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PAPER

Infants use shared experience to interpret pointing gestures

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Abstract

We investigated whether 1-year-old infants use their shared experience with an adult to determine the meaning of a pointing gesture. In the first study, after two adults had each shared a different activity with the infant, one of the adults pointed to a target object. Eighteen- but not 14-month-olds responded appropriately to the pointing gesture based on the particular activity they had previously shared with that particular adult. In the second study, 14-month-olds were successful in a simpler procedure in which the pointing adult either had or had not shared a relevant activity with the infant prior to the pointing. Infants just beginning to learn language thus already show a complex understanding of the pragmatics of cooperative communication in which shared experience with particular individuals plays a crucial role.

Introduction

By itself, a pointing gesture is almost totally ambiguous. For example, if I point for my daughter to her backpack on the kitchen counter, I could mean almost anything. In terms of referent, I could be indicating the backpack itself, or its contents, or its color. But even with a clear referent – say the backpack as a whole – I still might mean almost anything from 'it's time to do your homework' to 'try searching there for your missing keys'. To understand my communicative act, my daughter must understand both what I am directing her attention to (my referential intention) and also why I am directing her attention to it (my social intention or meaning; see Tomasello, Carpenter & Liszkowski, 2007, for more on these terms).

Recent theoretical accounts of human communication have emphasized the necessity of joint attention, shared experience, or common ground in determining the meaning of communicative acts (e.g. Clark, 1996; Lee, 2001; Lewis, 1969; Schiffer, 1972; Stalnaker, 1973, 1978; Bruner, 1983; Tomasello, 1992, 2003). The idea is that the 'mind-reading' required in cooperative communication is normally fruitful only if it takes place within some pool of shared experiences or common ground between communicator and recipient, which anchors their mutual inferences about one another's knowledge and attention in something that they both know (Tomasello, 2008). For example, if I enter the kitchen and completely out of the blue point to the backpack, my daughter will likely ask 'Huh?' She will not know what I mean because it is not sufficient for her simply to search for what is relevant about the backpack for herself egocentrically (Sperber & Wilson, 1986); she must figure out why I think the backpack is relevant for her in this context. Thus, even if she knows there is some illicit object inside her backpack, that only she knows is in there, despite her fears she would be perplexed as to what I could mean – or else she would wonder how I could have found out about it. On the other hand, if every day for the past two weeks when I enter the kitchen after school I have told her to remove her backpack from the counter, then my pointing gesture would be immediately meaningful and unambiguous because it would be grounded in our shared experience.

This process is illustrated most clearly by comparing apes' and human infants' responses in the so-called object choice experimental paradigm. In this paradigm, in the context of a hiding–finding game, a reward is hidden in one of several hiding places (typically, opaque containers). Then an experimenter simply points and gazes to the hiding place to inform the ape or infant of the location of the hidden reward. Apes often follow the pointing gesture to the designated container – in some sense they understand the referent of the experimenter's point – but then, even though they are seeking the food reward, they do not seem to know that this means that the food is hidden there; they do not seem to ask themselves *why* the human is directing them to this container (see Call & Tomasello, 2005, for a review). Human

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infants, on the other hand, succeed in this task by 14 months of age, suggesting that they do recognize why the experimenter is directing their attention to the container (whereas in a control condition in which the experimenter held her hand in a pointing-like configuration in a casual, non-intentional way, infants did not succeed in finding the reward; Behne, Carpenter & Tomasello, 2005). One interpretation of these findings is that infants are successful because they seek the relevance of the adult's pointing gesture in the common ground of the hiding–finding game, in which their role is to seek and the adult's role is to help them find the hidden toy – whereas apes do not create or use common ground in this way.

But it is still possible that in this task infants are interpreting the pointing gesture *egocentrically*: Since they are searching for the reward and their attention is drawn to the container, they simply search there (and the pointing-like configuration of the control condition does not direct their attention to the container in the necessary manner). It is thus important to determine whether infants already interpret others' communicative acts based on the common ground or experience they have shared with their interlocutors, as adults do (e.g. Hanna, Tanenhaus & Trueswell, 2003). There is evidence that 2-year-old and older children communicate differently depending on the previous discourse they have shared with an adult (e.g. use different referring expressions; Matthews, Lieven, Theakston & Tomasello, 2006), and that children, even 1-year-old infants, point more when adults are ignorant than when they are not (Liszkowski, Carpenter & Tomasello, 2007; O'Neill, 1996). But, to our knowledge, there are only two sets of studies that have directly investigated whether infants rely on their shared experience with an adult to interpret an otherwise ambiguous communicative act.

First, Ganea and Saylor (2007) found that 15- and 18-month-old infants responded appropriately to an adult's ambiguous verbal request ('Can you get it for me?') by handing over the one of two objects they had previously searched for together. Crucially, infants did not do this in a control condition in which the requester was a new, second adult who had not shared this searching experience with them. Saylor and Ganea (2007) showed in addition that 14- to 20-month-olds can keep track of which of two objects (balls) they had shared with which of two adults and select that object in response to an ambiguous request from one of the adults ('Where's the ball?'). Infants thus used their shared experience with the adult to identify the intended object referent of an ambiguous piece of language. Second, in a study by Moll, Richter, Carpenter and Tomasello (2008), 14-month-olds shared one object with an adult in a special way several times on their way to the test room, then shared two other objects in a more normal fashion in the test room. When the adult later entered the test room and requested an object ambiguously (she held out her hand toward a tray with all three objects on it and said, 'Wow, look, can you give it to me, please?'), infants gave her the object they had shared with her specially. In contrast, they did not do this in control conditions in which either infants first shared the object specially with a *different* adult or the requesting adult had explored the object on the way to the test room *individually* (see also Moll, Carpenter & Tomasello, 2007, for more evidence that directly sharing with the adult is important in these types of situations).

These studies provide evidence that infants can distinguish whether or not they have shared experience with others and can use this shared experience to identify the adult's referential intention, the referent of her ambiguous communicative act. However, they do not address the question of whether infants can use shared experience to further infer the adult's social intention, what she wants them to do with that referent, arguably a more complex task. Thus, in our studies, different experimenters pointed communicatively to a single, unambiguous referent in a similar manner in all conditions, and infants had to infer the experimenter's intended message regarding that referent on the basis of what particular activity they had previously shared with that particular adult. The question was whether infants would respond egocentrically, in terms of their own current goals and interests (and thus not show a difference in responding across conditions), or whether instead they would interpret and respond to the intended message differently depending on their previously shared experience with the pointing adult.

Study 1

To test whether infants can keep track of which particular experiences they have shared with particular adults and interpret the meaning of their gestures accordingly, all infants first shared one activity with one experimenter (E1) and then a second activity with a different experimenter (E2). Later, one of the experimenters – either E1 or E2 – pointed toward a novel target object (which was potentially appropriate for either activity). We predicted that infants would respond differently and appropriately based on what particular experience they had previously shared with the particular adult who pointed.

Method

Participants

Twenty-four 18-month-olds (12 girls, 12 boys; M = 18;8; *range* = 17;22–18;20) and 24 14-month-olds (10 girls, 14 boys; M = 14;9; *range* = 13;25–14;22) participated. Infants were recruited from a database of children whose parents had volunteered to participate in child development studies. Additional infants were tested but excluded because they did not participate at all (six 18- and 11 14-month-olds), they lost interest in one of the shared activities (12 14-month-olds), the parent interfered and

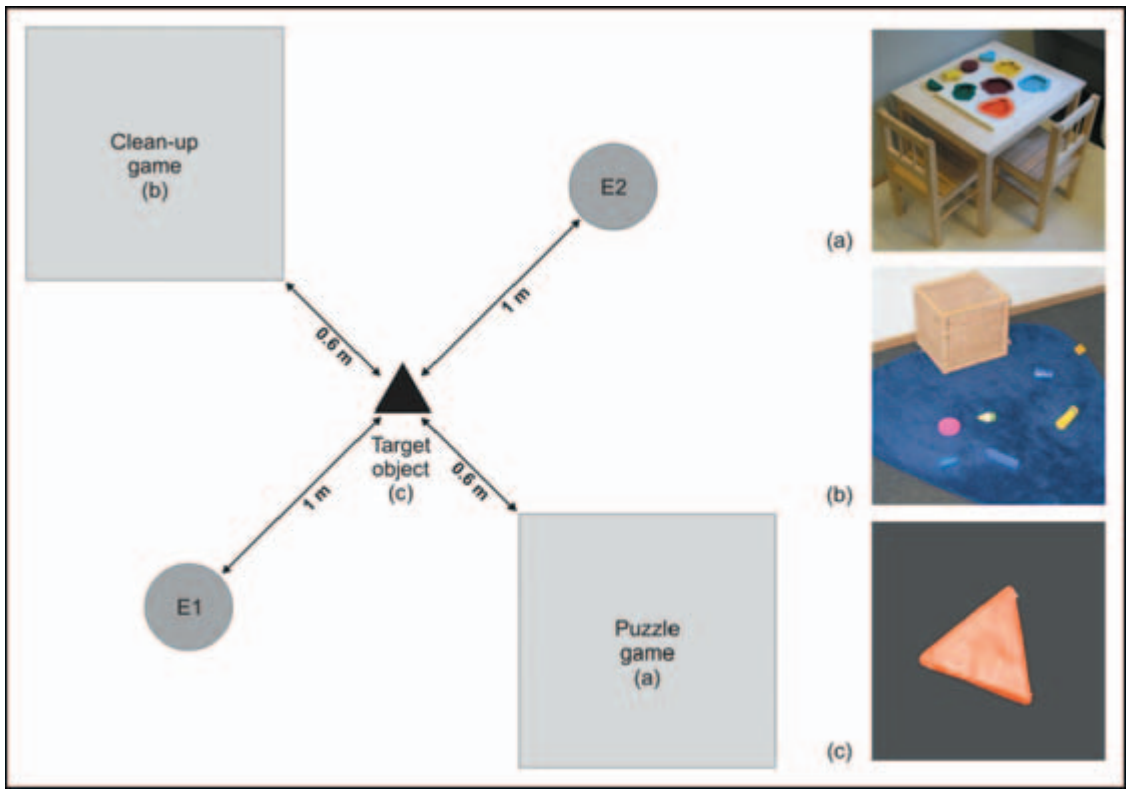

Figure 1 *Set-up of Study 1 with photos of (a) materials used for the puzzle game, (b) materials used for the clean-up game, and (c) the target object.*

influenced the infant's response (one infant at each age), or the infant did not look at the target object during the test (one 18-month-old).

Materials and design

Materials for the first activity (puzzle game) were a puzzle board (40 × 30 cm) with five holes and four pieces, played with at an infant-sized table. Materials for the second activity (clean-up game) were a basket (35 × 32 cm) and eight objects of mixed shapes, colors, and materials; this game was played on a small rug at the other side of the room, opposite the puzzle table (see Figure 1). The target object was an orange cardboard triangle (length of sides 7 cm, depth 2 cm) that could either be seen as the missing puzzle piece or an object of the clean-up game.

A between-subjects design was used. Each infant received just one trial. Infants were randomly assigned to either the E1-points or the E2-points condition. The experimenters assigned to the roles of E1 and E2 and the location of the games (see Figure 1) were fully counterbalanced.

Procedure

After a short *familiarization phase*, all infants first played a *puzzle game* with E1: they put each of four objects in turn into the puzzle with her. The final piece was missing, however, and E1 could not find it. She left the room, saying that they would continue later. Then, all infants played a *clean-up game* with E2 at the opposite side of the room: E2 and the infant playfully tossed a variety of objects which were spread over the floor into the basket. Near the end of this game, E2 surreptitiously placed the target object on the floor behind her in the center of the room, equidistant from both games.

Then, the *test phase* followed. Immediately after the last object was cleaned up, E1 re-entered the room, E2 moved to a predetermined location, and, depending on the condition, either E1 or E2 produced the pointing gesture in exactly the same manner. They did this by calling the infant's name and saying 'Oh, there!' (using the same intonation) while pointing at the target object for 4 seconds and alternating gaze between the infant's face and the target object. Note that during the pointing gesture the experimenters were positioned opposite each other, equidistant from both the target object and the games (see Figure 1). The response period was 15 sec starting from the moment the experimenter pointed. If the infant did not attend to the point at first, it was repeated until the infant saw the target object (and then that was when the response period started).

Coding, reliability and analyses

Infants' response to the pointing gesture was coded from videotape. Infants' responses were coded as either turning to the puzzle game, turning to the clean-up game or as 'other responses'. Infants' responses were scored as turning to the puzzle or clean-up game if infants either

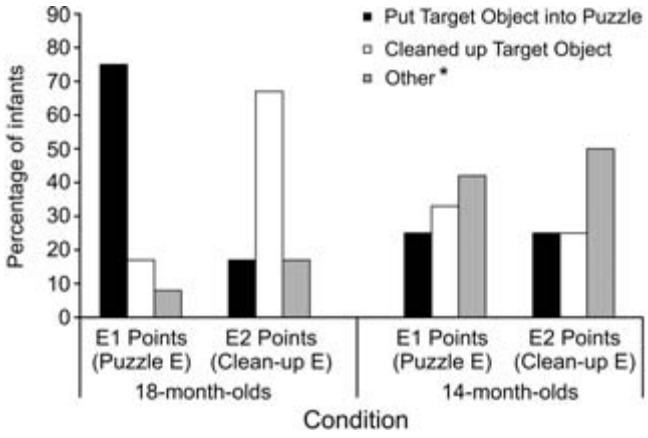

Figure 2 *Percentage of infants who showed each type of response in each condition in Study 1.*

* Other responses were those in which infants neither continued the puzzle game nor the clean-up game. They included (1) unclear responses (e.g. walking around the room with the target object or only looking at the target object) and (2) responses that were related to the games but did not involve clearly turning to one game (e.g. going to the puzzle game, taking out another puzzle piece and taking both pieces to the parent). A second analysis that treated this second category of related responses as correct responses showed the same pattern of results as that reported above for both age groups.

put the target object into the respective game themselves or else gave it to the pointing experimenter and went expectantly to the puzzle table or basket. Each infant received a single score. To assess interrater reliability, a coder who was unaware of which experimenter had shared which activity with the infant independently coded 100% of the videotapes. Perfect agreement was achieved ($\kappa = 1$ for both age groups).

As a manipulation check, a coder who was blind to condition watched each point and was asked to judge which activity the pointing gesture related to. All of the points were rated as 'indeterminable'. Thus, as designed, neither experimenter provided any inadvertent cues that could have biased infants' responses. Because the response measure was categorical, each age group was analyzed separately. Exact, two-tailed *p*-values are reported throughout.

Results and discussion

For the 18-month-olds, there was a significant difference in infants' response to the pointing gesture depending on who pointed (Fisher's exact test comparing the three responses across the two conditions, $p < .02$, $\phi = .35$, medium effect, see Cohen, 1988; see Figure 2). More specifically, when E1 pointed, the majority of infants put the target object into the puzzle, the game they had shared with her (Fisher's exact test comparing puzzle vs. all other responses combined, $p < .02$, $\phi = .59$, large effect). In contrast, when E2 pointed, the majority of infants put the target object into the basket, the game they had shared with her (Fisher's exact test comparing basket vs. all other responses combined, $p < .04$, $\phi = .51$, large effect; see Figure 2).

For the 14-month-olds, in contrast, there was no significant difference in infants' response to the gesture depending on who pointed (Fisher's exact test, $p = 1.00$; see Figure 2). Infants often put the target object into the games but they did so irrespective of which game they had previously shared with the pointing adult.

Thus, only the older infants were able to keep track of the particular experiences they had shared with two different adults, and use this to interpret the meaning underlying the adult's pointing gesture. When at the end of the clean-up game E2 pointed at the target object, 18-month-olds put it into the basket. Crucially, when at exactly the same moment in the procedure E1 pointed, infants pulled themselves away from the cleaning-up activity they had just been involved in and put the target object instead into the puzzle. This latter condition in particular thus indicates that infants were not interpreting the pointing gesture from an egocentric perspective in terms of what was most relevant for them at that moment but rather based on the shared experience they had previously had with the particular adult who pointed.

We suspected that the 14-month-olds' difficulty with this study was likely caused by the extra memory demands it placed on them. In particular, in this study infants had to keep track of two different people and two different, novel games before the test. Therefore, in Study 2 we used a simpler procedure in which infants shared just one activity with the adult prior to the pointing gesture, and the pointing adult had either shared or not shared this activity with the infant.

Study 2

In this study, in each of two conditions infants shared a clean-up game involving multiple different objects with an experimenter (E1). At the end of this game, depending on the condition, either E1 or a different experimenter (E2), with whom infants had not shared any relevant experience, pointed toward a new object. If infants understood the situation correctly, they should clean up this new object when E1 pointed but not when E2 pointed.

Method

Participants

Thirty 18-month-olds (15 girls, 15 boys; *M* = 18;6; *range* = 17;24–18;23) and 30 14-month-olds (17 girls, 13 boys; *M* = 14;7; *range* = 13;22–14;18) participated. Additional infants were tested but excluded from the final sample because they did not participate at all due to fussiness (nine 18- and 12 14-month-olds), they did not complete both trials in the two conditions (four 18- and five 14-month-olds), or because of experimental error or parental interference (three 14-month-olds).

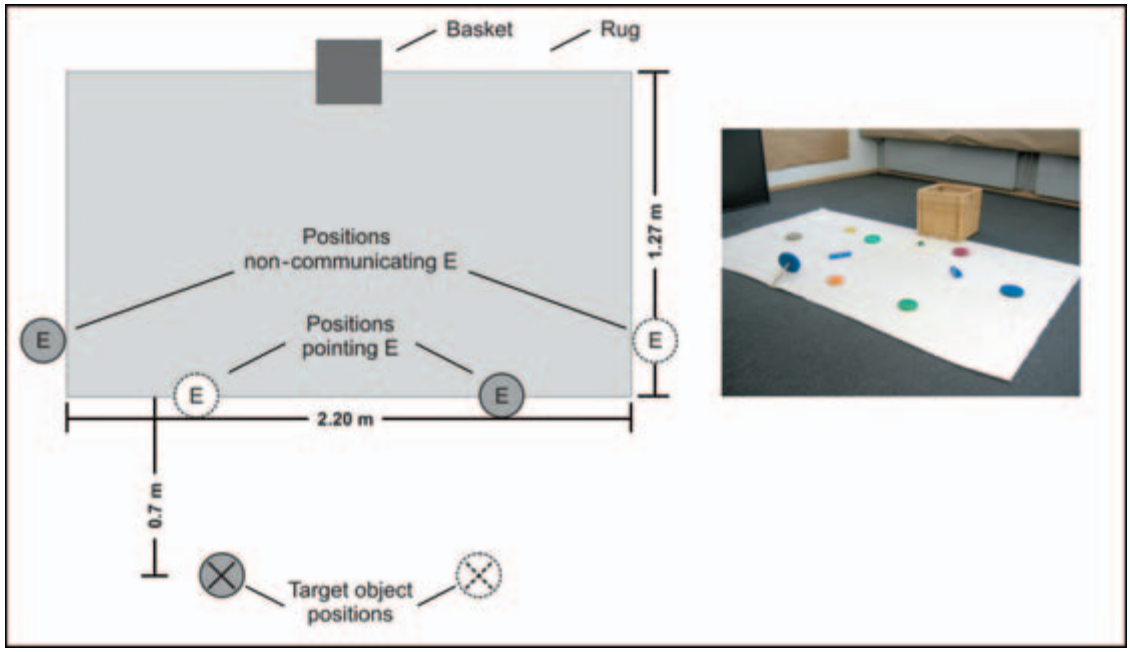

Figure 3 *Set-up of Study 2. Dark circles represent one counterbalancing configuration and light circles represent the other.*

Materials and design

Materials for the shared activity were: a square basket (35 × 32 cm) and 11 different objects of mixed shapes, colors, and materials (e.g. wooden blocks and plastic rings). The target object for each condition was one of three similar (although slightly more colorful) additional objects.

In a within-subjects design, all infants received two trials, one in each condition. In the final sample, conditions, target objects, and location of target object and position of the pointing experimenter (see below) were approximately counterbalanced across subjects.

Procedure

First, in a *familiarization phase*, infants played with both E1 and E2 with unrelated toys for approximately 15 minutes. Then the test began. Each of the two trials began with a *shared experience phase* during which E1 and the infant shared a clean-up game. At the end of this phase, E2 entered the room. Then, the *test phase* followed in which either E1 or E2, depending on the condition, pointed at the target object.

Thus, in the *Shared* condition, E1 spread the objects over the rug and said, 'Let's clean up all the objects!' When only three objects were left to clean up, E1 surreptitiously placed the target object on the floor behind her, beyond the rug, either to the left or right of the basket (see Figure 3), after which E2 entered the room. E1 then moved to a predetermined location (see Figure 3) and produced the pointing gesture by calling the infant's name and saying 'There!' while pointing at the target object for 4 seconds and alternating gaze between the infant and the target object. In the *Unshared* condition, E1 and the infant began by cleaning up the objects, exactly as in the Shared condition. When three objects were left, E1 placed the target object as before, E2 entered, and then E2, who had not shared the cleaning-up activity, pointed at the target object in the same manner as E1 had done in the other condition.

The response period was 15 seconds, starting when the experimenter pointed. If the infant did not attend to the point at first, it was repeated until the infant saw the target object (and then that was when the response period started).

Coding, reliability and analyses

Infants' cleaning up (i.e. putting the target object into the basket) responses following the experimenter's point were coded from videotape for each condition. To assess interrater reliability, a coder who was naïve to the hypotheses scored a random sample of 20% of the data. Perfect agreement with the main coder was achieved ($\kappa = 1$ for both age groups).

Results and discussion

To investigate whether infants responded differently to the adult's point based on their *shared* experience with the adult, or whether instead they interpreted the point from an egocentric perspective and simply continued their own individual activity, we compared infants' responses in the Shared and Unshared conditions. Results revealed significant differences for both age

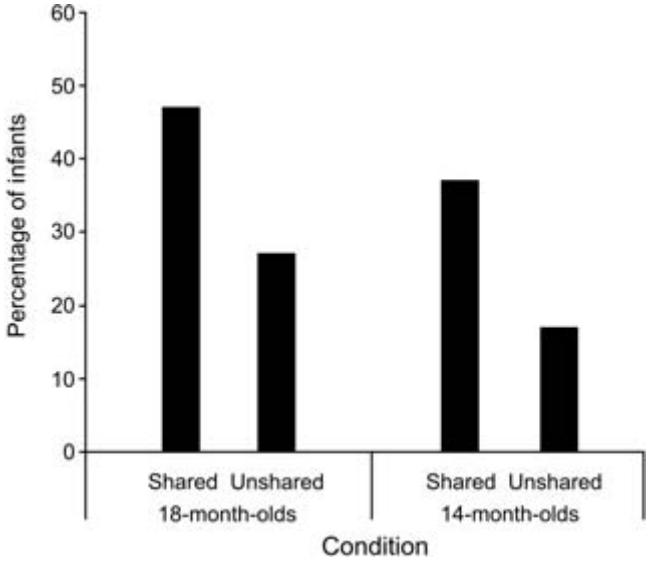

Figure 4 *Percentage of infants who cleaned up the target object in each condition in Study 2.*

Table 1 *Number of infants who cleaned up the target object in each condition in Study 2*

		Shared			
		18-month-olds		14-month-olds	
		Yes	No	Yes	No
Unshared	Yes	8	0	5	0
	No	6	16	6	19

groups: significantly fewer infants cleaned up the target object when E2, with whom they had not shared any relevant activity, pointed in the Unshared condition than when E1 pointed in the Shared condition (McNemar test, $p < .04$, $g = .50$ for 18-month-olds and $p < .04$, $g = .50$ for 14-month-olds; both large effects, see Cohen, 1988; see Figure 4 and Table 1 for individual responses). Importantly, a comparison of age groups revealed that equally as many infants in both age groups showed the correct pattern, that is, they cleaned up the target object in the Shared condition but not in the Unshared condition (Fisher's exact test, $N = 30$, $p = 1.00$; see Table 1), and no infant in either age group ever showed the wrong pattern and cleaned up in the Unshared but not in the Shared condition. There were no effects of order of condition in either age group (Fisher's exact tests, all four ps $> .21$).

Thus, in this simpler situation, even the 14-month-old infants responded differently to an adult's point depending on the experience they had previously shared with that adult. Importantly, infants did not do this egocentrically, just because they themselves had been engaged in the activity individually immediately prior to the point – their own previous experience was identical in both conditions. Instead, they used their shared experience with the adult to interpret her point, as evidenced by the finding that when E2, who had not participated in the activity with them, entered the room and pointed to the target object 'out of the blue', infants continued that activity significantly less often.

One could argue that perhaps infants responded differently when E2 pointed simply because of shyness or distraction when suddenly a new person entered the room and pointed. However, this is unlikely because infants were familiar with E2 from the familiarization phase before the test started. In addition, E2 entered the room at the same moment in the procedure – immediately before the test phase – in both conditions, so any distraction this might have caused would have been equivalent in both conditions (indeed, this distraction probably explains the finding that relatively high numbers of infants did not clean up in either condition). In addition, the majority of infants (67% of the 14-month-olds and 86% of the 18-month-olds) showed active responses with the target object in the Unshared condition: they responded appropriately with a wide variety of behaviors toward the object, for example by picking up and examining the object, showing it to E2, or pointing to it themselves. So it was not the case that infants were too shy to respond in the Unshared condition when E2 pointed. Instead, they responded differently depending on whether they had previously shared experience with the pointer or not.

General discussion

In the current studies, we presented 14- and 18-month-old infants with two situations in which two different interpretations of an adult pointing gesture were possible: one if infants responded to the point according to their own current interest and activity (the egocentric interpretation) and another if they took the point to be relevant to a shared experience they had just had with the pointing adult some moments previously (the shared experience interpretation). We found that infants interpreted the exact same pointing gesture towards the exact same object in the exact same context differently, depending only on the shared experience they had had with the pointer. And it was clear from the results that it really was the shared experience rather than their own individual experience that infants used to interpret the adult's point. In Study 2, for example, when the pointer had shared the clean-up activity with infants, significantly more infants responded by cleaning up than when the pointer had not shared that activity with them. Already by age 14 months, then, infants interpret communication cooperatively, from a shared rather than an egocentric perspective.

One could argue that perhaps infants might have shown this pattern of responding on the basis of low-level association alone – that somehow the presence of

the experimenter simply primed the activity associated with her. However, this is unlikely for two reasons. First, in both studies both experimenters were present at the moment of the point – in Study 1 E1 and in Study 2 E2 came into the room right before the test in all conditions. Second, the study by Moll *et al*. (2008) shows more directly that 14-month-olds rely on shared experience instead of association alone. When the adult in that study ambiguously asked for 'it', infants chose the target object only in the shared condition, not in the control condition in which they had watched the adult explore that object specially but individually. According to the association explanation infants should have chosen the target object in that individual condition as well, as they had built up an association between the object and the adult in that condition too, but they did not.

The finding that infants as young as 14 months can interpret others' pointing gestures based on what experiences they have shared with them is consistent with results from the studies of Ganea and Saylor (2007), Saylor and Ganea (2007), and Moll *et al.* (2008). In those studies, infants had to determine which of several possible objects an adult was referring to. Here we show that infants are able to use shared experience not only to identify referents but also to infer intended messages about already identified referents, thus showing a very flexible use of shared experience to interpret others' communicative acts. In addition, in the current studies infants used shared experience even when interpreting nonlinguistic, gestural communication (the pointing gesture was accompanied by some speech – the experimenters said 'There!' when pointing at the object – however, this did not provide infants with any information about what to do with the object). The fact that infants rely on shared experience even to interpret others' nonverbal pointing gestures suggests that this ability is not specific to language but rather reflects a more general social-cognitive, pragmatic understanding of human cooperative communication.

The current studies have thus shown that both 14- and 18-month-old infants know what common ground or experiences they have shared with particular people and interpret the meaning of others' communication from that shared perspective. This ability will serve them well in their emerging competence with language. In particular, as young children acquire language they need to be able to do such things as (1) know when they can use a pronoun because the referent is mutually known to them and their interlocutor, (2) mark information in their linguistic message as either given/shared or new/unshared with their interlocutor by using stress and intonation, and (3) interpret indirect requests and responses (e.g. understand that when a librarian scolds 'This is a library!', she is telling you to be quiet, not informing you about the type of the building you are in). The present results provide evidence that, just as language acquisition is first beginning, infants are already skillful with these crucial aspects of human cooperative communication.

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