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Young children understand how social connections affect what people know about each other

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An unwritten expectation in our everyday social interactions is that intimate personal information about someone—"insider knowledge"—is usually confined within close relationships. For example, it would be odd, or even unsettling, if a stranger knew about your favorite movie. Such expectations about who knows what about whom constitute a cornerstone of complex social behavior, but much remains unknown about their cognitive underpinnings and developmental origins. Drawing on parental report (Study 1) as well as a novel experimental approach using controlled but naturalistic videochat conversations (Study 2 & 3), we find that 4- to 5-y-old children have an abstract, theory-like understanding of how social connections give rise to interpersonal knowledge. Self-report, facial expressions, and memory errors provide converging evidence that children were surprised when someone possessed insider knowledge that is misaligned with their relationships, such as a stranger knowing their favorite food (Study 2a) or their own parent knowing a stranger's favorite movie (Study 2b). Children also generated coherent ad-hoc explanations about how someone might have acquired that knowledge, appealing to either first-hand observations or second-hand sources (Study 3). These findings demonstrate an early-emerging understanding of how individual minds are shaped in the context of their social networks, supporting a precocious ability to detect and explain anomalies in what people know about each other in real-time conversations. The current work also opens possibilities for leveraging open-ended online interactions to study social cognition without compromising experimental control.

cognitive development | Theory of Mind | communication | epistemic cognition | social cognition

Significance

Many of our most ubiquitous social behaviors—forming social ties, managing our reputations, and gossiping—involve reasoning about who knows what about whom. The ability to draw these inferences quickly in real-time interactions is critical for successfully navigating the complex social world. Using casual but experimentally controlled conversations, we find that children—by around age 4—can spontaneously track who has "insider knowledge" about themselves or others, and explain how people might have acquired this knowledge. These results demonstrate that humans develop an early-emerging, intuitive understanding of how information flows in social networks and shapes the minds of individuals, enabling even young children to make rapid, on-the-fly inferences about what and how people know about each other.

Our expectations about what people know plays a fundamental role in our lives; they guide how we communicate with (1–4), learn from (5, 6), and affiliate with others (7, 8). But there is something particularly special about what people know about other people. Unlike general knowledge that can be acquired from many possible sources, "insider knowledge" about someone—their likes and dislikes, personal opinions, and cherished memories—is usually acquired through, and contained within, close social relationships. Therefore, our expectations about insider knowledge depend on how we think people are related to one another and how those relationships shape what people know about each other.

These expectations usually operate without explicit awareness, but they can rise to the surface when violated. For instance, you would take it for granted that your partner knows your favorite food, but find it surprising, or even unsettling, if a stranger knew what it was. Consistent with this intuition, adults show spontaneous surprise (evidenced by slower self-paced reading) when they read about a stranger commenting on something personal about them (9). Although such real-time monitoring of who knows what about whom is crucial for navigating the complex social world, little is known about its underlying cognitive mechanisms and development.

Decades of prior work show that from early in development, humans can reason about how people's knowledge is shaped by first-hand experience (i.e., Theory of Mind, see refs. 10 and 11). Expectations about insider knowledge, however, require us to go beyond reasoning about how isolated individuals learn from the world; we also need to understand how people's knowledge is shaped by others via their relationships (12) and broader social networks (13). As adults, we understand that each tie within a social network is a unique relationship that affects how people interact and communicate, and by extension, what they know about each other. Close, tight-knit relationships generally offer more opportunities for people to learn intimate details about others, either via direct observation or personal disclosures; outside of these relationships, insider knowledge is acquired only when there is a *breach*, such as gossip (14). These intuitions reflect an

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Fig. 1. An example conversation in Study 2a. The experimenter casually mentions to the child that (*A*) the child's mom or (*B*) the experimenter's mom told him about the child's favorite food or movie. (*C* and *D*): Later, the experimenter asks whether the child was surprised that each source possessed knowledge about their favorite food/movie.

abstract, causal, theory-like understanding of how social connections affect what people know.

Drawing on the broader idea that humans, starting early in life, build intuitive theories about the world (e.g., intuitive physics, intuitive psychology; see refs. 15–18), here we ask whether young children's reasoning about insider knowledge is also supported by a theory-like understanding of how knowledge is transmitted via social connections. Such an understanding requires at least three key constituents. First, it requires the ability to reason about an individual person's mental states, such as what someone knows and thinks (i.e., Theory of Mind). Second, it requires an understanding of dyadic relationships: how particular kinds of social ties between two individuals lead certain information to be shared between them. Third, it also requires an understanding of how such dyadic relationships are embedded in broader social structures (e.g., groups or social networks) that enable information to flow through a series of connected individuals.

Existing work has demonstrated that at least some of these prerequisite capacities emerge quite early in life. First, regarding individual minds, even infants have expectations about what others know given their perceptual access or communication with others (e.g., refs. 19–22); by 18 mo, infants also track the common knowledge and experiences they share with social partners, which guides how they communicate (23) or interpret others' communication (24, 25). By the preschool years, children can reason explicitly about the contents of others' beliefs (see refs. 10 and 11), later extending to second-order beliefs about others' mental states (26). Second, regarding dyadic relationships, infants can use a variety of cues—language use (27), preferences (28), imitation (29), and even saliva sharing (30)—to reason about the existence and strength of the relationship between two individuals (see ref. 7). By around 4 to 5 y of age, children can infer that two people are friends based on their gender, race, and even the degree to which they engage in physical contact or share mutual friends (31–33); they also expect friends to share secrets and speak favorably about each other (34, 35). Nonetheless, children still have difficulty distinguishing kinship from friendship even at age 5 (36), and their understanding of the kinds of knowledge shared by friends, peers, and community members undergoes significant refinement into middle childhood and beyond (32, 34). Finally, although young children can readily parse individuals into different social groups depending on their attributes (37–39), it remains unclear whether children understand how personal relationships facilitate the transmission of knowledge across these broader social structures.

If children possess an intuitive theory (15, see also refs. 16–18) that is capable of generating predictions and explanations about others' insider knowledge, it should systematically influence children's reasoning about who knows what about whom in the following ways. First, it should support reasoning about what anyone might know about anyone else—including themselves as well as total strangers—based on even sparse information about their social connections. Second, it should generate reasonable expectations about what others know, eliciting an error signal when they are violated. Finally, a key characteristic of a theory-like understanding is that it enables the generation of ad-hoc explanations about how an event occurred. Thus, children should not only detect instances of unexpected insider knowledge, but also explain *how* someone might have acquired that knowledge, however unexpected it might be.

It is possible, however, that such an integrated understanding does not emerge until later; instead, children might rely on more piecemeal representations of relationships and interpersonal knowledge. In fact, their rapidly expanding social experiences—with family, friends, neighbors, and even strangers—could give rise to fairly sophisticated inferences about who knows what even in the absence of an integrated theory. For example, given that children readily generalize properties of individuals to broader social categories (39, 40), observing that their caregiver knows a lot about their preferences can lead to the expectation that caregivers in general tend to know a lot about their children's preferences. Critically, while such piecemeal knowledge could support certain person- or relationship-specific inferences, it would fall short of explaining how anomalous insider knowledge could be acquired. Children this age also tend to overestimate what others know about a variety of topics (41) and struggle to accurately track the sources of people's knowledge, including their own (42). Thus, even if young children can accurately infer others' knowledge given enough time and context (see refs. 10 and 11), they might default to overestimating what people know about each other, especially when these expectations must be generated quickly in real-time conversations.

In sum, prior literature points to a range of possibilities about children's understanding of who knows what about whom. To adjudicate these accounts, we leveraged something even young children care about and are motivated to track: what people know about their own and others' personal preferences (43). If children hold expectations about such insider knowledge, then violations of these expectations (e.g., a stranger knowing your favorite food) should elicit surprise. Further, if children have a theory-like understanding of how social connections shape what people

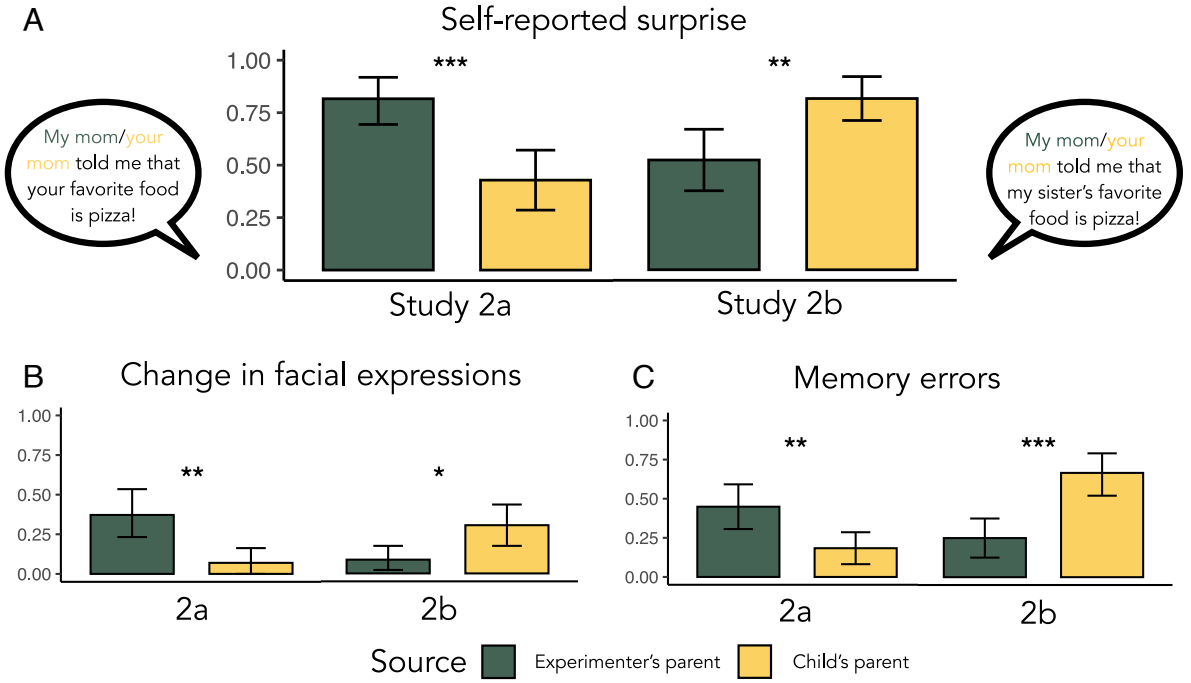

Fig. 2. Study 2 results. (*A*) Proportion of children who reported being surprised that a given source possessed knowledge about them (Study 2a) or the experimenter's sibling (Study 2b). (*B*) Proportion of children whose expression changed after the experimenter said a given source possessed knowledge. (*C*) The proportion of children who misattributed knowledge to the other (incorrect) source. Error bars indicate 95% bootstrapped CIs.

know, they should not only react with surprise when someone's insider knowledge is misaligned with their relationship, but also systematically explain how this could have occurred by appealing to possible channels of transmission. Going beyond prior research that relies on vignettes or hypothetical scenarios, we used a combination of parental reports (Study 1) and seminaturalistic experiments involving seemingly casual but well-controlled conversations (Study 2 & Study 3).

Results

Study 1. In Study 1, we asked parents of children aged 3 to 8 y (n = 128 parents of n = 177 children) to report when they first observed their child react to someone knowing something unexpected about them. Overall, 72% of parents (128/177) reported that their child had expressed surprise that someone knew something about them, beginning at 3.78 (SD = 1.35) years on average.

Of the parents who reported that their child had demonstrated this behavior, 84% (108/128) were able to describe a particular episode. For example, one parent reported: "He started kindergarten last year and the teacher sent me a message asking for the things that he liked and disliked. He came home super surprised at the fact that [his teacher] knew that his favorite food was pizza... He still talks about it today." While a majority of these reports (67/108, 61%) did not specify how children expressed surprise, 29% (32/108) mentioned that the child explicitly verbalized their surprise (e.g., by asking how someone knew), and 9% (10/108) mentioned that the child was visibly surprised (e.g., eyes widening) without specifying a verbal reaction. Most parents (90%, 97/108) specifically mentioned how the person with unexpected knowledge in the episode acquired their knowledge, either via communication (65%, 70/108; e.g., the child's parent told the person about the child's favorite toy) or direct observation (25%, 27/108; e.g., inferring a child's preference from their clothes or behaviors).

In sum, parents reported that beginning around age 4, children expressed surprise when someone possessed unexpected insider knowledge about them. These results provide preliminary support for the possibility that young children are sensitive to violations of expectations about what others know about themselves. These personal anecdotes, however, may reflect one-off incidents that are actually quite rare in children's daily lives. If children's responses indicate a robust ability to reason about others' knowledge, we should be able to reliably elicit similar responses in an experimental context. We test this possibility in Study 2.

Study 2. In Study 2, we used naturalistic but controlled videochat conversations to elicit and measure children's surprise in response to others' unexpected knowledge about them (Fig. 1). The study session consisted of a short, face-to-face conversation between the experimenter and the child on an online videochat platform (Zoom), lasting approximately 3 min. Unbeknownst to the child, when parents signed up for their child to participate they were asked to provide their child's favorite food and movie/show. During the study, the experimenter engaged the child in a seemingly casual conversation and naturally brought up each piece of information about the child (favorite food or movie/show, order counterbalanced) as something he heard from the child's parent (e.g., "I was talking to *your mom*, and your mom said that your favorite food is pizza") or the experimenter's parent (e.g., "I was talking to *my mom*, and my mom said that your favorite movie is Frozen").

After having a conversation about the child's favorite food and movie, children were asked whether they could remember who told the experimenter about the child's favorite food/movie, and were corrected if they mentioned the incorrect source. Children

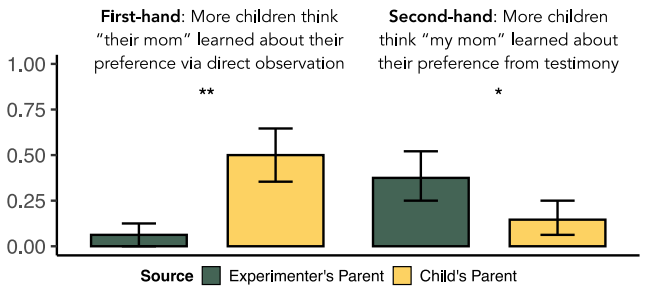

Fig. 3. Proportion of children who provided a (*Left*) first-hand and (*Right*) second-hand explanation for how a given source learned about them in Study 3. Error bars indicate 95% bootstrapped CIs.

were then asked if they were surprised that their parent (or the experimenter's parent) knew about their favorite food (or movie). In addition to their explicit reports of surprise, we also measured real-time changes in children's facial expressions when the experimenter mentioned the unexpected knowledge (see 44, 45).

To determine whether children's responses varied by the source of insider knowledge (the child's parent vs. the experimenter's parent), we conducted three separate mixed-effects logistic regression analyses, each predicting children's explicit report of surprise, change in facial expressions, and whether they misremembered the source, respectively; each model had the source of knowledge, participant age, and their interaction as fixed effects, with random intercepts fitted to source order (child's parent first vs. experimenter's parent first) and preference type (food vs. movie).

In Study 2a, children were significantly more likely to report being surprised that the experimenter's parent knew their preference compared to their parent (82% vs. 43%, $\beta = 1.82[0.88, 2.76], P < 0.001$). Complementing these findings, children were also more likely to show a change in their facial expression when the experimenter's parent was mentioned as the source compared to their parent (37% vs. 7%, $\beta = 2.06[0.72, 3.41], P = 0.003$). Finally, children were more likely to misremember the source as their parent when it was stated to be the experimenter's parent compared to the reverse (45% vs. 18%, $\beta = 1.39[0.42, 2.36], P = 0.005$). Importantly, even when the children who misremembered the source were excluded from analysis, the remaining children ($n = 26$) were still significantly more likely to report being surprised that the experimenter's parent knew about their preference compared to their parent ($\beta = 2.63[1.13, 4.14], P = 0.001$). Finally, we did not find an effect of age or an interaction between source and age for any of the analyses (all Ps > 0.09). See Fig. 2.

One way to explain these findings, however, is that children simply attributed knowledge indiscriminately to their own parent. To address this possibility, Study 2b used the same procedure to examine children's expectations about who has insider knowledge about someone who is essentially a stranger to them: the experimenter's sibling. If children always expect their parent to be knowledgeable regardless of their relationship to the target, we might find the same pattern of results as Study 2a. If, however, children genuinely understand that someone's parent is more likely to know about their child's preferences than a stranger, we should find an opposite pattern in this study: Children should express more surprise when their own parent knows the experimenter's sibling's favorite food or movie than when the experimenter's parent knows about them.

As expected, children in Study 2b showed a reversed pattern on all measures compared to Study 2a. Children were significantly more likely to report being surprised that their parent knew about the preference of the experimenter's sibling compared to the experimenter's parent (81% vs. 52%, $\beta = 1.53[0.53, 2.52], P = 0.003$). They were also more likely to change their facial expression when their parent was mentioned as a source compared to the experimenter's parent (30% vs. 9%, $\beta = 1.55[0.32, 2.77], P = 0.013$). Finally, children were more likely to misremember the source as the experimenter's parent when it was stated to be their parent compared to the reverse, (67% vs. 25%, $\beta = 1.82[0.92, 2.72], P < 0.001$).* There was no significant effect of age or an interaction between source and age for any of the analyses (all Ps > 0.15). See Fig. 2.

To summarize: Children were more likely to report being surprised when the experimenter's parent possessed insider knowledge about their preferences compared to their own parent; this pattern was reversed when the insider knowledge was about the experimenter's sibling. These explicit reports of surprise were accompanied by real-time changes in their facial expressions as well as a tendency to misattribute the knowledge to a more plausible source. Thus, by around age 4, children can use people's relationships to generate real-time expectations about what people know about both themselves and others. Study 3 goes further to ask whether these responses stem from a theory-like understanding of *how* people acquire insider knowledge.

Study 3. Going beyond children's ability to detect violations of expectation about insider knowledge, Study 3 investigated whether children can explain how someone might have acquired unexpected insider knowledge. For instance, when children learn that an unexpected source—the experimenter's mom—knew their favorite food, would they appeal to a process that is more plausible, such as communication with a knowledgeable source (e.g., perhaps she heard it from my mom, second-hand) rather than attributing it to direct observation (first-hand)? To this end, Study 3 used the same procedure as Study 2a, but instead of whether they were surprised, children were asked to explain how their parent and the experimenter's parent learned about their preferences. Analysis plans for Study 3 was preregistered.

First, consistent with our prediction, children generated different kinds of explanations for how their parent and the experimenter's parent learned their preference ($\tilde{\chi}^2 = 23.45$, $P < 0.001$, chi-square test). Next, we conducted two separate mixed-effects logistic regressions, each predicting the proportion of first- and second-hand explanations produced, respectively; in each model, source (the child's parent vs. the experimenter's parent) was entered as a fixed effect, with random intercepts fitted to source order and preference type. Children were significantly more likely to provide a first-hand explanation for how their parent learned about their preference (50%) compared to the experimenter's parent (6%), $\beta = 4.23[1.08, 7.38], P = 0.008$. In contrast, children were significantly more likely to provide a second-hand explanation for how the experimenter's parent learned about their preference (38%) compared to their parent (15%), $\beta = 1.28[0.19, 2.37], P = 0.022$. Notably, when children provided second-hand accounts for the experimenter's parent, most of their explanations (14/18) specifically stated that the experimenter's parent learned about their preference from children's own parent; however, when children provided second-

*After excluding children with memory errors ($n = 40$), children's explicit surprise reports showed a similar qualitative pattern (6/8 children for Experimenter's parent vs. 8/8 for Child's parent), but it is difficult to interpret these results due to the small sample size.

hand accounts for their own parent, most stated that they told their parent themselves (5/7).

These results suggest that rather than merely expecting parents to know about their children's preferences, children in our study generated plausible descriptions of how people–both within and outside their close social network—might acquire such information.

Discussion

Using parental report (Study 1) and naturalistic yet experimentally controlled conversations with children (Studies 2 and 3), our work shows that children as young as four years of age have a sophisticated understanding of who knows what about whom. Children in our studies expressed surprise when someone had unexpected insider knowledge given their relationship and even explained how someone might have acquired such knowledge. Going beyond traditional laboratory testing, our work leverages conversations in virtual settings to reveal a surprisingly precocious understanding of how social connections shape what people know.

Despite the rising popularity of online data collection in developmental science (46–48), it has generally been used as a cheaper, faster recruiting strategy to replace limited types of in-person studies (e.g., vignette-based) rather than a novel research method with its own unique advantages. Our study invited children to engage in a naturalistic conversation about their favorite things, while capitalizing on the very fact that videochat conversations can connect people who are physically and relationally distant from one another. This setup minimized the possibility that children expected the stranger—the experimenter's parent—to live in their neighborhood or actually know the child or their parent. Although the prevalence of videochat may vary by culture, we were able to use this method to create an ecologically valid context for the children in our sample to naturally elicit violations of their everyday social expectations.

Although our main measure—self-reported surprise—may not necessarily reflect children's immediate reactions so much as post hoc reasoning, children in our study also showed real-time changes in facial expressions when the experimenter mentioned the source of information. Prior work has reported that 3-y-olds show spontaneous changes in facial expressions (reflecting suspense or tension) when they encounter scenarios where something unexpected or disappointing is about to happen to an agent (44, 45). While such changes do not tell us much about the content of the underlying inferences, these prior findings suggest that children in our studies detected that something is "off" as soon as the source was mentioned.

Additionally, children showed a distinctive pattern of memory errors, remembering that the experimenter acquired unexpected insider knowledge from a more plausible source when it was, in fact, from an implausible source. While the overall low accuracy is consistent with prior work suggesting that children this age struggle to remember the sources of their own knowledge (see refs. 49 and 50), it does not explain why the pattern of errors closely aligns with their surprise. Prior work suggests that preschool-aged children engage in conversational repair (51) and even flexibly adjust their interpretation of unexpected utterances based on the quality of the speech signal and the speaker's past reliability (52). In light of these findings, the "errors" children made in our study may reflect more than simple memory failures. Beyond detecting the violation of expectation at the time the experimenter mentioned an unlikely source, some children may have even spontaneously repaired the utterance, believing that the experimenter must have misspoken. Taken together, the converging patterns across the three measures provide robust evidence for rapid, on-the-fly inferences about who knows what about whom.

These findings have broader implications for theories of human social cognition, especially the idea that humans develop intuitive theories about different aspects of the world (15, 16, 18, 53). If children only had piecemeal representations of what others know (e.g., strangers lack insider knowledge about them), a stranger revealing insider knowledge about them would simply leave children stumped. But children in our study not only detected (Study 2) but also explained (Study 3) unexpected insider knowledge, suggesting that these expectations are grounded in an abstract understanding of *how* insider knowledge is transmitted via social connections. Such reasoning requires an integration of multiple kinds of representations—minds, relationships, and larger social structures—and is consistent with the idea that from early in development, humans have an abstract, causal understanding of how people influence each others' mental states (i.e., "Theory of Minds," see refs. 54–58).

The fact that young children can effortlessly integrate and reason across different levels of their social world raises questions about the richness of these inferences. First, while the current study focused on using relationships to infer knowledge, adults routinely draw inferences in the reverse direction, using insider knowledge to reason about the latent structure of the social world. For instance, adults affiliate with those who share their knowledge or preference, especially when it is rare (8), and use individuals' preferences (e.g., movie choices) to recover the latent structure of social groups (59). While the earliest evidence for such inverse inferences based on knowledge come from children aged 6 and older (e.g., inferring friendship based on secret-sharing or knowing about each others' mental states; 32, 60), our work suggests that younger children may be able to use mutual knowledge to infer relationships, or even a chain of relationships (e.g., friends-of-friends).

Second, the current work leveraged insider knowledge about a person, preferences in particular, because it is usually shared within close relationships and easily understood by young children (e.g., 43, 61). However, insider knowledge can encompass a range of contents, from mundane facts like daily schedules to deeply private thoughts, feelings, or experiences. These contents vary along many dimensions—subjectivity, rarity, valence, and more—that likely impact our expectations about what others know and even whether that knowledge is accurate or not. For instance, it would be relatively less surprising that a stranger knew your favorite movie if it was wildly popular (easily guessed) compared to an obscure indie movie, which would be difficult to know without privileged access. Further, many other aspects of our minds—knowledge about the world, intentions, emotions, and values—are also influenced by others, but in ways that might meaningfully differ from insider knowledge. While the current studies show that young children have the underlying capacity to reason about the acquisition of a specific type of insider knowledge, the development of these inferences across other kinds of mental states is an important frontier for future research.

Finally, despite the early-emerging competence we found in our studies, the richness of children's inferences in everyday social interactions likely undergoes substantial developmental change. Undoubtedly, children's growing social experiences shapes their cultural knowledge and affects their reasoning, which

may help explain why prior work on children's understanding of shared knowledge and relationships has found continued development well beyond early childhood (e.g., refs. 34–36, and 60). Additionally, changes in executive function—capacities regarding the deployment of cognitive resources such as memory, attention, and processing speed—likely influence how quickly children can generate on-the-fly expectations and explanations.

As an initial investigation, the current work has focused on a relatively simple social structure between the child, the experimenter, and their parents. However, young children are sensitive to the properties of much larger social structures and institutions (see refs. 39 and 62), which may fundamentally shape how children affiliate (e.g., refs. 63–65), interact (e.g., refs. 66 and 67) and learn (68, 69), as well as how they expect others to do the same (e.g., refs. 31, 70, and 71). As children's own social networks expand in size and complexity, their understanding of social connections and how they shape individual minds offers a powerful tool for navigating their rapidly evolving social world.

Materials and Methods

Full data and analysis for each study can be found at https://osf.io/9hprk (72). All studies were approved by the Stanford University IRB (protocol 31350). Adult participants gave informed consent to participate. Caregivers provided informed consent for child participants, and children themselves assented to participating before the study began.

Study 1.

Participants. We recruited 132 adults from Cloud Research (Mean age = 36, 69 males) who reported to be a parent of at least one child aged between 3 to 8 y. Participants provided information about a total of 177 children in this age group (Mean age = 5.6, 90 males, 62% White) and were provided with modest compensation for their time ($2).

Procedure. The study was administered as a self-paced Qualtrics survey. Participants listed how many children they had between 3 to 8 y of age and then completed the following procedure for each child.

Participants first provided their child's age (in years), gender, and race. They were then asked "Has your child ever been surprised that someone knew something about them?" and presented two options: "Yes, they currently engage in such behavior or recently have" or "No, they have never engaged in such behavior." To help participants better understand the question and recall relevant behaviors, we provided three examples obtained from a previous pilot study (e.g., "For Halloween last year, she (the child) was Elsa (a character in the movie Frozen). She was surprised that people were able to figure out that Frozen was her favorite movie. She was floored and kept asking how they knew"). Participants who reported that their child had shown similar behaviors were then asked to provide their best guess at what age their child first demonstrated them, and to briefly describe, if they could, a specific episode that came to mind.

Studies 2a and 2b.

Participants. We recruited 4- and 5-y-old children (2a: $N = 49$, range: 4.0 to 5.9, mean: 5.1 y, 19 males, 43% White. 2b: $N = 48$, range: 4.0 to 5.9, mean: 4.9 y, 30 males, 52% White). Parents of potential participants received an email describing the study and asking them to provide two pieces of information about their child: their favorite food(s) and their favorite movie/show(s). Those who responded were scheduled for a synchronous study on Zoom (http://zoom.us). Ten additional children participated (five in each study) but were excluded due to experimenter error ($n = 4$), uninterpretable responding ($n = 4$), technical difficulties ($n = 1$), or inattention ($n = 1$).

2a procedure. The study procedure consisted of a conversation between the child and the experimenter (Fig. 1). After greeting the child and obtaining parental consent, the experimenter mentioned they had something to tell them. The experimenter first brought up one of the two pieces of information about the child (their favorite food or movie/show), describing the source as either the child's parent (i.e. "your mom") or the experimenter's parent (i.e. "my mom"). For example, "I was talking to *your mom*, and your mom said that your favorite food is pizza." The experimenter then engaged the child in brief conversation about the topic[†] (e.g., "what kind of toppings do you like on your pizza?") before bringing up the second piece of information in a similar manner, using the other parent as the source this time: "I was talking to *my mom*, and my mom said that your favorite movie is Frozen." The order of the information and source was counterbalanced across participants.

After discussing the second topic, the experimenter asked the child a series of questions about each piece of information in the order they were discussed. The first question probed whether children remembered the source of personal information: "Do you remember who told me what your favorite food/movie is? Was it your mom or my mom who told me?". If children responded with the incorrect source or could not remember, the experimenter corrected them by telling them the original source: "actually, it was *my* mom who told me ...". The experimenter then asked the key question: "Were you surprised that your/my mom knows what your favorite food/movie is, or were you not surprised?".

2b procedure. The procedure was similar to Experiment 2 but knowledge about the child was replaced by knowledge about the experimenter's sibling. First, the experimenter told the child that they had a sibling (gender matched to the child) just like them, and mentioned something they learned about their sibling from either the child's parent (i.e., "your mom") or their own parent (i.e., "my mom"). For example, the experimenter said: "I was talking to your mom, and your mom told me that my sister's favorite food is pizza!"). Next, the experimenter asked the child what their favorite food or movie was and engaged them in conversation. The experimenter then brought up the second piece of information in a similar manner, describing the source as the other parent.

Finally, the experimenter asked the child the same series of questions as Study 2, but about their sibling: "Do you remember who told me what my sister's food/movie is? Was it your mom or my mom who told me?"; "Were you surprised that your mom/my mom knows what my sister's favorite food/movie is, or were you not surprised?".

Expression coding. To determine whether participants' facial expressions changed when a given source was mentioned, two independent coders reviewed each video during the time frame when the experimenter mentioned a given source and when the experimenter asked the child if the information mentioned was true (e.g., "Your mom told me that your favorite food is pizza. Is that true?"). During this window for both source statements, coders determined whether the child's facial expression changed, paying special attention to the brows, eyes, and mouth, in line with previous work examining children's facial expressions during mentalizing tasks (44, 45). If the child's face was completely or partially obscured for either source statement, they were excluded from subsequent expression analyses ($n = 6$ in 2a, $n = 2$ in 2b). For the remaining source statements, coders had relatively high agreement (2a: 71/84, $\kappa = 0.46$; 2b: 76/92, $\kappa = 0.49$). When coders disagreed, they reviewed the video together and made a final determination.

Study 3. Our hypotheses and analysis plan was preregistered at https://aspredicted.org/3xnm-zp4v.pdf. While we originally preregistered a sample of 5-y-olds, we included 4-y-olds to match the prior studies. Additional analyses with the 5-y-old sample can be at https://osf.io/9hprk.

Participants. We recruited 4- and 5-y-old children ($N = 48$, range: 4.0 to 5.9, mean: 5.0 y, 20 males, 54% White) via lookit (73). Parents of potential participants received an email describing the study and asking them to provide two pieces of information about their child: their favorite food(s) and their favorite movie/show(s) when scheduling for a synchronous study on Zoom (http://zoom.us). Twenty additional children participated but were excluded due to experimenter error ($n = 8$), inattention ($n = 4$), parental interference ($n = 3$), uninterpretable responses ($n = 3$), or technical difficulties ($n = 2$).

[†]The conversations varied based on the individual participant and their preferences. However, to avoid drastic differences between participants, the experimenter typically asked participants to explain their preferences and tried to keep the conversations around a minute per topic.

Procedure. The procedure was similar to Study 2a. However, after providing a source statement and discussing their preference, the experimenter asked the child how the source learned about their preference (e.g., "how do you think your mom (or my mom) learned that your favorite food is pizza?").

Explanation coding. Participants' explanations were coded as either first-hand, second-hand, unsure, or other. Explanations were coded as *first-hand* if they explicitly stated that the source observed their preference (e.g., "my mom saw me watch Frozen") or implied it (e.g., "I watch Frozen at home all the time"). Explanations were coded as *second-hand* if they stated that the source acquired their knowledge from someone else (e.g., "my mom told your mom"); we also coded who the source was in these cases, including the child's parent, the child themselves, the experimenter, or an ambiguous third-party. Explanations were coded as *unsure* if the child did not respond or expressed uncertainty after repeated prompting and *other* if their explanation did not fit into any of these three categories (e.g., "because pizza is delicious"). As we anticipated a high proportion of "unsure" or "other" responses given the age range, our preregistered analysis focused on the relative proportion of "first-hand" and "second-hand" responses (Fig. 3).

Data, Materials, and Software Availability. Anonymized participant responses (csv files), analytic and visualization code (written in R markdown), and survey files (qsf) have been deposited in OSF (https://osf.io/9hprk) (72).

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