

# Early emerging system for reasoning about the social nature of food

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Selecting appropriate foods is a complex and evolutionarily ancient problem, yet past studies have revealed little evidence of adaptations present in infancy that support sophisticated reasoning about perceptual properties of food. We propose that humans have an early-emerging system for reasoning about the social nature of food selection. Specifically, infants' reasoning about food choice is tied to their thinking about agents' intentions and social relationships. Whereas infants do not expect people to like the same objects, infants view food preferences as meaningfully shared across individuals. Infants' reasoning about food preferences is fundamentally social: They generalize food preferences across individuals who affiliate, or who speak a common language, but not across individuals who socially disengage or who speak different languages. Importantly, infants' reasoning about food preferences is flexibly calibrated to their own experiences: Tests of bilingual babies reveal that an infant's sociolinguistic background influences whether she will constrain her generalization of food preferences to people who speak the same language. Additionally, infants' systems for reasoning about food is differentially responsive to positive and negative information. Infants generalize information about food disgust across all people, regardless of those people's social identities. Thus, whereas food preferences are seen as embedded within social groups, disgust is interpreted as socially universal, which could help infants avoid potentially dangerous foods. These studies reveal an early-emerging system for thinking about food that incorporates social reasoning about agents and their relationships, and allows infants to make abstract, flexible, adaptive inferences to interpret others' food choices.

food | social cognition | infancy | cognitive development | disgust

Although eating is a basic drive, humans' food selection is incredibly complex (1). Being a competent eater requires considerations of safety, nutritional diversity, caloric intake, and at least in modern times, health (2, 3). Discovering the developmental trajectory and mechanisms involved in food choice can help us understand how people solve the critical problem of selecting appropriate foods. Given its ecological importance, there may be early-emerging adaptations that support complex reasoning in the food domain. Yet, past research has revealed that human infants are surprisingly inept at categorizing and selecting appropriate foods (4, 5). However, these studies did not consider the importance of social aspects of food choice. Eating is inherently social, and the foods that people eat are embedded in cultural systems (6–18). Thus, although infants may not be skilled at reasoning about perceptual or nutritional properties of foods, they may instead be skilled at thinking about the relationship between food choice and social identity. Here, we explore the idea that a specialized system for reasoning about food choice is present early in life, and depends on social input about people and their relationships.

On first blush, infants' reasoning about food seems surprisingly limited. Although infants and young children have basic taste preferences (19–23), they make maladaptive food choices, including ingesting inedible and dangerous substances (e.g., refs. 4 and 24–26). Indeed, children under 2 y of age are the most likely age group to accidentally poison themselves (24). Additionally,

although adults, older children, and even adult monkeys rely on different perceptual properties to make inferences about foods and about artifacts (e.g., using color when reasoning about foods, shape when reasoning about artifacts), human infants do not (5, 27–35). Because human infants have historically relied on caregivers to provide safe and nutritious diets, they may not need to have mechanisms in place for reasoning about food. In this case, cognitive mechanisms that support careful food choice may only emerge once children are actively selecting foods themselves. Indeed, young children begin to display neophobia and picky eating (24, 36, 37), which could protect them from selecting potentially dangerous novel foods.

Critically, though, humans do not choose their foods in isolation. Reframing food selection as a social rather than nutritional problem may shed light on the relevant mechanisms that could support early reasoning about food (38). Social learning about food selection and food avoidance has been observed in a diverse range of animal species (38–44). For humans, in addition to social learning about edibility, food choice has broad social and cultural significance (6–11). People decide not only what they should eat, but also how, when, and with whom to eat, and human cultures converge on radically different food choices and eating practices (12–18). Food choice can even serve as a social shibboleth, whereby information about what an individual eats affords insight into her cultural background and social relationships (24, 45–54). Because of the inherent social and cultural nature of eating, even human infants may interpret eating behaviors as communal across agents who share a common social identity.

Consistent with the possibility that early reasoning about food may be fundamentally social, the cases where infants appear to make savvy decisions about food occur in situations that provide social context. Infants eat more when other people are eating

## Significance

Food choice can serve as a social shibboleth, whereby information about what an individual eats affords insight into her cultural background and social relationships. We provide evidence for an early-emerging system linking food preferences to social identity. Infants expect people to share food preferences, unless those people belong to different groups, suggesting human reasoning about food preferences is fundamentally social. However, infants generalize disgust toward a food even across people who belong to different groups, suggesting that infants are particularly vigilant to social information that might signal danger. This research opens new lines of investigation regarding infant social cognition and food selection across the lifespan, and has implications for social policy surrounding nutrition, health, and obesity.

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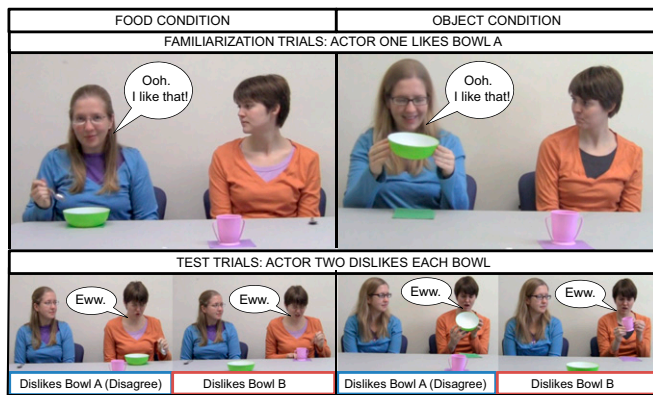
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**Fig. 1.** Study 1 Stimuli. During familiarization the first actor liked either food A or bowl A. During the test, the second actor actively disagreed by disliking food A or bowl A, or disliked the previously untouched item, food B or bowl B.

with them (22), they learn about edibility by watching other people eat (38), and they preferentially eat foods associated with native speakers and prosocial actors (55, 56). However, existing data do not provide evidence for a system of reasoning that specifically targets the food domain and allows infants to make socially relevant inferences about food choices. Critically, first-person social preferences offer little insight on infants' conceptual representations because these behavioral responses may arise based on infants' domain-general preferences for familiarity, rather than as a result of abstract inferences about familiar people's identities or social relationships. In fact, infants rely on the same cues (e.g., prosociality and native language) to inform their choices for foods and for nonfood objects (56–60), suggesting these social preferences cannot tell us whether infants form a specific link between social identity and food choice. Therefore, we investigate infants' third-party expectations about what other people will eat to gain traction on infants' conceptual system for reasoning about food choice. We asked whether there is an early-emerging, domain-specific system for reasoning about food that relies on input about agents' identities and social relationships.

We first asked whether infants' inferences about food choice are qualitatively different from their inferences about nonfood objects. After learning that a person prefers a particular object, infants typically do not generalize that person's preference to a new person (60–63). However, given the ecological and social significance of food, infants may expect people to eat the same foods, and therefore they might generalize one person's food preference to a new person. We tested infants around 1 y of age because this age is typically studied in research on inductive inferences in infancy (60–63), and because infants this age are gaining more agency in their food choices (64).

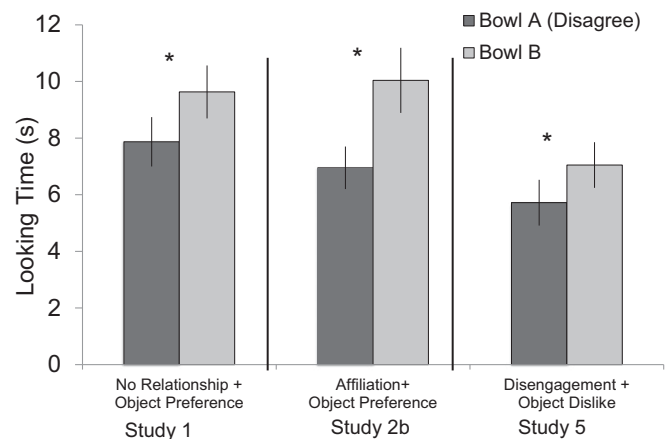
An initial study compared 14-mo-old infants' expectations about food versus object preferences by creating perceptually similar movies in which actors interacted with two items (bowl A and bowl B), and expressed their preferences. During familiarization, one actor interacted with one item. In the food condition, she ate a bite from bowl A, liked the food, smiled, and said, "Ooh. I like that!" in a positive tone. In test trials, a second actor alternated between eating a bite from each bowl, disliking it, frowning, and saying, "Ew. I don't like that" in a negative tone. The object condition was identical except that rather than eating from each bowl, the actors lifted and examined each empty bowl before providing evaluations (Fig. 1 and [Movies S1–S6](#)). When the second actor disliked food A or bowl A, she was actively disagreeing with the first actor. However, when the second actor disliked food B or bowl B, she provided no information because the first actor had not interacted with that item. Familiarization and test trials were infant-controlled: after the actor expressed her opinion, movement on the screen paused and the infant's

cumulative looking time to the display was measured until the infant looked away for 2 consecutive seconds. If infants only attended to perceptual properties of the events, we would expect them to look longer when the second actor disliked food or bowl B, because this event was the most perceptually novel event, given that it was the first time anyone interacted with that item. However, if infants generalized preferences across actors, then we would expect them to find disagreement unexpected and to look longer when the second actor disagreed with the first actor by disliking food or bowl A.

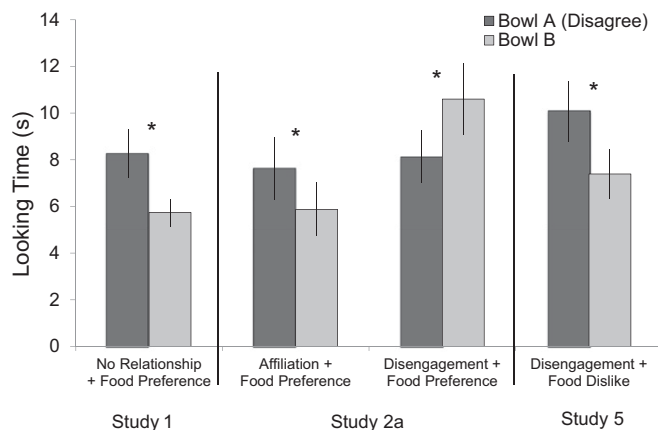
A repeated-measures ANOVA revealed a significant interaction showing that infants' patterns of looking to the two types of test trials (A vs. B) differed across condition (foods vs. objects;  $F_{1, 30} = 18.565$ ;  $P < 0.001$ ). Replicating past work, infants in the object condition did not generalize object preferences across actors: infants looked significantly longer at the perceptually novel event [mean ( $M$ )<sub>B</sub> = 9.6 s] than at the disagreement ( $M_A = 7.9$  s;  $F_{1, 15} = 6.919$ ;  $P = 0.019$ ) (Fig. 2, *Left*). However, infants in the food condition successfully generalized food preferences: infants looked significantly longer when the second actor actively disagreed with the first actor ( $M_A = 8.3$  s) than when she disliked the perceptually novel food ( $M_B = 5.7$  s;  $F_{1, 15} = 11.781$ ;  $P = 0.004$ ) (Fig. 3, *Left*).

Infants generalized food preferences but not object preferences across individuals. One explanation for these results could be that infants learn that food A is edible from watching the first person eat, and therefore expect the second person to also like food A. In fact, young children learn about which foods are safe and palatable by observing other people eat (65). As an illustration, when an infant sees someone eat from a plant, she learns that the substance is likely edible, and later generalizes her expectation of edibility to a new person (38). However, important open questions remain about the nature of infants' representation of others' food choices. If seeing someone like a food exclusively provides infants with veridical information about edibility, then infants should expect all people to share food preferences. Alternatively, if infants' reasoning about food relies on information about agents and their social relationships, then infants may constrain their generalization of food preferences to people who share a common social identity.

Capitalizing on infants' ability to track social relationships and make inferences about when individuals will affiliate (48, 66), in study 2a, we asked whether infants use social relationships to inform their inferences about who will share food preferences. In an introduction phase, a new group of 14-mo-old infants were randomly assigned to see the two actors affiliate with each other



**Fig. 2.** Looking times for Studies 1, 2b, and 5. This graph depicts the average looking time to bowl A and bowl B trials for infants in the object conditions of studies 1, 2b, and 5. Error bars represent the SEM looking time. Asterisks indicate a significant difference in the individual ANOVAs for each condition.



**Fig. 3.** Looking times for Studies 1, 2a, and 5. This graph depicts the average looking time to bowl A and bowl B trials for infants in the food conditions of studies 1, 2a, and 5. Error bars represent the SEM looking time. Asterisks indicate a significant difference in the individual ANOVAs for each condition.

or disengage from one another. In the affiliation condition, the actors turned toward each other, smiled, waved, and said, “Hi” in a positive tone. In the disengagement condition, the actors turned away from each other, crossed their arms, and said, “Hmph” in a negative tone. Next, infants watched the familiarization and test trials from the food condition of study 1. A repeated-measures ANOVA revealed that infants’ patterns of looking to the test trials (A vs. B) differed across the conditions (affiliation vs. disengagement;  $F_{1, 30} = 15.527$ ;  $P < 0.001$ ) (Fig. 3, Center). Infants who saw the actors affiliate generalized the food preference: they looked significantly longer when the second actor disagreed with the first ( $M_A = 7.6$  s) than at the perceptually novel event ( $M_B = 5.9$  s;  $F_{1, 15} = 13.443$ ;  $P = 0.002$ ). However, infants did not generalize food preferences across actors who disengaged; they instead looked significantly longer at the perceptually novel event ( $M_B = 10.6$  s) than when the second actor disagreed with the first actor ( $M_A = 8.1$  s;  $F_{1, 15} = 6.609$ ;  $P = 0.021$ ). Thus, infants’ inferences about food preferences depended on the social relationships at play. Rather than expecting food preferences to be indiscriminately shared across people, infants generalized food preferences across affiliative partners but not across people who disengaged.

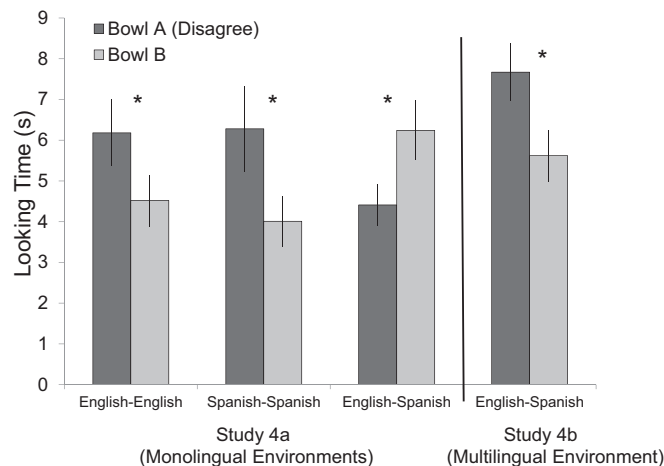
Study 2b investigated whether social information uniquely constrains infants’ generalization of food choices, or whether social information is equally impactful for infants’ inferences about objects. Because at baseline infants do not generalize object preferences, we asked whether giving additional information, that the actors affiliated, would lead infants to generalize an object preference across individuals. Study 2b was therefore identical to the affiliation condition of study 2a, except that the actors expressed their opinions about the bowls rather than about foods. Even when given information that the actors affiliated, infants did not generalize object preferences across individuals: they looked significantly longer at the perceptually novel event ( $M_B = 10.0$  s) than when the second actor disagreed ( $M_A = 7.0$  s;  $F_{1, 15} = 14.329$ ;  $P = 0.002$ ) (Fig. 2, Center). These results further indicate that infants’ reasoning about food is distinct from their reasoning about objects: infants’ inferences about agents’ food preferences, but not about agents’ object preferences, were guided by information about the agents’ social relationships.

In study 3 we conceptually replicated the influence of social relationships on infants’ generalization of food preferences with a slightly different method. After seeing two actors affiliate or disengage, infants viewed familiarization events in which the first actor expressed a preference for a food, and test events in which the second actor either liked the same food (agreement) or liked the previously uneaten food (perceptually novel event). Infants

expected affiliative partners to agree, but found agreement unexpected if people had disengaged (see *Supporting Information* and Fig. S1 for detailed methods and results). Taken together, studies 2a and 3 indicate that although infants may learn about edibility by watching people eat, knowing that a food is edible does not lead them to expect all people to like it. Rather, infants generalize food preferences across some people (those who have affiliated) but not across others (those who have disengaged).

A further question is whether infants use more abstract aspects of social structure to reason about which people share food preferences. Language and accent are robust indicators of social and cultural groups (67, 68), and infants are sensitive to the social significance of language (58, 69). Therefore, we asked whether infants selectively generalize food preferences across people who speak the same language. In study 4a, 11-mo-old infants from monolingual English-speaking backgrounds were randomly assigned to one of three introductions: native bilingual actors were presented as two English speakers (English–English), two Spanish speakers (Spanish–Spanish), or as one English speaker and one Spanish speaker (English–Spanish). Then, infants watched familiarization and test trials like the food condition of study 1 (Movies S7–S10). Infants’ patterns of looking to the test trials (A vs. B) differed across the conditions ( $F_{2, 45} = 12.378$ ;  $P < 0.001$ ) (Fig. 4, Left). Infants who saw the actors speak the same language generalized the food preference. In both same-language conditions (English–English and Spanish–Spanish) infants looked significantly longer when the second actor disagreed with the first actor than when she disliked the perceptually novel food (English–English:  $M_A = 6.2$  s,  $M_B = 4.5$  s,  $F_{1, 15} = 5.695$ ,  $P = 0.031$ ; Spanish–Spanish:  $M_A = 6.3$  s,  $M_B = 4.0$  s,  $F_{1, 15} = 14.148$ ,  $P = 0.002$ ). Infants therefore found disagreement about food preferences unexpected among same-language speakers. However, infants did not generalize food preferences across speakers of different languages: infants in the English–Spanish condition looked significantly longer at the perceptually novel event ( $M_B = 6.2$  s), than at disagreement ( $M_A = 4.2$  s;  $F_{1, 15} = 9.957$ ;  $P = 0.007$ ). These results indicate that the language that people speak, which serves as an informative indicator of social group, influences infants’ inferences about shared food preferences. Infants constrain their generalization of food preferences to people who speak the same language.

An adaptive social learning system would likely be influenced by variation in infants’ social experiences, which could modulate the types of information deemed meaningful for making social inferences. One important dimension in which infants’ environments



**Fig. 4.** Looking times for Studies 4a and 4b. This graph depicts the average looking time to bowl A and bowl B for infants in each condition. Error bars represent the SEM looking time. Asterisks indicate a significant difference in the individual ANOVAs for each condition.

vary is the diversity in their sociolinguistic backgrounds. Experiencing a monolingual vs. multilingual environment might lead infants to make different inferences about the degree to which a common language marks a common social group, which, in turn, could influence infants' generalization of food preferences. We hypothesized that infants raised in multilingual environments might expect food preferences to be shared even across different-language speakers. In study 4b we replicated the English-Spanish condition of study 4a with infants who were raised in bilingual environments. Unlike monolingual infants, infants who were raised in bilingual environments generalized the food preference across individuals who spoke in different languages: they looked significantly longer when the second actor disagreed ( $M_A = 7.4$  s) than at the perceptually novel event ( $M_B = 5.4$  s;  $F_{1, 15} = 20.267$ ;  $P < 0.001$ ) (Fig. 4, *Right*). Interestingly, infants' generalization across speakers of English and Spanish did not appear to depend on exposure to Spanish per se (*Supporting Information*). Taken together, studies 4a and 4b indicate that infants' inferences about food preferences are adaptively responsive to variation in their social environments.

The findings from the first four studies indicate that infants' reasoning about food choice is tightly linked to their reasoning about social behaviors and social identity. Nevertheless, an adaptive system for reasoning about food choice as social might have important limits. In particular, choosing appropriate foods requires avoiding ingesting dangerous substances, so a competent social learning system should show special responses to foods that may be harmful. Given the potential value of being able to use one person's disgust response to learn veridical information about potential danger, infants may generalize disgust even across people who do not share a common social identity. That is, there might be critical asymmetries in infants' thinking about the generalizability of someone liking versus disliking a food.

Study 5 asked this question by investigating whether infants generalize food dislike even across people who have socially disengaged. In study 5, after seeing the actors disengage in the introduction phase, infants saw a familiarization phase where the first actor expressed dislike toward food A. Then, in alternating test trials (A versus B) the second actor liked each food. Thus, during bowl A test trials the second actor actively disagreed with the first actor by liking the previously disliked food, whereas during bowl B test trials she liked the previously uneaten food, which was perceptually novel but which did not provide information about disagreement. Infants generalized food disgust: they looked significantly longer when the second actor actively disagreed ( $M_A = 10.1$  s) than at the perceptually novel event ( $M_B = 7.4$  s;  $F_{1, 15} = 19.636$ ;  $P < 0.001$ ) (Fig. 3, *Right*). To ask whether these results were specific to reasoning about disliked foods, a second group of infants saw identical events, except that the actors expressed their opinions about the bowls themselves rather than about foods. Infants did not generalize object disgust across actors: they looked significantly longer at the perceptually novel event ( $M_B = 7.0$  s) than at the disagreement ( $M_A = 5.7$  s;  $F_{1, 15} = 5.749$ ;  $P = 0.030$ ) (Fig. 2, *Right*). Infants' patterns of looking to the two types of test trials (A vs. B) differed across the conditions (foods vs. objects;  $F_{1, 30} = 23.953$ ;  $P < 0.001$ ), suggesting infants' generalization of food dislike was not a result of a general negativity bias (70, 71). Critically, these results provide further evidence that infants' inferences about others' food choices are again specific to reasoning about foods: infants generalized information about disliked foods across all people (even those who disengaged), but they did not generalize perceptually similar information about disliked objects. Seeing opinions about disgust toward foods as universally shared could be a helpful strategy that allows infants to eventually make their own safe choices.

Taken together, the current findings reveal early-emerging, domain-specific adaptations for reasoning about food selection that are distinct from reasoning about nonfood objects. Although infants seem to lack expectations about which physical properties are relevant for reasoning about foods (5), and they can make maladaptive food choices themselves (24), they nonetheless

reason adaptively about other people's food preferences and dislikes. Infants readily recruit social information about agents and their social relationships to make inferences about food choice, adapt these expectations based on their own sociocultural experience, and show critical asymmetries in their generalization of people's liking versus disliking of foods. These responses suggest a strong conceptual foundation for solving the complex learning problems that human infants and children need to become competent in the food domain.

Our findings raise new questions about the origins and species-specificity of these adaptive responses. It is possible that parts of infants' system for reasoning about food are evolutionarily ancient and seen across a variety of species. As an example, infants may learn about which foods to approach or avoid by watching other people eat (38), and seeing someone dislike a food may teach infants objective information that the food is bad and should be avoided. This ability to determine whether a substance is edible or inedible by watching someone else eat has immense adaptive value in that it might help infants avoid dangerous foods without having to try those foods themselves. This aspect of social learning in the food domain is not specific to humans: nonhuman primates and rats also use socially provided information from conspecifics to make inferences about edibility (39–44).

On the other hand, other aspects of infants' social systems for reasoning about food may be unique to humans. Specifically, in addition to being able to reason about edibility, infants form a rich conceptual link between food preferences and social identity: human infants reason about who is likely to eat which foods, and expect people with a shared social identity to be more likely to share food preferences than people from dissimilar backgrounds. Additionally, this social-cognitive system is importantly flexible such that infants can use their own social experiences, such as their sociolinguistic background, to determine what social input is relevant to constraining their generalization of food preferences. Constraining generalization of food preferences to people who belong to the same social group may be specific to humans and could arise because, for humans, food choice and eating behaviors are fundamentally social experiences (6–18).

The fact that infants have specialized, socially laden mechanisms for reasoning about foods revolutionizes how we can think about infant social cognition by opening entirely novel questions. As an example, rather than being agnostic as to what dimensions are socially important, infants may be predisposed to expect some dimensions of variation to be informative for signaling social relations. We provide evidence that infants are sensitive to at least two of these dimensions: the languages people speak and the foods people eat. Although there has been growing interest in infants' reasoning about intrapersonal social structure (72–74), little is known about which factors infants use to decide whether two individuals likely belong to the same group. We propose that infants may begin with a circumscribed set of sensitivities (which can be adapted based on experience) that allow them to focus on, and learn about, aspects of human behavior that signal intrapersonal structure. In addition to language and food, this account would imply that infants may use other cues that fundamentally mark social identity when making social inferences, such as dominance, ritual behaviors, and kinship (75–79). On the other hand, we would not expect infants to make inferences about social structure based on arbitrary or trivial similarities. Further studies can probe the boundaries of features that infants view as socially or culturally relevant.

Our findings reveal the deeply social nature of human thinking about food, which could have real-world implications. Many researchers have focused on nutritional properties in explaining food choice (3), but our results indicate that early reasoning about food is strongly related to social factors (11). Indeed, obesity spreads through social networks (80), further suggesting that reframing food selection as a social problem could be useful in encouraging healthy eating practices. Thus, we suggest that health-based interventions focusing on the social aspects of eating may be a more profitable approach than interventions

focusing solely on nutrition (81–85). More generally, the current findings reveal a tight connection between food and social cognition early in ontogeny, which can shed light on the mechanisms that drive food-related behaviors in social and cultural groups, and can contribute to an understanding of the origins of the relationship between food choice and social cognition across the lifespan.

## Materials and Methods

**General Methods.** All study procedures were approved by the Institutional Review Board of the University of Chicago. Across studies, infants were from diverse racial and ethnic backgrounds, representative of the Chicago area: 43.2% White, 25.6% Black, 4.5% Asian, 17.1% Hispanic, and 9.5% Multiracial. Parents gave informed consent for their infants to participate and were compensated with either a travel reimbursement or a gift for their child. Studies all portrayed videos embedded in Keynote software that were presented onto a large screen, such that the videos were 4-feet high and 7-feet wide, making the actors appear approximately life-sized. Infants watched the videos from a high-chair positioned ~5.5 feet from the screen. See [Dataset S1](#) for details regarding infants' responses to all conditions of all studies.

**Study 1.** Participants were 32 full-term infants (18 females,  $M = 14:12$ , range 13:19 to 15:15). Infants were randomly assigned to the food or object condition. Stimuli consisted of two actors sitting at a table with two bowls (A and B). The study featured familiarization (three trials) and test phases (six trials). All movies were ~10 s long. During familiarization, one actor liked one of the bowls (A) by saying, "Ooh! I like that!" in a high-pitched voice. During test, the second actor disliked each bowl on alternating trials by saying, "Ew. I don't like that." in a low-pitched voice. In the food condition, the actors each ate the food before expressing their opinion; in the object condition, the actors each lifted and examined the bowl itself before expressing their opinion. We counterbalanced the following: which actor was first, which bowl she talked about, and which bowl was referred to first in the test phase.

Familiarization and test trials were infant-controlled, meaning trials advanced when an infant met the looking criteria. Trials started when motion on the screen ended, and ended when the infant looked away for 2 consecutive seconds. Infants' looking was coded by two coders who were unaware of condition (the first coder wore noise-cancelling headphones and viewed only the infants' face, and the second coder only watched the test phase of the videos). The first coder recorded infants looking live, during the study, by watching the videos on an infant monitor from behind the projection screen, and the second coder coded independently from recorded video of the session. We measured reliability by looking at whether the two coders agreed on the endpoint of each trial. Coders agreed about the look-away that ended the trial on 94% of trials. We also looked at nonparametric statistics to determine whether the patterns of results held across the majority of individuals in the sample. The majority of infants in the object condition looked longer when the second actor disliked bowl B ( $n = 13$  of 16, binomial  $P = 0.021$ , two-tailed). In contrast, the majority of infants in the food condition looked longer when the second actor disagreed with the first by disliking the food in bowl A ( $n = 13$  of 16, binomial  $P = 0.021$ , two-tailed).

**Study 2a.** Participants were 32 full-term infants (16 females,  $M = 14:7$ , range 13:12 to 15:4). Three additional infants were excluded because of fussiness ( $n = 2$ ) and experimenter error ( $n = 1$ ). The study was identical to the food condition of study 1, with the addition of an introduction phase (three trials). Infants were randomly assigned to see the actors either affiliate or disengage before eating. The coders agreed about the look-away that ended the trial on 91% of trials. The repeated-measures ANOVA on test trial looking times also revealed a main effect of pair ( $F_{2, 29} = 3.57$ ;  $P = 0.041$ ), indicating decreased looking across the session. The majority of infants who saw the actors affiliate looked longer when the second actor disagreed by disliking bowl A ( $n = 13$  of 16, binomial  $P = 0.021$ , two-tailed). In contrast,

the majority of infants who saw the actors disengage looked longer when the second actor disliked bowl B ( $n = 13$  of 16, binomial  $P = 0.021$ , two-tailed).

**Study 2b.** Participants were 16 full-term infants (7 females,  $M = 14:9$ , range 13:9 to 15:14). The study design was identical to the affiliation condition of study 2a, except the actors expressed their opinions about the bowls themselves. The coders agreed about the look-away that ended the trial on 93% of trials. The majority of infants looked longer when the second actor disliked bowl B ( $n = 14$  of 16, binomial  $P = 0.004$ , two-tailed).

**Study 3.** See [Supporting Information](#) and [Fig. S1](#) for details.

**Study 4a.** Participants were 48 full-term monolingual infants (21 females,  $M = 10:26$ , range 10:5 to 11:28). One additional infant was tested but excluded because of fussiness. The design was like the food condition of study 1 with a few changes. First, infants saw an introduction phase (three trials, 30-s each) before familiarization where the actors introduced themselves by speaking either English or Spanish. The actors were bilingual, which allowed us to randomly assign infants to see the actors either speak the same language (English–English; Spanish–Spanish), or speak different languages (English–Spanish). Then, infants saw familiarization (three trials) and test phases (six trials). To show all infants the same videos, actors expressed liking by saying, "Ooh! Ooh!" in high-pitched voices, and expressed disliking by saying, "Ugh. Ugh." in low-pitched voices after eating.

The repeated-measures ANOVA on test-trial looking times revealed a marginal main effect of trial type ( $F_{1, 45} = 3.75$ ;  $P = 0.059$ ) and a significant effect of pair ( $F_{2, 44} = 5.86$ ;  $P = 0.006$ ), indicating decreasing looking across the test session. The coders agreed about the look-away that ended the trial on 95% of trials. The majority of infants who saw the actors speak the same language looked longer when the second actor disagreed by disliking bowl A ( $n = 25$  of 32 combining across same-language conditions, binomial  $P = 0.002$ , two tailed). In contrast, the majority of infants who saw the actors speak different languages looked longer when the second actor disliked bowl B ( $n = 14$  of 16 from English–Spanish, binomial  $P = 0.004$ , two-tailed).

**Study 4b.** Participants were 16 multilingual infants (8 female,  $M = 11:2$ , range 10:15 to 11:22). In addition to English, infants were exposed to their non-English language between 10% and 70% of the time according to parental report. The languages they heard were: Spanish ( $n = 8$ ), French ( $n = 3$ ), Cantonese ( $n = 1$ ), Gujarati ( $n = 1$ ), Mandarin ( $n = 1$ ), Swahili ( $n = 1$ ), and Tagalog ( $n = 1$ ). The coders agreed about the look-away that ended the trial on 93% of trials. The majority of infants looked longer when the second actor disagreed by disliking bowl A ( $n = 15$  of 16, binomial  $P < 0.001$ , two-tailed). See [Supporting Information](#) for more details.

**Study 5.** Participants were 32 full-term infants (18 females,  $M = 14:21$ , range 13:19 to 15:23). One additional infant was tested but excluded because of experimenter error. Infants saw an introduction phase where the two actors socially disengaged. Familiarization and test events were like study 1, but the pattern of emotions switched. The coders agreed about the look-away that ended the trial on 94% of trials. The repeated-measures ANOVA on test trial looking times also revealed a main effect of pair ( $F_{2, 29} = 11.663$ ;  $P < 0.001$ ), indicating a decrease in looking across the test session. The majority of infants in the food condition looked longer when the second actor actively disagreed by liking bowl A ( $n = 15$  of 16, binomial  $P < 0.001$ , two-tailed). In contrast, the majority of infants in the object condition looked longer when the second liked bowl B ( $n = 12$  of 16, binomial  $P < 0.076$ , two-tailed).

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- Rozin P (1976) The selection of foods by rats, humans and other animals. *Advances in the Study of Behavior*, ed Rosenblatt JS (Elsevier, London), pp 21–76.
- Gripshover SJ, Markman EM (2013) Teaching young children a theory of nutrition: Conceptual change and the potential for increased vegetable consumption. *Psychol Sci* 24(8):1541–1553.
- Hill JO, Peters JC (1998) Environmental contributions to the obesity epidemic. *Science* 280(5368):1371–1374.
- Rozin P, Hammer L, Oster H, Horowitz T, Marmora V (1986) The child's conception of food: Differentiation of categories of rejected substances in the 16 months to 5 year age range. *Appetite* 7(2):141–151.
- Shutts K, Condry KF, Santos LR, Spelke ES (2009) Core knowledge and its limits: The domain of food. *Cognition* 112(1):120–140.
- Fischler C (1988) Food, self, and identity. *Soc Sci Info* 27(2):275–292.
- Fox R (1994) *The Challenges of Anthropology: Old Encounters and New Excursions* (Transaction, New Brunswick, NJ).
- Frazier BN, Gelman SA, Kaciroti N, Russell JW, Lumeng JC (2012) I'll have what she's having: The impact of model characteristics on children's food choices. *Dev Sci* 15(1): 87–98.
- Germov J, Williams L (2008) *A Sociology of Food and Nutrition: The Social Appetite* (Oxford Univ Press, Melbourne).

10. Kass LR (1994) *The Hungry Soul: Eating and Perfecting out Nature* (Simon and Schuster, New York).
11. Shutts K, Kinzler KD, DeJesus JM (2013) Understanding infants' and children's social learning about foods: Previous research and new prospects. *Dev Psychol* 49(3): 419–425.
12. Grunfeld I (1975) *Dietary Laws Regarding Plants and Vegetables, with Particular Reference to the Produce of the Holy Land* (Socinio Press, London).
13. Harris M (1966) The cultural ecology of India's sacred cattle. *Curr Anthro* 7(1):51–66.
14. Korsmeyer C (2005) *The Taste Culture Reader: Experiencing Food and Drink* (Oxford Univ Press, Oxford).
15. Lewin K (1943) Forces behind food habits and methods of change. *The Problem of Changing Food Habits 1941–1943. Bulletin No. 108* (National Research Council, National Academy of Sciences, Washington, DC).
16. Millstone E, Lang T (2002) *The Atlas of Food: Who Eats What, Where and Why* (Univ of California Press, Oakland, CA).
17. Nemeroff C, Rozin P (1989) You are what you eat: Applying the demand-free impressions technique to an unacknowledged belief. *Ethos* 17(1):50–69.
18. Rozin E, Rozin P (1981) Culinary themes and variations. *Nat Hist* 90(2):6–14.
19. Aldridge V, Dovey TM, Halford JCG (2009) The role of familiarity in dietary development. *Dev Rev* 29(1):32–44.
20. Birch LL (1999) Development of food preferences. *Annu Rev Nutr* 19:41–62.
21. Hausner H, Nicklaus S, Issanchou S, Molgaard C, Møller P (2010) Breastfeeding facilitates acceptance of a novel dietary flavour compound. *Clin Nutr* 29(1):141–148.
22. Lumeng JC, Patil N, Blass EM (2007) Social influences on formula intake via suckling in 7 to 14-week-old infants. *Dev Psychobiol* 49(4):351–361.
23. Mennella JA, Jagnow CP, Beauchamp GK (2001) Prenatal and postnatal flavor learning by human infants. *Pediatrics* 107(6):E88.
24. Cashdan E (1994) A sensitive period for learning about food. *Hum Nat* 5(3):279–291.
25. Fallon AE, Rozin P, Pliner P (1984) The child's conception of food: The development of food rejections with special reference to disgust and contamination sensitivity. *Child Dev* 55(2):566–575.
26. Rozin P, Fallon AE, Augustoni-Ziskind M (1985) The child's conception of food: The development of contamination sensitivity to disgusting substances. *Dev Psychol* 21(6): 1075–1079.
27. Graham SA, Kilbreath CS, Welder AN (2004) Thirteen-month-olds rely on shared labels and shape similarity for inductive inferences. *Child Dev* 75(2):409–427.
28. Welder AN, Graham SA (2001) The influence of shape similarity and shared labels on infants' inductive inferences about nonobvious object properties. *Child Dev* 72(6): 1653–1673.
29. Lavin TA, Hall DG (2002) Domain effects in lexical development: Learning words for foods and toys. *Cogn Dev* 16(4):929–950.
30. Macario JF (1991) Young children's use of color in classification: Foods and canonically colored objects. *Cogn Dev* 6(1):17–46.
31. Santos LR, Hauser MD, Spelke ES (2001) Recognition and categorization of biologically significant objects by rhesus monkeys (*Macaca mulatta*): The domain of food. *Cognition* 82(2):127–155.
32. Santos LR, Hauser MD, Spelke ES (2002) Domain-specific knowledge in human children and non-human primates: Artifact and food kinds. *The Cognitive Animal*, eds Bekoff M, Allen C, Burghardt G (MIT Press, Cambridge, MA), pp 205–215.
33. Santos LR, Miller CT, Hauser MD (2003) Representing tools: How two non-human primate species distinguish between the functionally relevant and irrelevant features of a tool. *Anim Cogn* 6(4):269–281.
34. Shutts K, Markson L, Spelke ES (2009) The developmental origins of animal and artifact concepts. *The Origins of Object Knowledge*, eds Hood B, Santos L (Oxford Univ Press, Oxford), pp 189–210.
35. Spelke ES, Breinlinger K, Jacobson K, Phillips A (1993) Gestalt relations and object perception: A developmental study. *Perception* 22(12):1483–1501.
36. Addessi E, Galloway AT, Visalberghi E, Birch LL (2005) Specific social influences on the acceptance of novel foods in 2-5-year-old children. *Appetite* 45(3):264–271.
37. Carruth BR, Ziegler PJ, Gordon A, Barr SI (2004) Prevalence of picking eating among infants and toddlers and their caregivers' decisions about offering a new food. *J Am Diet Assoc* 104(1 Suppl 1):s57–s64.
38. Wertz AE, Wynn K (2014) Selective social learning of plant edibility in 6- and 18-month-old infants. *Psychol Sci* 25(4):874–882.
39. Buttelmann D, Call J, Tomasello M (2008) Behavioral cues that great apes use to forage for hidden food. *Anim Cogn* 11(1):117–128.
40. Galef BG (1993) Functions of social learning about food: A casual analysis of effects of diet novelty on preference transmission. *Anim Behav* 46(2):257–265.
41. Galef BG, Jr, Whiskin EE (1995) Learning socially to eat more of one food than of another. *J Comp Psychol* 109(1):99–101.
42. Jaeggi AV, van Noordwijk MA, Burkhardt JM, van Schaik CP (2009) The evolution of voluntary food transfers among primates. *Folia Primatol (Basel)* 80(2):121–122.
43. Schiel N, Huber L (2006) Social influences on the development of foraging behavior in free-living common marmosets (*Callithrix jacchus*). *Am J Primatol* 68(12):1150–1160.
44. Ueno A, Matsuzawa T (2005) Response to novel food in infant chimpanzees. Do infants refer to mothers before ingesting food on their own? *Behav Processes* 68(1): 85–90.
45. Appadurai A (1981) *Gastropolitics in Hindu South Asia*. *Amer Ethno* 8(3):494–511.
46. Barker ME, Tandy M, Stookey JD (1999) How are consumers of low-fat and high-fat diets perceived by those with lower and higher fat intake? *Appetite* 33(3):309–317.
47. Cashdan E (1998) Adaptiveness of food learning and food aversions in children. *Soc Sci Info* 37(4):613–632.
48. Counihan CM (1992) Food rules in the United States: Individualism, control, and hierarchy. *Anthro Quar* 65(2):55–66.
49. Johnson KA, White AE, Boyd BM, Cohen AB (2011) Matzah, meat, milk, and mana: Psychological influences on religio-cultural food practices. *J Cross Cult Psychol* 42(8): 1421–1436.
50. Liberman Z, Kinzler KD, Woodward AL (2014) Friends or foes: Infants use shared evaluations to infer others' social relationships. *J Exp Psychol Gen* 143(3):966–971.
51. Miller L, Rozin P, Fiske AP (1998) Food sharing and feeding another person suggest intimacy; two studies of American college students. *Eur J Soc Psychol* 28(3):423–436.
52. Peryam DR (1963) The acceptance of novel foods. *Food Technol* 17:33–39.
53. Rozin P, Siegal M (2003) Vegemite as a marker of national identity. *Gastro* 3(4):63–67.
54. Vartanian LR, Herman CP, Polivy J (2007) Consumption stereotypes and impression management: How you are what you eat. *Appetite* 48(3):265–277.
55. Hamlin JK, Wynn K (2012) Who knows what's good to eat? Infants fail to match food preferences of antisocial others. *Cogn Dev* 27(3):227–239.
56. Shutts K, Kinzler KD, McKee CB, Spelke ES (2009) Social information guides infants' selection of foods. *J Cogn Dev* 10(1-2):1–17.
57. Fawcett CA, Markson L (2010) Similarity predicts liking in 3-year-old children. *J Exp Child Psychol* 105(4):345–358.
58. Kinzler KD, Dupoux E, Spelke ES (2007) The native language of social cognition. *Proc Natl Acad Sci USA* 104(30):12577–12580.
59. Mahajan N, Wynn K (2012) Origins of "us" versus "them": Prelinguistic infants prefer similar others. *Cognition* 124(2):227–233.
60. Sloane S, Baillargeon R, Premack D (2012) Do infants have a sense of fairness? *Psychol Sci* 23(2):196–204.
61. Buresh JS, Woodward AL (2007) Infants track action goals within and across agents. *Cognition* 104(2):287–314.
62. Henderson AM, Woodward AL (2012) Nine-month-old infants generalize object labels, but not object preferences across individuals. *Dev Sci* 15(5):641–652.
63. Novack MA, Henderson AM, Woodward AL (2014) Twelve-month-old infants generalize novel signed labels, but not preferences across individuals. *J Cogn Dev* 15(4): 539–550.
64. Birch LL (2002) Acquisition of food preferences and eating patterns in children. *Eating Disorders and Obesity: A Comprehensive Handbook*, eds Fairburn CG, Brownell KD (The Guildford Press, New York, NY), pp 75–79.
65. Harper LV, Sanders KM (1975) The effect of adults' eating on young children's acceptance of unfamiliar foods. *J Exp Child Psychol* 20(2):206–214.
66. Kuhlmeier V, Wynn K, Bloom P (2003) Attribution of dispositional states by 12-month-olds. *Psychol Sci* 14(5):402–408.
67. Cohen E (2012) The evolution of tag-based cooperations in humans: The case for accent. *Curr Anthropol* 53(5):588–616.
68. Labov W (2006) *The Social Stratification of English in New York City* (Cambridge Univ Press, New York), 2nd Ed.
69. Liberman Z, Woodward AL, Kinzler KD (2016) Preverbal infants infer third-party social relationships based on language. *Cogn Sci*, 10.1111/cogs.12403.
70. Hamlin JK, Wynn K, Bloom P (2010) Three-month-olds show a negativity bias in their social evaluations. *Dev Sci* 13(6):923–929.
71. Vaish A, Grossmann T, Woodward A (2015) Person-centred positive emotions, object-centred negative emotions: 2-year-olds generalize negative but not positive emotions across individuals. *Br J Dev Psychol* 33(3):391–397.
72. Baillargeon R, Setoh P, Sloane S, Jin K, Bian L (2014) Infant social cognition: Psychological and sociomoral reasoning. *The Cognitive Neurosciences*, eds Gazzainiga MS, Mangun GR (MIT Press, Cambridge, MA), 5th Ed, pp 7–14.
73. Johnson SC, Dweck CS, Chen FS (2007) Evidence for infants' internal working models of attachment. *Psychol Sci* 18(6):501–502.
74. Powell LJ, Spelke ES (2013) Preverbal infants expect members of social groups to act alike. *Proc Natl Acad Sci USA* 110(41):E3965–E3972.
75. Howard LH, Carrazza C, Woodward AL (2014) Neighborhood linguistic diversity predicts infants' social learning. *Cognition* 133(2):474–479.
76. Legare CH, Nielsen M (2015) Imitation and innovation: The dual engines of cultural learning. *Trends Cogn Sci* 19(11):688–699.
77. Mascaro O, Csibra G (2012) Representation of stable social dominance relations by human infants. *Proc Natl Acad Sci USA* 109(18):6862–6867.
78. Medin D, Ortony A (1989) Psychological essentialism. *Similarity and Analogical Reasoning*, eds Vosniadou S, Ortony A (Cambridge Univ Press, Cambridge, UK), pp 179–195.
79. Thomsen L, Frankenhuis WE, Ingold-Smith M, Carey S (2011) Big and mighty: Preverbal infants mentally represent social dominance. *Science* 331(6016):477–480.
80. Christakis NA, Fowler JH (2007) The spread of obesity in a large social network over 32 years. *N Engl J Med* 357(4):370–379.
81. Greenhalgh J, et al. (2009) Positive- and negative peer modelling effects on young children's consumption of novel blue foods. *Appetite* 52(3):646–653.
82. Hendy HM, Raudenbush B (2000) Effectiveness of teacher modeling to encourage food acceptance in preschool children. *Appetite* 34(1):61–76.
83. Blom-Hoffman J, Kelleher C, Power TJ, Leff SS (2004) Promoting healthy food consumption among young children: Evaluation of a multi-component nutrition education program. *J Sch Psychol* 41(1):45–60.
84. Murphy AS, Youatt JP, Hoerr SL, Sawyer CA, Andrews SL (1995) Kindergarten students' food preferences are not consistent with their knowledge of the Dietary Guidelines. *J Am Diet Assoc* 95(2):219–223.
85. Wardle J, Huon G (2000) An experimental investigation of the influence of health information on children's taste preferences. *Health Educ Res* 15(1):39–44.