Correction

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Correction for "Young children communicate their ignorance and ask questions," by Paul L. Harris, Deborah T. Bartz, and Meredith L. Rowe, which was first published July 25, 2017; 10.1073/pnas.1620745114 (*Proc Natl Acad Sci USA* 114:7884–7891).

The authors note that on page 7887, right column, second full paragraph, lines 9–11, "At 22 mo, one-fifth of the sample had been observed producing a flip to signal ignorance, and by 42 mo, almost half had done so" should instead appear as "At 22 mo, almost one-third of the sample had been observed producing a flip to signal ignorance, and by 42 mo, three quarters had done so."

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COLLOQUIUM PAPER

Young children communicate their ignorance and ask questions

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Children acquire information, especially about the culture in which they are being raised, by listening to other people. Recent evidence has shown that young children are selective learners who preferentially accept information, especially from informants who are likely to be representative of the surrounding culture. However, the extent to which children understand this process of information transmission and actively exploit it to fill gaps in their knowledge has not been systematically investigated. We review evidence that toddlers exhibit various expressive behaviors when faced with knowledge gaps. They look toward an available adult, convey ignorance via nonverbal gestures (flips/shrugs), and increasingly produce verbal acknowledgments of ignorance ("I don't know"). They also produce comments and questions about what their interlocutors might know and adopt an interrogative stance toward them. Thus, in the second and third years, children actively seek information from interlocutors via nonverbal gestures or verbal questions and display a heightened tendency to encode and retain such sought-after information.

ignorance | questions | children | communication

An influential body of research in developmental psychology has shown that infants are cognitively attuned to stable properties of the world: They possess core knowledge (1), a set of concepts enabling them to make sense of events and transformations in the physical, biological, and psychological domains. Moreover, building on that core knowledge, young children gradually construct a variety of deeper conceptual and causal insights within each of those domains (2–4). Alongside this portrayal of the child as a young scientist who steadily builds up a coherent and objective conception of the natural world, recent developmental research has paid increasing attention to the ways in which infants and young children can also be viewed as anthropologists. They are cultural learners, receptive to information from other people, including caregivers, adult members of their group, and peers, especially regarding the distinctive languages, beliefs, and practices of the culture that they live in (5–8).

Much of this recent research has emphasized that despite their receptivity to the information provided by other people, young children are selective about their informants. More specifically, they appraise potential informants along a variety of dimensions, including their familiarity (9, 10), their prior accuracy (9, 11, 12), apparent group membership (13, 14), and degree of consensus (15–17). Such selectivity is likely to facilitate children's acquisition of those beliefs and norms that are representative of their culture.

In highlighting children's appraisal of, and receptivity to, potential informants, research on early cultural learning has tended to ignore children's self-appraisals and their concomitant information seeking. However, unlike other species, cultural learning by human children is often based on the testimony and teaching of others (i.e., on nonverbal or verbal messages deliberately aimed at informing naive or ignorant learners). Granted that distinctive mode of cultural learning, it is plausible that even from an early age, children communicate gaps in their knowledge and ask for pertinent information. In this view, young children are not just selective recipients of the information that is made available by the surrounding community; they also remedy their own ignorance by adopting an interrogative stance toward potential informants.

Below, we review recent findings on children's appraisal of informant consensus, highlighting the research lacuna just mentioned. We then turn to research focusing on young children's appraisal of themselves, especially their states of ignorance, as well as the emergence of the interrogative stance.

Sensitivity to Consensus and Uncertainty

Research on children's appraisal of informant consensus has drawn on approaches to cultural learning grounded in evolutionary theorizing. Adopting this approach, Morgan et al. (17) asked how far children would be swayed by varying degrees of consensus among their informants when making numerical judgments. Children ranging from 3 to 7 y of age were asked to say which of two displays, each containing 10–30 dots, was numerically greater. Consistent with prior findings (18), children were better at choosing the numerically larger display the greater the difference in size between the two displays, as indexed by the dot ratio (i.e., the ratio of the difference between the displays relative to the size of the smaller display); the gradient of this improvement in accuracy for easier compared with more difficult trials was steep for older children but shallow for younger children.

Having made a decision about any given pair of displays, children were offered feedback by 10 informants who each either agreed or disagreed with their decision, with the number of informants who agreed versus disagreed varying (from 0 to 10) from one trial to the next. Thus, children might be confronted with unanimous agreement with their initial decision, unanimous disagreement, or any split between those two extremes. After this social feedback, children were invited to make a second decision about the two displays, thereby completing that particular trial. All age groups were prone to stick with their initial decision, and, surprisingly, they did so even on difficult trials. Moreover, Fig. 1 shows that the tendency to stick with an initial decision became stronger with age, irrespective of the ease or difficulty of the trial. Nevertheless, children's overall tendency to stick to their initial decision was tempered by their sensitivity to social feedback, and the pattern of that sensitivity changed considerably with age. Fig. 2 indicates that 7-y-olds displayed a so-called "conformist" bias: They were disproportionately sensitive to the majority opinion among informants. In contrast, 6-y-olds displayed a linear or proportionate response: The greater the

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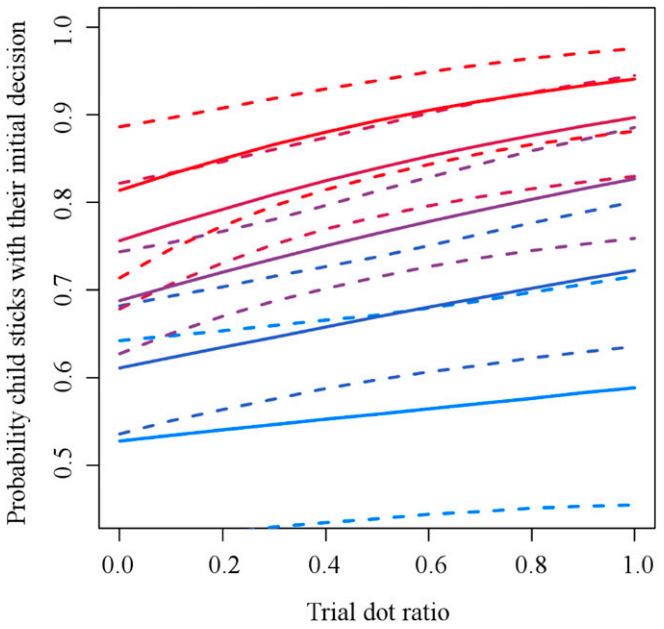

Fig. 1. Probability that children stick with their initial decision for the case of five versus five informants such that whether or not children stick is based on the initial information they gathered via observation of the displays (asocial information) and their sticking tendency. Children tend to stick with their initial decision across all trial ratios (i.e., irrespective of trial difficulty), although the tendency to stick is slightly lower on the more difficult (low dot ratio) trials. The tendency to stick sharply increases with age; the oldest children (7-y-olds) display a >80% chance of sticking (color-coding of the ages of 3, 4, 5, 6, and 7 y is provided in Fig. 2). Reprinted with permission from ref. 17.

number of informants choosing a given option, the greater was the likelihood that 6-y-olds responded similarly. Finally, younger children were swayed by unanimity among informants but showed little sensitivity to social feedback that fell short of unanimity. For example, their final decisions were roughly the same whether two of the 10 informants judged like them and eight did not, or the reverse. In sum, although the exact nature of children's reactions to disagreement among informants changed sharply with age, children were sensitive to social feedback at all ages. Moreover, older children displayed the type of conformist bias (i.e., a disproportionate sensitivity to nontotal majorities) that evolutionary theory has identified as a highly effective strategy for widespread cultural dissemination (19). Hence, children's tendency to stick with their initial judgment cannot be attributed to any overall insensitivity to social feedback.

An alternative explanation of children's tendency to stick, and to stick even on difficult trials, is that they lack an ability to monitor their own knowledge states. They treat what effectively amounts to a random judgment on difficult trials and a well-founded judgment on easy trials as more or less equivalent. In this view, young children ultimately have little ability to differentiate cognitive states that, in principle, ought to be quite distinct: notably, states of ignorance, in which only a guess can be made, and states of knowledge, in which a judgment can be made with a high probability of its being correct. If this hypothesis is correct, it implies that children are poor at weighing social feedback against their own asocial information. Having little awareness of the epistemic standing of their own asocial information, they do not appropriately calibrate their deference to social information.

However, even if young children are insensitive to the certainty versus uncertainty of their numerical judgments, it is unlikely that they are insensitive to the standing of their cognitive states across all domains of knowledge. Indeed, as elaborated below, recent evidence suggests that even 2-y-olds have some metacognitive awareness, especially in the context of ongoing dialogue with an interlocutor. In the next section, we argue that very young children display five interlinked abilities: (*i*) an understanding of the nature of communication, especially its power to convey information from an informant to a recipient; (*ii*) an ability to signal their ignorance to an interlocutor; (*iii*) an ability to talk cogently about knowledge and ignorance; (*iv*) an ability to communicate their desire for information via gestures and questions; and (*v*) an ability to monitor the extent to which the information requested of an informant does or does not remedy their ignorance.

An Early Understanding of Communication

In the course of the second year, when the ability of human infants to communicate with words remains limited, they nonetheless display a basic understanding of the way that communication works. They understand that requests and assertions can be communicated from one person to another so that the recipient is likely to end up with information that he or she can act upon, and may indeed favor relative to prior information based on first-hand observation (20). Thus, infants show some understanding of the way that communication can guide the actions and update the knowledge base of a recipient. Moreover, they display an understanding of the impact of communication, not simply when they seek information from a potential informant or when they supply information to a recipient but also when, as a third party, they witness or eavesdrop on an exchange between two other people. In such contexts, infants appear to encode the message supplied by the informant and to work out its likely impact on the actions and knowledge of the recipient.

The following body of experimental work illustrates these basic points. Krehm et al. (21) had infants aged 9 and 11 mo watch while an informant expressed her preference for one of two objects by reaching for and manipulating her preferred

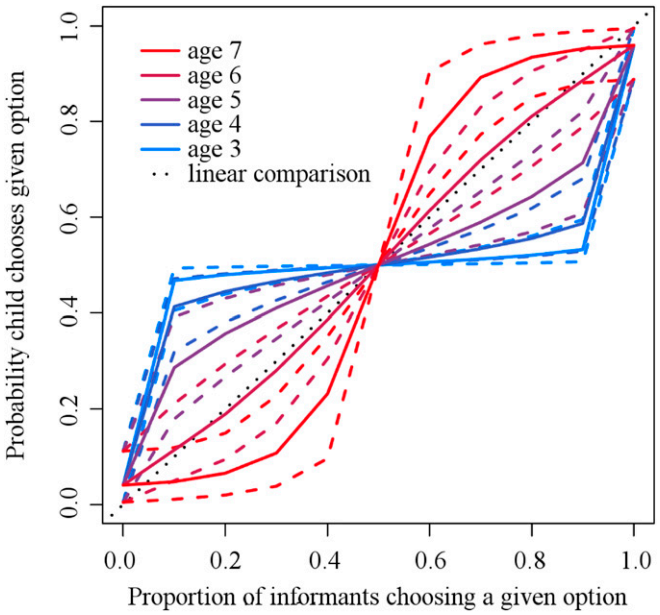

Fig. 2. Probability that children stick with a given decision (e.g., the right-hand side display of dots) for a trial of intermediate difficulty. The 7-y-olds show a conformist bias by responding disproportionately to majorities that fall short of unanimity. The 6-y-olds display a proportionate response to the number of informants endorsing their decision. Younger children, especially 3- and 4-y-olds, are only affected by informant feedback when there is complete unanimity; they are prone to ignore informant feedback when there is disagreement among informants. Reprinted with permission from ref. 17.

object. A recipient then appeared who expressed no specific preference for either object insofar as she handled both. In the subsequent test phase, the informant reappeared and pointed to her preferred object as the recipient watched. Infants expressed more surprise (by looking longer) when the recipient handed the informant her nonpreferred object as opposed to the one that she had pointed at. By implication, infants expected the recipient to understand which object the informant wanted, given her pointing gesture, and to respond accordingly. A control condition consolidated this interpretation. If the informant gestured with an open fist rather than a point, or if the recipient closed her eyes rather than watched the informant's gesture, the selective pattern of looking disappeared. This selective pattern was displayed by both 9- and 11-mo-olds, and indeed irrespective of whether infants had started to point themselves.

Martin et al. (22) obtained similar findings when the informant signaled that she wanted a preferred object, not via a pointing gesture but by saying "koba." This lexical item was unfamiliar to the 12-mo-olds being tested. Nevertheless, they tended to construe it as a request by the informant for her preferred object, again as indexed by the pattern of looking that they displayed when the recipient did or did not comply in terms of the particular object that she handed to the informant. Infants expressed more surprise (looked longer) if the recipient handed the informant the nonpreferred object. Control conditions indicated that infants' construal of the informant's signal as a request was restricted to speech-like utterances. If the informant coughed rather than spoke, or produced a vocalization ("Oooh!") rather than a lexical item, the pattern of selective looking disappeared.

Thus, at the very beginning of the second year, infants are not inattentive or uncomprehending bystanders with respect to ongoing patterns of communication. They grasp that particular signals can be interpreted as requests for a particular object. Moreover, their construal of dialogic communication is such that they expect the recipient to interpret the requests appropriately and to act accordingly. This construal of dyadic communication is appropriately confined to certain types of signals, notably a pointing gesture or the production of a lexical item (including one that is novel) rather than a hand movement, a cough, or a vocalization.

Song et al. (23) asked if older infants, aged 18 mo, would understand not just a request for an object, as conveyed by a pointing gesture or lexical item, but an assertion, and notably an assertion that could, in principle, update the recipient's knowledge base. Infants watched as an adult repeatedly placed a ball in a box, withdrew it, replaced it, and eventually left the room. A second adult who had witnessed the actions of the first adult then moved the ball to a cup and covered it with a lid. The first adult returned to retrieve the ball, but before her making any attempt to retrieve it, she was provided with information about its new location by the second adult: "The ball is in the cup." Alternatively, the second adult made an uninformative remark that did not indicate the ball's new location: "I like the cup." In the informative condition, infants expressed surprise (looked longer) when the returning adult searched in the now empty box rather than in the cup where she had just been told that the ball was located. In the uninformative condition, by contrast, infants were more surprised if the returning adult appeared to know that the object was in the cup, as indexed by her searching there rather than in the box where she had left it. Moreover, in line with the findings for requests discussed above, a pointing response by the second adult was also construed by 18-mo-olds as an informative assertion that was likely to guide the search behavior of the returning adult.

Eighteen-month-olds also display some facility in decoding the information conveyed by head gestures as well as hand gestures. As in the studies described above, Fusaro and Harris (24) arranged for infants to witness a minidialogue between two adults and then probed their construal of that dialogue. One adult sought information about the location of a hidden object by pointing to each of two boxes in succession and asking: "Is it here?" A second adult answered with a nod to one query and a shake of the head to the other. When infants were then prompted to find the object, they typically selected the correct box. Effectively, infants were able not only to note the difference between the two head gestures of the second adult but to tie each gesture to a query about a particular location indicated by the first adult.

Taken together, these findings imply that infants aged 12–18 mo possess a relatively abstract comprehension of the nature of communication. They realize that certain signals, such as pointing gestures, lexicalized speech, and head gestures, can provide information about what an informant wants or knows. They expect the recipient of those communicative signals to construe and respond to them appropriately, by compliance if a request has been made and by acting in relation to new information about the state of the world if it has been supplied. By implication, human infants have a basic understanding of the way that communication conveys information between two interlocutors. Moreover, they do so at an age when their own production of spoken language remains limited. Accordingly, when infants proceed to exploit the rich communicative power of language, they are likely to situate that power within a broad understanding of the way that human communication operates, particularly their realization that communication can function to provide an interlocutor with information.

Granted that young infants understand how communication operates, we may ask whether they build on that understanding by actively eliciting information rather than remaining passive observers or recipients of information that is on offer. To optimize the elicitation of information, it would be helpful for infants to possess four interrelated abilities: the ability to signal their own ignorance, to talk about knowledge and ignorance, to produce interrogative acts of communication, and to gauge the adequacy of the replies received. In the following sections, evidence will be reviewed showing that human children display each of these abilities in the course of the second and third years, especially in the context of an ongoing dialogue with an adult.

Signaling Ignorance

Nonhuman animals appear to possess at least some metacognitive capacity. They are capable of monitoring their own uncertainty in that they deliberately withhold a response when faced with a difficult discrimination between different choices (25). There is also evidence that chimpanzees and young children (aged 27–32 mo) appropriately seek out additional visual evidence in the context of uncertainty about the location of a hidden object. For example, if they have had the opportunity to observe in which of several tubes a desirable object has been hidden, both species search promptly in that particular tube. However, if they have not seen the hiding and do not know in which particular tube the object was hidden, they are likely to bend their head or body to look inside the available tubes before searching in the one where the hidden object can be seen; alternatively, they opt for a smaller reward in a known location (26, 27). By implication, both chimpanzees and children realize when they do not know, or have not seen, an object's location and act accordingly. They proceed to gather more location information before searching accurately on the basis of that newly gathered information, or they opt for a less desirable object in a known location.

In these cases, neither the chimpanzee nor the child communicates ignorance to another individual. Rather, in the context of ignorance, they engage in visual exploration or opt out of searching. However, recent evidence indicates that human infants are capable of signaling their ignorance. Goupil et al. (28) trained 20-mo-old infants to ask their caregiver for guidance if they were uncertain of a hidden object's location. More specifically, infants watched as a toy was hidden in one of two opaque containers. On so-called "possible" trials, the infant observed the

hiding of the object. By contrast, on so-called "impossible" trials, the hiding was carried out behind a curtain so that infants could not tell which container the object was hidden inside. In either case, the two containers were subsequently occluded for a delay ranging from 3 to 12 s and then uncovered once more. Infants were taught to indicate which container they had remembered the object to be in by pointing to its location. The container indicated was then moved forward so that the infant could either recover the toy (if correct) or find the container to be empty (if incorrect). Note that depending on the nature of the hiding, and on the length of time that the two containers were subsequently occluded, trials varied in terms of the likelihood that infants could know and remember where the object was hidden. Thus, on possible trials, especially when the delay was short, remembering the object's location was relatively easy. However, on possible trials when the delay was longer, remembering was more difficult. Finally, on impossible trials, remembering was precluded because the initial hiding of the object had not been witnessed.

Half the infants were taught in a prior training session to ask their caregiver for help when needed. In this training session, their pointing responses on impossible trials were ignored. Instead, caregivers waited until infants turned to look at them in the eyes and then provided help by pushing the correct container forward and saying: "Here it is, look." Thus, infants were effectively taught that, when uncertain of the object's location, they should turn to look at their caregiver, who would then help them to identify the correct container.

Several results showed that infants in the trained group produced this help-seeking signal in an appropriate fashion (i.e., when they were unsure of the object's location). First, compared with infants in the untrained group, infants in the trained group proved to more accurate on those occasions when they did point. This greater accuracy was because, when they were uncertain, instead of pointing with a considerable risk of error, they were likely to seek help by looking toward their caregiver. In addition, the trained infants who asked for help were more likely to do so when the experimental setup created uncertainty. Thus, they were more likely to ask for help on impossible compared with possible trials, and, within the set of possible trials, they were more likely to ask for help if the containers had been occluded for a longer delay. Taken together, these findings provide strong evidence that infants aged 20 mo are able to monitor their ignorance or uncertainty and can learn to signal that uncertainty by gazing at a potential informant, notably a caregiver, in such circumstances.

Despite the impressive and systematic nature of such uncertainty monitoring and help seeking, the findings also point to the critical role of training. More specifically, control infants who received no initial training did sometimes look at their caregiver. However, such responses were no more frequent with greater delay lengths and were no more frequent for impossible compared with possible trials. Thus, even if these gaze responses were aimed at prompting help from the caregiver, there was no evidence that they signaled uncertainty because their production was not positively correlated with the experimental conditions producing uncertainty. By implication, although 20-mo-olds do spontaneously look toward a caregiver, and indeed may do so with the expectation that helpful information will be supplied, training might be needed if such looks are to be produced in a strategic fashion to signal uncertainty. More generally, this study provides persuasive evidence that infants have some awareness of their own uncertainty or ignorance, echoing findings with nonhuman primates, but it provides no evidence that they are prone to signal ignorance or uncertainty in a spontaneous fashion even if it shows that they can be trained to do so.

When do young children begin to signal their ignorance spontaneously? Limited observational evidence suggests that in the course of the second year, human toddlers will sometimes spontaneously express their ignorance via a distinctive nonverbal flip (or shrug) gesture. Acredolo and Goodwyn (29) report a case study of a child whose communicative gestures were studied from the age of 12–17 mo. Starting at the age of 15 mo, the child produced a gesture that appeared to signal ignorance. She shrugged her shoulders and flipped the palms of her hands upward and out to the side. However, because this case study was a study of a single child, it is unclear whether production of this gesture is widely used to signal ignorance or is produced in only a small minority of families and by a small minority of children. It is also unclear whether the child observed by these researchers was especially precocious in her communication skills or representative of the communication patterns displayed by typically developing toddlers.

To examine these issues, Bartz (30) analyzed data from 64 children included in the Language Development Project (31), a longitudinal study of early language development in which the families of the children constituted a representative sample of the US population in terms of education and socioeconomic status. The project researchers recorded children's everyday interactions with caregivers in their homes every 4 mo from the age of 14 mo onward for a 90-min period. The recordings from eight successive visits (at 14, 18, 22, 26, 30, 34, 38, and 42 mo of age) were analyzed with the goal of identifying the age of emergence and prevalence of flip gestures.

Fig. 3 shows the cumulative number of children who had produced at least one of various types of flip gesture across this 18-mo period. Fig. 3 also shows the cumulative number of children whom coders judged to be expressing ignorance via their flip gesture. Finally, Fig. 3 shows the cumulative number of children who produced the explicit verbal utterance, "I don't know." Inspection of Fig. 3 shows that, consistent with the earlier case study of a single child, the flip gesture expressing ignorance emerged among some children in the course of the second year. At 22 mo, one-fifth of the sample had been observed producing a flip to signal ignorance, and by 42 mo, almost half had done so. Verbal statements of ignorance emerged somewhat later but rose sharply in frequency across the same period, eventually becoming more widespread.

These findings build on the findings of Goupil et al. (28) by showing that deliberate teaching and reinforcement are not required for the production of gestures signaling ignorance. Many children produce such a signal in the course of everyday interaction outside the laboratory. The results also raise the possibility that such signals are produced not just in the context of goal-directed behavior, such as in the search for a hidden object, but in the context of an ongoing dialogue in which an adult poses a question that the child is unable to answer. By implication, it would be wrong to assume that signals of ignorance arise only in problem-solving contexts where children face a practical dilemma or obstacle and turn to an adult for help in resolving it.

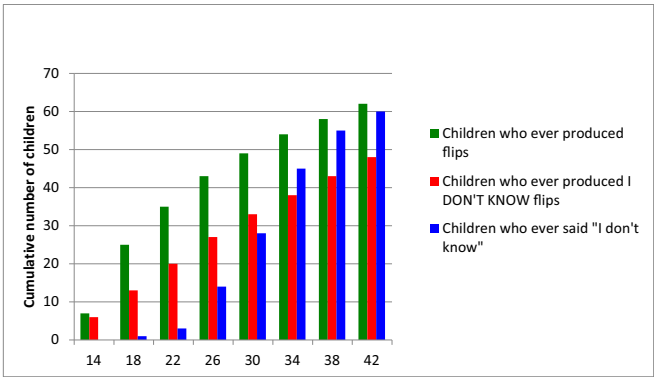

Fig. 3. Cumulative number of children who ever produced a flip, produced an I DON'T KNOW flip, or said, "I don't know" at each age point (14–42 mo).

The data suggest that expressions of ignorance also occur in the context of conversation.

In an experimental study, this conclusion was examined more systematically (30). Children (aged 16–37 mo) were asked a series of questions by an adult, only some of which they could easily answer based on their existing knowledge. More specifically, they were shown a mix of pictures and asked the name for each of the entities depicted. Some pictures depicted familiar, easy-to-name entities (e.g., book, bird), whereas others depicted unfamiliar, hard-to-name entities (e.g., unusual hardware item). The pattern of responding was different for the unfamiliar entities compared with the familiar entities. Not only did children make more naming errors and produce more filled speech pauses (e.g., "umm"), but they were also more likely to look toward an adult (either the experimenter or their mother) to ask for information (e.g., "What's that?") or to say "I don't know." This differential pattern of responding was apparent among younger infants (16–27 mo) but was more systematic among older infants (28–37 mo), especially with respect to filled speech pauses and requests for information.

Taken together, these studies show that toddlers communicate their uncertainty in various ways. They communicate by looking toward an adult and by producing a filled speech pause, a flip gesture, an explicit affirmation of ignorance, or a question to an interlocutor. Admittedly, when they look at an adult or produce a filled pause or a flip, such responses might reflect behavioral uncertainty rather than metacognitive awareness of ignorance. However, such a parsimonious interpretation seems less appropriate when toddlers begin to affirm their ignorance verbally. Note also that there was only a modest developmental lag between the production of flips and the emergence of verbal affirmations of ignorance. In the next section, such affirmations are scrutinized in more detail.

Talking About Knowledge and Ignorance

The scope of children's metacognitive awareness can be illuminated by analyzing their production of the cognitive verb "know" in the context of everyday conversations with caregivers (32). Arguably, young children are aware only of gaps in their knowledge. They might have little or no awareness of when their information retrieval processes operate smoothly. For example, they might register occasions when they cannot readily respond to questions about an object's name or location but ignore or fail to register occasions when they can successfully answer. In this view, children would be likely to deny that they have knowledge ("I don't know…") but unlikely to affirm that they do have knowledge ("I know…"). A further question concerns children's insight into the cognitive states of other people. Do they talk about the ignorance or knowledge of other people in the same way as they talk about their own, or is there any asymmetry between talk about the self and talk about others?

To answer these questions, the spontaneous utterances of three children were analyzed. Two children were English-speaking (Adam, a middle-class, African-American child and Sarah, a white, working-class child), whose early language had been recorded by Brown (33) and his colleagues at regular intervals. The utterances of each child could be retrieved via the child language data exchange system, CHILDES (34). All utterances produced by the two children that included the mental verb know from the age of 27 mo (the age at which recordings had begun) to the age of 36 mo were analyzed. The third child, Qiānqian (芊芊), was a Mandarin-speaking child whose utterances had been recorded and transcribed from the age of 16 to 39 mo by her mother, a psycholinguist. Qiānqian's production of the verb *zhi1dao4* was analyzed. Similar to the phrase "know that" in English, *zhi1dao4* is an epistemic verb that is used in the context of factual knowledge. [Note that, in contrast to English, Mandarin uses a different verb (i.e., *hui4*) for the phrase "know how" (as in "know how to dance") (35)].

Did the three children simply use the word know by echoing its production in an immediately prior utterance by their interlocutor or did they introduce the word know into the conversation in an autonomous fashion? The same pattern emerged for all three children: The large majority of children's references to the word know were autonomous, rather than echoes of their interlocutor's prior utterance. Next, utterances were analyzed to determine whether children referred only to their own cognitive states or also made references to the cognitive states of their interlocutor or to the cognitive states of a third party. The majority of references were indeed to children's own cognitive states. Nevertheless, children also referred quite often to the cognitive states of their interlocutor. By contrast, references to a third party, someone not participating in the conversation, were rare.

Granted that children talked about their own cognitive states as well as the cognitive states of their interlocutor, an analysis was conducted to assess whether the pragmatic function of the utterances was similar or different for these two persons. More specifically, the proportions of affirmations ("I know…" or "You know…"), denials ("I don't know…" or "You don't know…"), and questions ("Do I know…?" or "Do you know…?") that involved a reference to the self compared with the interlocutor were compared. These proportions varied across the three pragmatic functions. In the case of affirmations, children produced them with respect to both the self and their interlocutor. Denials and questions, by contrast, exhibited a strongly asymmetrical pattern. Children often denied their own knowledge ("I don't know…") but very rarely denied the knowledge of their interlocutor ("You don't know…"). Conversely, children often asked questions about their interlocutor's knowledge ("Do you know…?") but never asked questions about their own knowledge ("Do I know…?"). This asymmetry in the pattern of production for denials compared with questions was marked, but it was based on only three children. To establish its existence firmly, the utterances of a further eight English-speaking children drawn from the CHILDES database were also analyzed (36). An identical pattern emerged for all eight children: Denials were almost invariably produced with respect to the self rather than the interlocutor, whereas questions were invariably produced with respect to the interlocutor rather than the self.

Returning to the two questions guiding this study, the data show that 2-y-olds do not simply talk about their ignorance. They also affirm that they possess particular items of knowledge. In addition, the pattern of talk about the self is different from the pattern of talk about the interlocutor: Denials of knowledge are frequent for the self ("I don't know") but not for the interlocutor, and questions about knowledge are frequent for the interlocutor ("Do you know?") but not for the self.

The exact explanation for this asymmetry warrants further investigation (36), but its existence points to the following possibility for early communication between young children and their interlocutors. On the one hand, children monitor their own cognitive states: They are aware of knowing some items of information and affirm possessing that knowledge, and they are also aware of lacking other items of information and deny having that knowledge. Their monitoring of other people's knowledge is more circumspect. They sometimes affirm, but almost never deny, that an interlocutor knows something. Rather, they ask an interlocutor about what he or she knows. Given children's awareness of what they do not know (as indexed by their explicit denials) combined with their receptivity to the possibility that an interlocutor might know (as indexed by their questions), and given also their understanding of the way that communication can pass knowledge between an informant and a recipient, it is feasible for them to turn to other people for information when they do not know something. In particular, it would make sense for them to ask information-seeking questions. In the next section, we review the onset of such questions.

The Onset of Information-Seeking Questions

A long tradition of developmental research has investigated the emergence of joint attention in infancy: the capacity to turn the head and eyes toward a target that is pointed out by a caregiver and the reciprocal capacity to call a caregiver's attention to objects via pointing. The emergence of pointing follows a stable developmental timetable. At around 8 mo, whole-handed pointing starts to emerge, and at around 11 mo, index finger pointing starts to emerge across markedly different cultural settings (37). Despite this stable timetable, more hand gestures, including pointing gestures, were observed between caregivers and their infants in China than in Holland, and more were observed in Holland than in the Yucatan (38). In all three settings, however, pointing was a dyadic or reciprocal mode of engagement. Thus, when a caregiver pointed, the infant often reciprocated with a point to the same target (within 10 s), and vice versa.

The standard functional interpretation of infant pointing has been that it serves either to request an out-of-reach object or to establish joint attention to an object of interest (39). More recently, however, it has been proposed that pointing can serve an interrogative function (40). Thus, an infant point can imply not just "I want this" or "Look at this" but also "What is this?" with the expectation that the interlocutor will respond with pertinent information. Begus and Southgate (41) report evidence supporting this emphasis on the interrogative function of pointing. Sixteen-month-olds proved to be more likely to point to an object if an available informant appeared to be knowledgeable. A female informant sat facing the infant, and a series of novel objects was presented behind her but in view of the infant. Infants often pointed out these novel objects to her. They appeared to be signaling that they wanted her to provide information about the objects because they pointed out novel objects less often if she had proven to be an unreliable informant. Thus, they were less likely to point to the novel objects if she had previously named familiar objects incorrectly and now appeared unsure of the names of the novel objects. A follow-up study suggested that the experimenter's prior naming errors were especially important in reducing infants' interrogative points. If the experimenter simply called attention to the objects (e.g., "Wow, look at this!") and then appeared unsure how to name the novel objects, infants still pointed them out.

When infants receive information in the wake of an interrogative point, how well do they process that information, and do they process it more effectively than unsolicited information? To examine these questions, Begus et al. (42) presented 16-mo-old infants with two objects at once. When infants pointed to one of the two objects, the experimenter modeled an action either on the indicated object or on the alternative object. After a 10-min delay, the demonstration object was presented again and infants were given an opportunity to imitate the action they had seen demonstrated. Infants reproduced the actions demonstrated on the objects they had pointed at significantly more than those actions demonstrated on the nonchosen objects. Moreover, this difference emerged even though infants had been equally attentive visually during the demonstrations on both types of objects. A follow-up experiment showed that this difference in copying was due to learning being facilitated when infants' pointing was responded to rather than hindered when their pointing was ignored. Thus, even when infants' pointing was not ignored and a single object was presented, copying was still inferior to when two objects were presented and the experimenter consistently offered a demonstration on the one that infants pointed to. By implication, infants' pointing at a given object had been aimed at eliciting information about it and that information was better encoded than information they had not aimed to elicit.

Toddlers' early word learning provides more evidence for the information-seeking role of pointing. Lucca and Wilbourn (43) presented 18-mo-olds with pairs of unfamiliar objects, and when the infants targeted one of them via selective pointing, reaching, or looking, the experimenter provided a novel name for the targeted object. Infants subsequently showed greater learning of names for the objects they had targeted via pointing compared with reaching or looking. By implication, infants were especially receptive to learning a novel name if it was supplied in the wake of their interrogative point toward it.

This early emerging disposition toward interrogative communication is not just a subtle behavior whose diagnosis requires the tools of the laboratory. Chouinard (44) asked parents of infants aged 12–17 mo and 18–23 mo to keep a diary in which they noted instances in which they judged their toddler to be asking a question. Despite the limited verbal ability of the infants, especially in the younger group, parents had little difficulty in identifying instances of questions. For example, one younger child was beside her mother when she was unpacking groceries. The child noticed a kiwi fruit, a fruit that was novel to her; picked it up; and, as she showed it to her mother with a puzzled expression, produced a vocalization "Uh?" The mother interpreted her communication as a question about the name or identity of the fruit, roughly: "What's this?" Further analysis showed that such "questions" rose in frequency in the course of the second year.

Overall, the available evidence indicates that toddlers use several means in the course of the second year to prompt an interlocutor to supply them with information. They use pointing, showing, and vocalization, either separately or in combination, in advance of any capacity to formulate a question in words fully.

Monitoring an Informant's Replies

We have argued that infants understand how communication can provide information and ask questions when they do not know something. Indeed, from the age of ~18 mo onward, children ask an increasing proportion of questions aimed at gathering information as opposed to questions that make other types of requests (e.g., for permission, for clarification) (44). When asking such information-seeking questions, do they monitor the replies that they receive? In particular, do they differentiate between a satisfactory answer, one that dispels their ignorance, and an unsatisfactory answer that does not? To examine this issue, Chouinard (44) looked at what children said in reply to an informative answer versus an uninformative answer. When adults failed to supply the information they sought, children were likely to persist with their questions.

Extending this analysis, Frazier et al. (45) focused on the "why" or "how" questions (i.e., the explanation-seeking questions) of six English-speaking children whose language had been recorded regularly from 2–5 y of age. Children reacted differently depending on whether they received a satisfactory explanation or not. Following a satisfactory explanation, they were likely to acknowledge their agreement or to ask a new, follow-up question on the same topic. By contrast, when they were not given a satisfactory explanation, they were likely to persist with their initial question or to offer an explanation of their own. A follow-up study confirmed that explanatory information is also better remembered. Thus, when preschoolers received an explanation for a puzzling illustration, they were more likely to remember that information than a nonexplanation. Indeed, children often misremembered nonexplanations, converting them into explanations via appropriate elaboration (46).

Conclusions and Implications

In the course of the second year, children begin to communicate their doubt or ignorance in various ways: through nonverbal gestures, explicit statements of their ignorance ("I don't know"), as well as information-seeking questions. Nonhuman primates also indicate their uncertainty: They act differently depending on whether they are sure or unsure of what to do next. In particular, they suppress responding in a situation where a mistaken response would impose costs. However, despite important parallels, notably the implication that all primates are able to monitor their own level of certainty or doubt, the two bodies of evidence

also diverge. Toddlers readily express doubt or ignorance in the context of communication; their flips, "I don't know" utterances, and information-seeking questions are directed at an interlocutor. Conceivably, some of these signals could be produced when children are alone and faced with uncertainty. For example, having searched unsuccessfully, a toddler might produce a flip gesture, signaling uncertainty about the object's location and/or where to search next. However, pending more evidence of children's expressive gestures when they are alone, it is plausible that the majority of such metacognitive signals are produced in a communicative context, not as an adjunct to ongoing solo behavior. More generally, these signals appear to serve two interwoven functions. First, they provide an answer to an interlocutor's question: an admission of ignorance that amounts to a well-formed turn in an ongoing conversation. Second, when formulated as questions, they convey not just ignorance but also a request that the interlocutor offer help by supplying missing information. That children aim to elicit missing information with their questions is underlined by their differential reactions to informative vs. uninformative replies.

Young children's facility in communicating their ignorance and in asking questions appears to build on their foundational insight into the way that testimony works (20). As described earlier, infants aged 12–18 mo understand that someone who lacks information (e.g., regarding the location of an object) can be provided with that information via the gestures or vocalization of an informant. The present review indicates that toddlers and young children go beyond that basic insight. They produce avowals of ignorance and adopt an interrogative stance. Moreover, the interrogative stance appears to involve not simply the seeking of information from others via pointing and/or questions but an accompanying state of informational receptivity (i.e., a motivational readiness to encode and retain the information thereby elicited). Thus, information about object names or object functions is better retained if it is received in response to an interrogative gesture rather than supplied in an unsolicited fashion (42, 43), and explanatory information is better retained than nonexplanatory information (46).

Research on the child's theory of mind has highlighted the important role of language and conversation in promoting children's insight into the way that the mind works (47). The primary focus of that research has been on children's developing insight into false beliefs. The present findings point to a more basic insight that conversation is likely to promote. In several of the studies reported above, children signaled their ignorance in the context of an ongoing conversation with an adult. A speculative but plausible implication is that involvement in conversation can serve as a constant tutorial for children with respect to the range and depth of their ignorance. To the extent that children are prone to engage in conversation with better informed interlocutors, they are likely to discover that their existing knowledge is limited and fragmentary, albeit open to expansion if they pose appropriate questions. Granted that children vary in the quantity of speech that they are exposed to by their caregivers (48) in the extent to which that speech is directive rather than discursive (49), is tightly focused on the immediate situation or includes an exploration of situations and events displaced from the here and now (50), and includes satisfactory answers to children's causal questions (51), we can anticipate that children will grow up with markedly different assessments of the scope of human knowledge, the magnitude of their own comparative ignorance, and the potential role of question asking in mitigating that ignorance.

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