact that another person had been there, and pointed to one of the two (closed) boxes. We reasoned that if infants take into account that this experimenter does not know that the objects have been switched, they will understand that the intended referent is not the object in the box to which the experimenter is now ostensively gazing and pointing, but the object in the other, non-referred box.

Experiment 1

Infants participated in either a false-belief condition or a true-belief condition, the only difference being the point at which the first experimenter returned to the room. In the false-belief condition, the first experimenter returned after the second experimenter had switched the objects and disappeared. In the true-belief condition, the first experimenter returned before the second experimenter began switching

the objects, and so witnessed the actual location of each of the objects. If infants take into account the speaker's beliefs in order to assign reference, they should interpret the first experimenter's communicative act differently in the two conditions.

Method

Participants

Twenty-four 17-month-olds participated in Experiment 1 (15 female; mean age = 17 months 21 days, range = 17 months 10 days through 18 months 6 days). An additional 3 infants were excluded because of fussiness (2) and failing to make a choice (1). Twelve infants were assigned to each of two conditions: false-belief (mean age = 17 months 22 days), and true-belief (mean age = 17 months 19 days).

Procedure

Each infant was seated on the floor with their parent. Two boxes (orange and black) were placed on the floor 120 cm from the child and 100 cm apart. Each infant was presented with between 2 and 4 warm-up trials designed to familiarize them with searching for objects in the boxes. Each infant then received a single test trial.

Warm-up trials. Infants were shown a pair of familiar objects (e.g., a duck and a shoe) by an experimenter (E1) and allowed to play with them for roughly 10 seconds. E1 then took the objects and placed one in each box. E1 then asked the child to find one of the objects, followed by the other one. This was continued until the child correctly chose the requested object twice in a row from two different boxes.

Test trials. Following the warm-up trials, E1 gave infants two novel objects (a green watering can spout and a red lemon squeezer), chosen to be of similar size and interest, and infants were allowed to explore the two objects for about 10 seconds. E1 then took the objects and placed one in each box, and closed the lids. The location of each object (orange or black box) was counterbalanced across infants. E1 then told the infant that she had to go out of the room for a minute and left. As soon as E1 had left the room, a second experimenter (E2) appeared from behind curtains at the back of the room, greeted the infant and approached the boxes. To emphasize the deceptive nature of the context, an element that may improve performance on false belief tasks (Sullivan & Winner, 1993), infants did not know that E2 was behind the curtains, had never seen her before, and E2 behaved in a deceptive manner (crept towards the boxes, and gestured to the infant to 'shush').

False-belief condition. E2 switched the objects, closed the boxes, gestured 'shush' to the infant, waved goodbye, and crept back behind the curtains. At this point, E1 returned to the room, greeted the infant, and sat on the floor behind the two boxes. E1 then pointed towards one of the boxes (counterbalanced across infants[1]) and said, "Do you remember what I put in here? There's a sefo in here. There's a sefo in this box. Shall we play with the sefo?", constantly alternating gaze between the infant and the referred-to box. E1 then reached forward and simultaneously opened both boxes, without looking inside of them, and whilst looking at the child. At this point, the contents of the boxes were visible to the infant, but not to E1. E1 then said to the infant, "Can you get the sefo for

[1] Counterbalancings for object location and box pointed to were crossed so that the experimenter did not always refer to the same object.

me?", while looking directly at the infant, and not signalling either box. E1 continued to repeat the question until the infant began to approach one of the boxes, or pointed towards one of the boxes.

True-belief condition. The procedure was identical to the one used in the false-belief condition except for one difference: E2 removed each object from its box, at which point E1 returned to the room, and watched as E2 placed each of the objects in the opposite boxes. As in the false-belief condition, E2 then disappeared back behind the curtains and E1 sat behind the two boxes. E1 then did exactly what was done in the false-belief condition, opened the boxes and asked the infant "Can you get the sefo for me?".

Coding

The whole session was recorded on videotape and coded off-line. The first response towards one of the boxes after E1 had said "Can you get the sefo for me?" was coded as the infant's choice. Responses were either 'box first approached', or 'box first pointed at'. A second coder viewed the recordings of each infant, cut to exclude E1's pointing and everything that preceded this. Agreement between coders was 100%. Furthermore, although E1's referential behaviour was intended to be identical in the true- and false-belief conditions, in order to verify that E1's referential behaviour was indistinguishable in the true- and false-belief conditions, a naïve coder assessed a subset (6 randomly selected from each of the true- and false-belief conditions) of video recordings, which were cut immediately prior to the onset of pointing and after E1 had openened both boxes. In this way, the coder, who was informed about the experimental

procedure, did not know whether the clip was taken from the true- or false-belief condition. The coder was asked to judge in a 2AFC procedure whether E1 had witnessed the swap. She was correct in 6 cases, which is not different from chance (p = .23, two-choice binomial).

Results and Discussion

The number of infants who chose the referred and the non-referred box is depicted on Figure 1. In the false-belief condition, 9 out of 12 infants chose the non-referred box (7 by approaching, 2 by pointing), whereas in the true belief condition, 9 out of 12 infants chose the referred box (8 by approaching, 1 by pointing). A Fisher's exact test confirmed that the number of infants choosing the referred box differed significantly between conditions (p = .039, two-tailed), suggesting that infants in the two conditions interpreted the communication as referring to different objects. In the true-belief condition, the majority of infants interpreted E1's communication as referring to the object in the box towards which she was pointing, whereas in the false belief condition most infants interpreted the referent as being the object in the opposite box to the one indicated by E1. In order to choose the non-referred box, infants must have understood that E1 intended to label an object, but that the object she was intending to label was not in the box towards which she was gesturing. This result suggests that infants take into account others' false beliefs when interpreting their communication.

Experiment 2

Previous studies demonstrate that infants of this age can use pronouns to identify novel referents (Ganea & Saylor, 2007; Moll, Carpenter, & Tomasello, 2007; Tomasello & Harberl, 2003) as easily as they can use novel labels (Akhtar, Carpenter, & Tomasello, 1996). However, it is possible that infants might take into account other people's epistemic states more readily in situations where there is the potential to learn some new information (e.g., a new label). We explored this possibility in Experiment 2 by substituting the word 'sefo' for the pronoun 'it' in both false- and true-belief conditions identical to those of Experiment 1.

Method

Subjects

Twenty-four 17-month-olds participated in Experiment 2 (14 male; mean age = 17 months 28 days, range = 17 months 14 days through 18 months 19 days). An additional 11 infants were excluded because of fussiness (4), failing to make a choice (2), parental interference (3), and experimenter error (2). Twelve infants were assigned to each of two conditions: false-belief (mean age = 17 months 25 days), and true-belief (mean age = 18 months 1 days).

Procedure

The procedure for both the true- and false-belief conditions was identical to Experiment 1 except for what was said while pointing and gazing at the box. In this experiment, E1 said, "Do you remember what I put in here?

Shall we play with it? Shall we play with it? Let's play with it!". Finally she said, "Can you get it for me?".

Results and Discussion

The number of infants who chose each box is again depicted in Figure 1. In the false-belief condition, 10 out of 12 infants chose the non-referred box (6 by approaching, 4 by pointing), whereas in the true-belief condition, 11 out of 12 infants chose the referred box (all by approaching). A Fisher's exact test confirmed that the number of infants choosing the referred box differed significantly between conditions (p = .002, two-tailed), suggesting again that infants in the two conditions interpreted the communication as referring to different objects. Further tests comparing the performance of infants in both the false-belief and the true-belief conditions of Experiments 1 and 2 revealed no difference between Experiments (p = 1.0 and 0.6 for false- and true-belief conditions respectively), suggesting that infants in both false-belief groups assigned reference to the object in the box that the experimenter did *not* point to (the non-referred box), whereas infants in both true-belief groups assigned reference to the object in the box that the experimenter *did* point to (the referred box).

To confirm that infants were choosing the correct location rather than simply performing at chance, we first combined data from the false-belief conditions of Experiments 1 and 2. Overall, nineteen out of 24 infants chose the non-referred box on false-belief trials, a number significantly greater than would be expected by chance (p = .007, two-choice binomial test, two-tailed). We then combined data from the true-

belief conditions of Experiments 1 and 2. Twenty out of 24 infants chose the referred box on true-belief trials, a number significantly greater than would be expected by chance ($p = .002$, two-choice binomial test, two-tailed). Thus, infants in both true- and false-belief conditions chose the expected box significantly above chance. Furthermore, performance on Experiment 2 replicates that of Experiment 1, and indicates that novel labels are not necessary to elicit reference resolution through belief attribution.

Experiment 3

An alternative explanation for why children in the false belief conditions of the previous experiments chose the non-referred box is that they were able to make use of a literal interpretation of the lead-in phrase, "do you remember what I put in here?", in order to identify which object E1 had put in the box to which she was now referring. Responding on the basis of literal interpretation would not require the infant to reason that E1 had not witnessed the switch of objects, nor would it require any attribution of false belief. Although the opposite responding of infants in the true-belief conditions of Experiments 1 and 2 suggests that their behaviour was not driven by a literal interpretation of this phrase, a further experiment was designed to eliminate this possibility by replacing the lead-in phrase "do you remember what I put in here?" with the phrase "do you know what's in here?", in a final false-belief condition.

Method

Subjects

Twelve 17-month-olds participated in Experiment 2 (4 male; mean age = 17 months 29 days, range = 17 months 16 days through 18 months 9 days). An additional 6 infants were excluded because of fussiness (1), failing to choose correctly on warm-up trials (1), parental interference (2), and experimenter error (2).

Procedure

The procedure was identical to the false-belief conditions of Experiments 1 and 2, except for the fact that E1 replaced the lead-in phrase, 'do you remember what I put in here?' with 'do you know what's in here?'. As we found no difference between using a label and using a pronoun in Experiments 1 and 2, in Experiment 3 we combined these in a more natural usage, saying, "Do you know what's in here? There's a sefo in the box! There's a sefo in the here! Can you get it for me?".

Results and Discussion

In this experiment, 9 out of the 12 infants chose the non-referred box first (8 by approaching, 1 by pointing), which is not different from the number of infants who chose the non-referred box in the false-belief conditions of Experiments 1 (p = 1.0) and 2 (p = 1.0). Thus, we replicated the results from Experiments 1 and 2, and eliminated the possibility that infants were using the phrase 'do you remember what I put in here?' as a way to identify which object the speaker was referring to. Across all three Experiments, 28 out of 36 infants chose the non-referred box when E1

was absent during the switch, a number that is significantly greater than would be expected by chance (p = .0004, two-choice binomial test, two-tailed).

General Discussion

Our results demonstrate that 17-month-old infants are able to attribute beliefs to others, and that they can use this ability to assign reference in a communicative context. Whereas infants in the true-belief conditions predominantly chose the object in the box indicated by the experimenter, the majority of infants in all three false-belief conditions chose the object in the box that was *not* referred to by the experimenter. This provides strong evidence in favour of the proposal that children are able, from a very young age, to deal with referential ambiguity by taking into account a speaker's internal representations.

We argue that, in order to identify the object in the non-referred box as the intended referent, infants in our study needed to represent the status of E1's epistemic state about the content of the boxes. Although some have argued that children can solve false belief tasks by operating with a rule that if someone has not seen what has happened, they will 'get it wrong' (Fabricius & Imbens-Bailey, 2000; Ruffman, 1996; Saxe, 2005), recent research has found little support for the proposal that children make such mistaken inferences (Friedman & Petrashek, 2009; Perner & Horn, 2003; Southgate, Senju, & Csibra, 2007). Furthermore, in the case of the current task, it is not easy to see how such a rule could lead children to the conclusion that the referent object is in the non-referred box. Thus, in line with other authors (e.g., Happé & Loth, 2002; Carpenter

et al., 2002), we interpret our data from 17-month-olds as evidence that they can represent others as holding beliefs that are false.

Unlike in the standard 'displacement' false belief task (Wimmer & Perner, 1983; Onishi & Baillargeon, 2005), where the child is a mere observer of a scenario concerning two other characters, in the current task the child's role is more participatory. Here, they are involved in a finding game with E1 and their success in the game requires them to take into account E1's epistemic states. This may have several important consequences. First, a task involving direct participation takes advantage of young children's well-documented motivation to help and inform others (Liszkowski, Carpenter, Striano, & Tomasello, 2006; Warneken & Tomasello, 2007). It is interesting to note that a number of infants in our sample indeed attempted to inform E1 of the presence of E2 behind the curtains when she returned. The second consequence of this direct involvement is that such communicative contexts are proposed to be associated with very special expectations (Gergely & Csibra, 2006). The presence of multiple ostensive cues is likely to lead the child to infer that the situation has some relevance *for him/her* (Sperber & Wilson, 1986/1995), and as these kinds of ostensive contexts have been proposed to induce an expectation that one will receive valuable information to be learnt (Csibra & Gergely, 2009; Gergely & Csibra, 2006), tracking others' epistemic states may become more important than in situations involving pure observation.

This conclusion leads to the interesting proposal that infants may more readily track others' epistemic states in communicative than in non-communicative situations, a possibility that has previously been raised by

Roth & Leslie (1991). Indeed, successfully interpreting others' communication, and being a competent communicator oneself, likely depends on the ability to evaluate and take into account others' epistemic states (Grice, 1989). This claim echoes recent data obtained with 14-month-old infants who appear to track others' experiences only if they have been involved in (communicative) joint engagement with them (Moll, Carpenter, & Tomasello, 2007). Whether or not it is communicative engagement that facilitates the tracking of others' epistemic states, our finding shows that 17-month-old infants deploy such abilities as part of their pragmatic competence.

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Figure 1: Number of infants who searched in each box, in each of the conditions across the 3 experiments.