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Social identity and contamination: Young children are more willing to eat native contaminated foods

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ABSTRACT

Ingesting dangerous substances can lead to illness, or even death, meaning that it is critical for humans to learn how to avoid potentially dangerous foods. However, young children are notoriously bad at choosing foods; they are willing to put nonfoods and disgust elicitors into their mouths. Because food choice is inherently social, we hypothesized that social learning and contamination might separately influence children's decisions about whether to eat or avoid a food. Here, we asked how children reason about foods that are contaminated by someone from within versus outside their culture. We presented 3- to 11-year-olds ($N = 534$) with videos of native and foreign speakers eating snacks. In Studies 1a and 1b, one speaker contaminated her food and the other did not, and we asked children (a) which food they would prefer to eat, (b) how germey each food was, and (c) which food would make them sick. Although children rated the contaminated food as germier regardless of whether it was contaminated by a foreign speaker (Study 1a) or by a native speaker (Study 1b), children were more likely to report that they would avoid eating foreign contaminated food compared with native contaminated food. In Study 2, we used a non-forced-choice method and found converging evidence that children attend to both culture and contamination when making food choices but that with age they place more weight on contamination status.

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Introduction

It is essential for humans to make appropriate food choices; people must eat foods that provide energy and avoid foods that threaten health such as poisonous or rotten foods. Failing to choose the right foods has clear consequences. Ingesting poisonous or toxic substances can lead to anything from minor symptoms (e.g., headache, nausea) to more serious problems, including death (Centers for Disease Control and Prevention [CDC], 2019a, 2019b). Despite these adverse consequences, prior research suggests that people, and in particular young children, have a hard time avoiding contaminated foods or toxic items. Children under 5 years of age have the highest incidence rates of some foodborne infections (e.g., *Escherichia coli* [*E. coli*], *Salmonella*; CDC, 2019), and children under 2 years are the most likely age group to accidentally poison themselves (Cashdan, 1994). One possible contributor to this problem is that children at this age (16–29 months) will put substances into their mouths that adults would not consider to be food (95% are willing to mouth Play-Doh) and that adults find disgusting (55% are willing to mouth imitation feces; Rozin, Hammer, Oster, Horowitz, & Marmora, 1986). Even slightly older children are not good at avoiding contaminated foods, with 3- and 4-year-olds being willing to eat a food that was previously sneezed in (DeJesus, Shutts, & Kinzler, 2015) and 4- to 7-year-olds indicating that they would drink a previously contaminated version of their favorite beverage as long as the contaminant (e.g., flies, a used comb) has been physically removed (Fallon, Rozin, & Pliner, 1984; Rozin, Fallon, & Augustoni-Ziskind, 1985). Although children show improvement in their understanding of contamination at around 6 years of age, they are worse than adolescents and adults at differentiating between “contaminants” that would likely cause harm (e.g., a cough) and those that would not (e.g., a leaf) (Apicella, Rozin, Busch, Watson-Jones, & Legare, 2018). Thus, it is not until fairly late in development that children have a mature taxonomy of what counts as “safe” food and are able to accurately avoid ingesting harmful substances.

One paradox of children’s food choice is that even though children have a hard time avoiding contaminants, it is not the case that they are willing to eat any food presented to them. They are also notoriously picky eaters and avoid eating many foods that would be healthy for them to eat (e.g., vegetables). It is possible that young children’s food avoidance is based on perceptual properties and neophobia; children might not want to eat foods that are novel in terms of color, texture, smell, or taste (e.g., Cardona Cano et al., 2015; Cooke & Wardle, 2005; van der Horst, 2012). That is, avoidance decisions for picky eaters may be due to preferences for particular sensory properties (e.g., textures, smells) and preferences for familiarity. Indeed, neophobia tends to be strongest early in development (Cardona Cano et al., 2015) when children might not have the competence to understand the danger posed by contaminants (see Brown & Harris, 2012). That is, young children may lack cognitive prerequisites to fully reason about contamination. According to Rozin and Fallon (1987), these skills include the ability to consider that appearances differ from reality (i.e., someone can appear to be healthy but actually be a disease vector), knowledge that small invisible particles exist (i.e., germs that are not visible to the naked eye), and an understanding of opaque causal structures (i.e., some people can be infected with a germ but not get sick, or people may vary in how sick they become following disease exposure). These cognitive skills unfold during early childhood (Au, Siddle, & Rollins, 1993; Zhu, Liu, & Tardif, 2009) and could be required for children to appropriately avoid contaminated foods.

On the other hand, a few studies suggest that even young children have a developing understanding of germs and illness and that they may be able to use this knowledge of germs to guide their behavior. For example, preschoolers demonstrate evidence of naïve biological theories that highlight differences between living and nonliving things (Hatano & Inagaki, 2013) and have some understanding that illness is a biological process that is related the presence of germs (Kalish, 1996; Solomon & Cassimatis, 1999) and unfolds over time (Raman & Gelman, 2007). Children use cues of illness when making social decisions; by 5 years of age, children report social preferences for people who are physically clean rather than dirty (Rottman et al., 2020) and avoid playing with a person who appears to be sick (Blacker & LoBue, 2016). Indeed, children’s understanding of germs predicts their ability to avoid someone who might be sick (Blacker & LoBue, 2016), suggesting that children who demonstrate knowledge about contamination may have more effective behavioral avoidance.

However, children may be able to avoid some contaminated foods even without advanced cognitive skills (e.g., of understanding germs). In particular, they may leverage their *cultural knowledge* about foods when deciding what to eat or avoid. In this case, children may avoid contaminated foods in appropriate cultural contexts. Indeed, different cultures possess social customs and rituals when it comes to how foods are prepared, which foods are sacred, and how meals are shared (e.g., Anderson, 2005; Fischler, 1988; Grunfeld, 1975; Korsmeyer, 2005; Millstone & Lang, 2002; Rozin & Rozin, 1981). By 5 years of age, children develop knowledge that culture is tied to food choice; they expect Americans (cultural ingroup members) to be more likely to eat familiar conventional foods (DeJesus, Gerdin, Sullivan, & Kinzler, 2019). One of the earliest developing and most robust indicators of culture is language (e.g., Cohen, 2012; Kinzler, Shutts, & Correll, 2010). When presented with two foods, one associated with a native speaker and one associated with a foreign speaker, even infants are more likely to eat the food liked by a native speaker (Shutts, Kinzler, McKee, & Spelke, 2009), indicating an early preference for culturally relevant foods. Indeed, this study is part of a growing body of literature highlighting an early-developing preference for native speakers; infants and young children prefer to interact with native speakers (Kinzler, Dupoux, & Spelke, 2007) and to imitate native speakers (e.g., Buttelmann, Zmyj, Daum, & Carpenter, 2013; de Klerk, Bulgarelli, Hamilton, & Southgate, 2019; Howard, Carrazza, & Woodward, 2014). These preferences may be due to an expectation that native speakers are most likely to provide relevant information (Begus, Gliga, & Southgate, 2016), including information about what foods to eat. In addition to liking native foods and native speakers, infants use culture to form inferences about what people will eat; for instance, 11-month-olds expect same-language speakers to eat and like the same foods (Lieberman, Woodward, Sullivan, & Kinzler, 2016). Thus, humans see food as cultural from early in ontogeny. Perhaps children's initial decisions about whether to eat a food are driven more by *who* the food is associated with than by whether the food is safe versus contaminated.

If children are attending highly to the social and cultural contexts of food, then presenting children with foods in richer contexts may increase their ability to make appropriate food choices. In fact, most past studies on food contamination indicating that young children lack the ability to make sophisticated food choices present single contaminated foods with little to no context (Kalish, 1996; Rozin et al., 1986; Springer & Belk, 1994). But contextualizing food contamination within a social interaction may lead children to appear somewhat more sophisticated in their ability to avoid contaminated foods. For instance, although a surprisingly large group of 4- and 5-year-olds were willing to mouth nonfoods when the foods were presented without any social context (e.g., 61% put paper in their mouths; Rozin et al. 1986), most 5-year-olds were able to avoid a food that was contaminated in a social context (e.g., when a person sneezed into the food; DeJesus et al., 2015). Adding cultural context may further increase children's understanding of contamination. Although no research to date has tested this particular question, a past study found that children as young as 4 years use social identity to reason about germs; children predicted that characters were more likely to get sick when a stranger sneezed on them than when a friend or family member committed the same action (Raman & Gelman, 2008). Therefore, children's understanding of germs may also vary based on cultural identity of the contaminator. If so, children's developing understanding of germs may emerge earlier when reasoning about foreign germs compared with native germs. In addition, an earlier understanding that foreign contamination leads to germs coupled with a preference for foods associated with the cultural ingroup may lead children to avoid contaminated foods that are associated with a foreign speaker earlier in development than those that are associated with a native speaker.

In the current studies, we showed events similar to those in DeJesus et al. (2015) in which actors contaminated their food by sneezing into it or did not. We manipulated the cultural group membership (native vs. foreign) of the actors. Before sampling (and liking) a food, each actor spoke either English (participants' native language) or Russian (a foreign language). In Studies 1a and 1b, children made a forced-choice decision about whether they would prefer to eat a contaminated food or a clean food. We varied whether the contaminated food was associated with the foreign speaker (Study 1a) or native speaker (Study 1b). In Study 2, children were presented with only one food (either clean or contaminated, eaten by either a native or foreign speaker) and were asked how much they wanted to eat it. If children use cultural preferences when making decisions about contaminated foods, they may be better able to avoid foreign contamination than native contamination. Given previous research, we

hypothesized that children would attend to both the cultural background of the model eating the food and the contamination status of food when making a decision about whether they wanted to eat the food. However, we predicted that children may weigh the two factors differently across development. In particular, children become better with age at avoiding nonfoods and contaminated foods, so we predicted that older children would be more likely than younger children to rely on contamination status. On the other hand, even infants use cultural group (marked by language) to make food choices (Shutts et al., 2009), so we predicted that younger children might be highly attentive to the model's cultural identity.

We also included questions in which we asked children to rate each food's "germiness." These questions allowed us to ask whether children's eating decisions were primarily driven by knowledge that contamination increases germs (a competence account) or were instead based mostly on preferences (e.g., children may prefer native foods if they expect them to be more familiar) (see DeJesus et al., 2019). Specifically, if children's ability to avoid contaminated foods is primarily driven by a growing understanding that children should avoid germs, germiness ratings should align with willingness to try the foods. Indeed, children's understanding of the causes of illness is the best predictor of whether they avoid playing with a sick person (Blackler & LoBue, 2016), and even young children understand that germs cause illness (Kalish, 1996) and that contact with contagions (e.g., germs) increases the likelihood of transmitting a contagious illness (rather than a genetic one) (Raman & Gelman, 2005). But previous research has not asked about children's understanding of whether contaminated foods have germs, whether the expected germiness of a food changes children's willingness to eat it, or whether cultural identity (native vs. foreign) affects children's expectations about germs. These are important questions to consider when evaluating the difficulty of promoting behavioral change; if children are willing to eat a food even when they acknowledge its germiness, additional tools may be necessary to recruit to support early disease avoidance.

General procedure

All these studies were conducted at MOXI, the Wolf Museum of Exploration + Innovation, between January 2018 and March 2019. In accordance with procedures approved by the University of California Santa Barbara, institutional review board, we obtained verbal assent from each child. Participants sat at a table and watched videos played on a 13-inch Lenovo Ideapad 710S laptop while wearing over-ear headphones. Videos featured actors speaking in English or Russian and trying snacks (see each study for detailed methods). Children were asked whether they wanted to try the snack(s) depicted in the videos. Because these data were collected in a museum, we were not permitted to bring in any real foods. All eating decisions were hypothetical; children were not given any food to eat during the study and never explicitly knew what the food was when answering the test questions.

Study 1: Choosing clean or contaminated foods

Method

Participants

Participants were 190 3- to 11-year-old monolingual English-speaking children (Study 1a: $N = 88$; Study 1b: $N = 102$; $M_{\text{age}} = 7.20$ years, range = 3.04–11.99). An additional 14 children (Study 1a: $n = 8$; Study 1b: $n = 6$) were tested but excluded from analysis due to experimental error ($n = 4$) or not completing the study ($n = 10$). Although we did not conduct a power analysis prior to Study 1, a post hoc power analysis for a regression with three predictors indicated that a sample of 77 participants (for Studies 1a and 1b separately) would give 80% power to detect a medium effect ($f = .15$).

Procedure

Studies 1a and 1b were identical except with respect to whether a food was contaminated by a foreign speaker (Study 1a) or by a native speaker (Study 1b). In both studies, children first saw introductory videos in which each actor said a short vignette. One actor spoke English (native), and the other

actor spoke Russian (foreign). Both actors were native bilinguals, allowing us to counterbalance the identity of the foreign speaker across participants. The actors' statements did not provide any information about their preferences or about the foods that they would eat. For example, one actor said, "When it rains, I use my umbrella. I love jumping in puddles of water. After, when the sun comes out, I like to see the rainbow. The rainbow has six colors: red, orange, yellow, green, blue, and purple," or the equivalent sentences in Russian.

Then, each actor ate Cheerios from a different bowl. Children were unaware of what food was in the bowls; the bowls were opaque and the actors' hands covered their bites. Therefore, children's liking or disliking of Cheerios could not affect the results. One speaker contaminated her food; she ate one Cheerio and expressed positivity (by saying "Oh! Mmh!"), but then she sneezed into the bowl, wiped her nose with her hand and arm, and licked her fingers before eating a second bite with the same hand that she had used to wipe her sneeze and had licked. The food of the other speaker was clean; she ate one Cheerio and expressed positivity (by saying "Oh! Mmh!"), and then she picked up and ate a second Cheerio. Study 1a depicted foreign contamination; the English speaker was paired with the clean food action, and the Russian speaker was paired with the contamination action. Study 1b depicted native contamination; the Russian speaker was paired with the clean food action, and the English speaker was paired with the contamination action. The order of eating events (clean first vs. contaminated first) was counterbalanced across participants in each study.

After both eating videos, a still image of the two actors with their bowls remained on the screen as a reference point for the subsequent questions (see Fig. 1). We first asked participants which of the two foods they would prefer to eat (forced choice). Next, we asked participants whether they knew what germs were. If they said that they did, we asked them to provide a brief explanation. If their description was similar enough to our predetermined explanation (e.g., you cannot see germs, but they can make you sick), we moved on to the next question. If children reported that they did not know what germs were, or if their explanation left out a key component of what germs are, we provided a brief explanation (see Appendix for script). Afterward, children were shown a 4-point germ scale (0 = *not germy*, 1 = *a little germy*, 2 = *germy*, 3 = *really germy*) (see Fig. 2) and were asked to rate the "germiness" of each food. Then, we asked children which of the two foods could make them sick (forced choice). Finally, as a comprehension check, we asked participants to identify which actor sneezed into her food. Participants were thanked and given a sticker for their participation.

Results

Comprehension check

Across studies, the vast majority of children passed our comprehension check and were able to recall which actor sneezed into her bowl (Study 1a: $n = 85$ of 88 children passed; Study 1b: $n = 98$



Fig. 1. Stimuli shown during forced-choice questions in Studies 1a and 1b. Children were asked to point to which food they wanted to try and which food would make them sick.

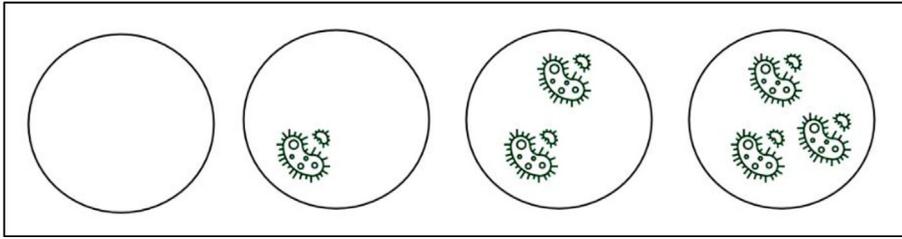


Fig. 2. Germiness scale. This scale was used in all these studies. Children were asked how germy each food was from *not germy* (far left = 0) to *very germy* (far right = 3).

of 102 children passed). Results for all other analyses (e.g., food choice, germ ratings, illness predictions) were the same regardless of whether we included children who failed the comprehension check or not, so our analyses include their data. In addition, we did not have any predictions about the effect of gender, and preliminary analyses did not reveal any significant effects of gender, so we collapse across gender in the reported models. In all analyses, age is treated as a continuous variable (in years), and we center the variable based on the mean age (but depict actual ages in graphs for transparency).

Food choice

We first investigated which foods children reported preferring to try. Children were significantly above chance at choosing the clean food over the contaminated food, both when the clean food was eaten by a native speaker (Study 1a: $n = 69$ of 88 children, binomial $p < .001$) and when the clean food was eaten by a foreign speaker (Study 1b: $n = 62$ of 102, binomial $p = .037$, two-tailed). Nonetheless, children were more likely to choose the clean food when it was paired with a native speaker (Study 1a) than when it was paired with a foreign speaker (Study 1b), $\chi^2(1, N = 190) = 6.85, p = .009$ (Fig. 3).

Next, we ran logistic regression models to examine the effects of age and children's germ ratings on their food choices. The models initially included children's choice of clean food as the outcome variable with age (continuous in years, centered), germiness of the clean food, germiness of the contaminated food, and their interactions as predictors. Then, models were reduced by removing any nonsignificant higher-order interactions.

When the clean food was eaten by the native speaker (Study 1a), the final model included all main effects as well as interactions between age and germ ratings. Specifically, the reduced model revealed significant main effects of germiness ratings of both the native clean food ($b = -1.88, p = .002$) and

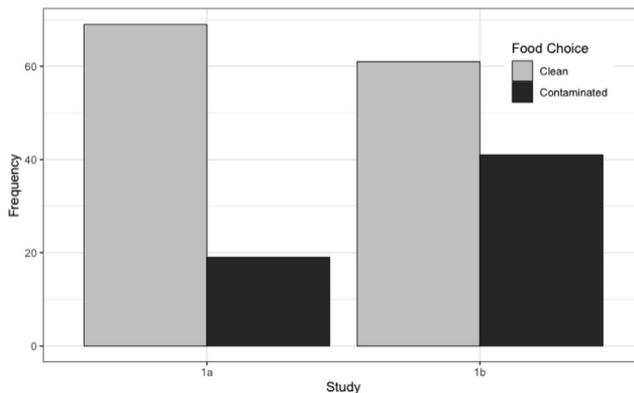


Fig. 3. Food choices in Study 1. Children were given a forced choice between two foods. Children chose the clean food above chance rates in both samples but were significantly more likely to choose the clean food when it was associated with a native speaker (Study 1a) than when it was associated with a foreign speaker (Study 1b).

foreign contaminated food ($b = 0.90, p = .022$), suggesting that children who gave the native clean food lower germ ratings, and who gave the foreign contaminated food higher germ ratings, were more likely to pick the native clean food. Although there was no significant main effect of age ($b = 0.08, p = .835$) in the model, there were significant interactions between age and germiness rating of both the native clean food ($b = -1.08, p = .001$) and the foreign contaminated food ($b = 0.43, p = .013$) (see Fig. 4). Thus, with age children's germiness ratings became more predictive of their food choice.

When the clean food was eaten by the foreign speaker (Study 1b), the final model included all main effects, and interactions between age and the germiness rating of the native contaminated food. In this model, there was no significant main effect of germiness rating of the foreign clean food ($b = -0.20, p = .40$), but there were significant main effects of age ($b = -0.55, p = .033$) and germiness rating of the native contaminated food ($b = 1.00, p < .001$), suggesting that children who rated the contaminated food as more germier were less willing to eat it. These main effects were qualified by a significant interaction between age and germiness rating of the native contaminated food ($b = 0.28, p = .029$) (see Fig. 4). As in Study 1a, children's germiness ratings of the contaminated food became more predictive of their food choices with age.

Germ ratings

To ask whether participants rated the contaminated food as germier, we ran multiple linear regression models on germ ratings (from 0 = *not germier* to 3 = *really germier*) with age (continuous in years) and food type (clean vs. contaminated) as predictors.

In Study 1a, when the contaminated food was associated with a foreign speaker, results revealed a significant effect of food type ($b = 1.34, p < .001$), such that foreign contaminated foods were rated as germier than native clean foods. There was no significant effect of age ($b = -0.04, p = .362$) or interaction between food type and age ($b = 0.04, p = .590$) (Fig. 5). Therefore, across the entire age range tested, children were equally likely to understand that foreign contaminated foods are germier than native clean foods.

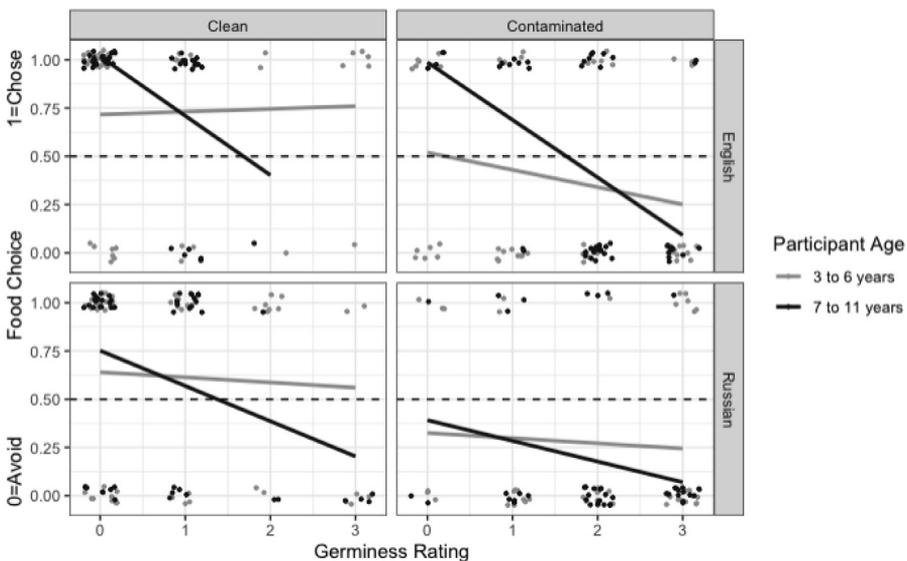


Fig. 4. The effect of age and germ rating on children's food choices in Studies 1a and 1b. Children's food choice (y axis: 0 = avoided, 1 = chose) varied based on their germiness rating (x axis) as well as their age (light or dark lines). As can be seen with the negatively sloped lines, as children's germiness ratings of a food increased, their likelihood of choosing that food decreased. The association between germiness ratings and food choice was stronger for older children (dark lines) compared with younger children (light lines). This pattern was seen less for native clean foods; the majority of children of all ages were willing to eat clean English foods (top left).

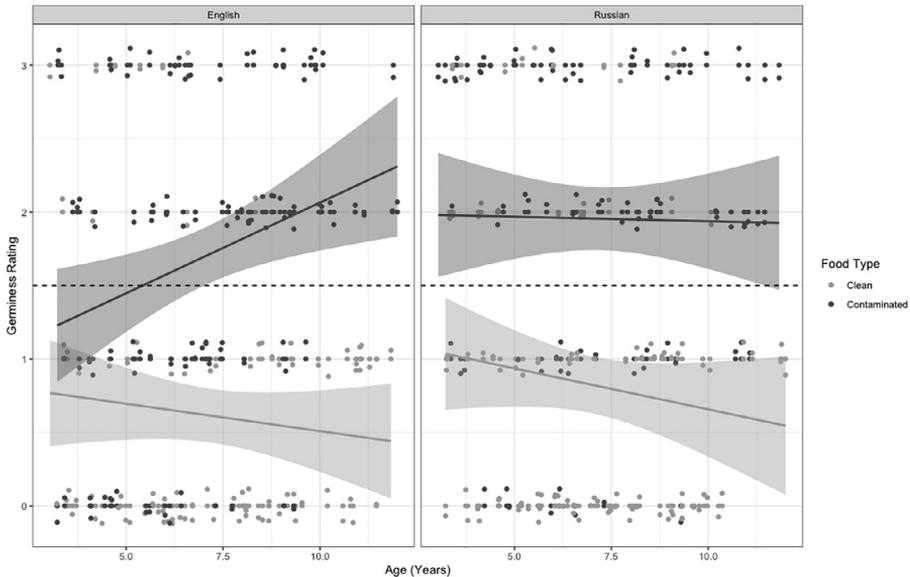


Fig. 5. Germiness ratings for Studies 1a and 1b. Children generally rated clean foods (light lines) as less germier than contaminated foods (dark lines). Although children's germiness ratings for foreign contaminated foods were stable across age, with age children became more likely to rate native contaminated foods as germier. Shaded areas around lines indicate 95% confidence intervals according to the linear model.

On the other hand, in Study 1b, when the contaminated food was associated with a native speaker, in addition to a significant effect of food type ($b = 0.87, p < .001$), the model revealed a significant interaction between age and food type ($b = -0.18, p = .004$) but no significant main effect of age ($b = -0.06, p = .20$). Therefore, although children rated the native contaminated food as germier than the foreign clean food, the difference in germiness ratings between the clean and contaminated foods became more pronounced with age, mostly due to children becoming more likely to rate the native contaminated food as germier (see Fig. 5).

Consequences of contamination

Finally, we asked participants to report which food would be more likely to make them sick. Children expected the contaminated food to be more likely to make them sick regardless of whether it was contaminated by a foreign speaker (Study 1a: $n = 70$ of 88 children, binomial $p < .001$) or by a native speaker (Study 1b: $n = 79$ of 102 children, binomial $p < .001$). Indeed, children's rates of choosing the contaminated food as more likely to make them sick were not significantly different across studies, $\chi^2(1, N = 190) = 0.12, p = .73$.

To examine predictors of children's judgments about the consequences of contamination, we ran multiple logistic regressions on children's expectations of which food would make them sick with age (continuous in years), germiness ratings, and their interactions as predictors. We reduced the full models by removing nonsignificant higher-order interactions.

When the contaminated food was eaten by the foreign speaker (Study 1a), the reduced model included all main effects as well as interactions between the two germiness ratings and between age and the germiness rating of the foreign contaminated foods. In particular, although there was no significant main effect of age ($b = -0.18, p = .573$) or germiness rating of the native clean food ($b = 0.34, p = .527$), there was a significant main effect of germiness rating of the foreign contaminated food ($b = 2.46, p = .002$), suggesting that the germier children rated the foreign contaminated food, the more likely they were to expect that food to make them sick. This main effect was qualified by significant interactions between germiness ratings of the native clean and foreign contaminated foods

($b = -0.79, p = .026$) and between age and germiness rating of the foreign contaminated food ($b = 0.52, p = .026$). Thus, with age children's germiness ratings of the foreign contaminated food became more related to their expectations that eating that food could lead to illness.

When the contaminated food was eaten by the native speaker (Study 1b), the reduced model included all main effects as well as interactions between age and each of the germiness ratings. Although there was no significant main effect of age ($b = -0.39, p = .266$), there were significant main effects of germiness rating of the native contaminated food ($b = 1.42, p = .003$) and foreign clean food ($b = -1.38, p = .006$). Thus, children who rated the native contaminated food as more germy and who rated the foreign clean food as less germy were more likely to expect the contaminated food to make them sick. These effects were qualified by significant interactions between age and germiness rating of the native contaminated food ($b = 0.67, p = .001$) and between age and germiness rating of the foreign clean food ($b = -0.46, p = .044$), suggesting that children's ratings of germiness of both foods became more predictive of their expectations about illness with age.

Discussion

In Studies 1a and 1b, children were presented with two foods: one clean and one contaminated. The difference was whether the contaminated food was associated with the foreign speaker (Study 1a) or with the native speaker (Study 1b). In both studies, children were above chance at saying that they would prefer to eat the clean food, rated the contaminated food as germier than the clean food, and knew that eating the contaminated food would be more likely to make them sick. Thus, children understood that they should avoid contaminated foods. In addition, the impact that children's germiness ratings had on their food choices and their expectations about illness became stronger with age, suggesting that children's knowledge of germs (competence) becomes a larger driver of their contamination avoidance behaviors across development.

However, there were a few interesting key differences between Study 1a and Study 1b. First, children were less likely to avoid the contaminated food when it was associated with a native speaker (Study 1b) than when it was associated with a foreign speaker (Study 1a), suggesting that in addition to attending to the contamination status of the foods, children cared about *who* was eating the food. In addition, whereas children's germiness ratings of the contaminated food did not vary significantly by age in Study 1a, there were significant age effects in Study 1b. In particular, children were equally likely to rate a foreign contaminated food as germier than a native clean food across all age ranges tested (Study 1a), but they became more likely with age to rate a native contaminated food as germier than a foreign clean food (Study 1b). This suggests that it may be easier for young children to understand that a contaminated food is germy when that food is associated with a foreigner. Interestingly, whereas in Study 1a germ ratings of both the native clean food and foreign contaminated food influenced children's preferred food choice, in Study 1b only germ ratings of the native contaminated food had an impact. Thus, children appeared to attend more to the native food, and not the foreign food, when making their choice; only children who understood that the native contaminated food was germy were able to avoid it. Taking these similarities and differences together, results suggest that children's food choices are driven by both social group and contamination.

Because this set of studies used forced-choice methods (where children chose between a clean food and a contaminated food), it is not clear whether differences between the studies are due to (a) a desire to *approach* foods associated with native speakers (even when those foods are contaminated) or to (b) an early-emerging ability to *avoid* foreign contaminated foods or whether (c) children have both of these motivations. To test this question, in Study 2 we randomly assigned participants to see one actor (presented as either a native or foreign speaker) eat one food (either clean or contaminated) and asked how much children desired to eat that food and how germy they thought the food would be. If children approach foods liked by native speakers, they should want to try the foods when they are presented by a native speaker. Or, if children are particularly vigilant toward foreign contamination, they may have the lowest desire to try the food when it is contaminated *and* presented by a foreign speaker.

Study 2: Single food

Method

Participants

Participants were 344 3- to 11-year-old monolingual, English-speaking children ($M_{\text{age}} = 7.08$ years, range = 3.01–11.93). An additional 28 children were tested but excluded from analyses due to experimental error ($n = 4$), not completing the study ($n = 11$), or parental interference ($n = 12$) or for having participated in the previous study ($n = 1$).

Procedure

To examine how children reason about each combination of language and contamination status more specifically, we presented children with only one actor eating one food. Therefore, unlike in Studies 1a and 1b, children did not make forced-choice judgments about which of the actors' food they preferred but instead made judgments about a single food.

Children were randomly assigned to one of four conditions: Native–Clean, Native–Contaminated, Foreign–Clean, or Foreign–Contaminated. All children first saw a picture of a person with an opaque bowl of food and were asked to rate how much they wanted to try the food on a 5-point scale (0 = *really don't want to eat it*, 1 = *don't want to eat it*, 2 = *maybe want to eat it*, 3 = *want to eat it*, 4 = *really want to eat it*) (Fig. 6). Then, we presented an introductory video in which the actor spoke English (Native conditions) or Russian (Foreign conditions) and an eating video in which the actor ate a food and either contaminated it (Contaminated conditions) or did not (Clean conditions). These videos were identical to those in Studies 1a and 1b. Afterward, children used the same 5-point scale (Fig. 6) to indicate how much they wanted to try the food. Then, children rated how germey the food was and reported whether or not they expected that eating the food would make them sick (answered as “yes” or “no”).

Results

Willingness to try food

We first investigated how interested children were in trying the presented food. To do so, we ran a multiple linear regression examining children's final responses on their desire to eat the food with age (continuous in years, centered), food type (clean vs. contaminated), language (native vs. foreign), germ rating, and initial response on their desire to eat as predictors. We also included children's initial desire to eat score in the model as a baseline to control for individual differences in children's willingness to try foods in general (because this score was measured before participants knew the cultural background of the model or whether the food was clean or contaminated). As in Study 1, we reduced the model by removing nonsignificant higher-order interactions (while retaining nonsignificant interactions that were subsumed by significant higher-order interactions).

The final model included all main effects as well as interactions between age and food type, between age and language, between age and germ rating, and among age, food type, and germ rating. The model revealed significant main effects of initial desire to eat score ($b = 0.54$, $p < .001$), suggesting that children who were initially more willing to try the foods remained more willing, of food type

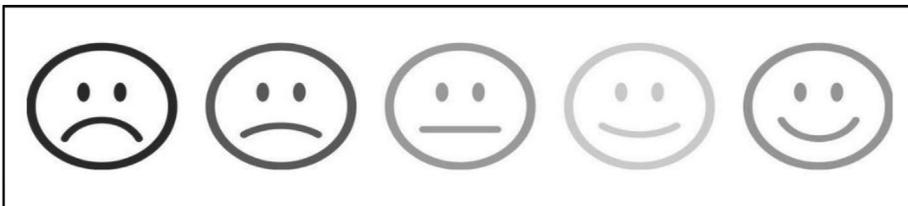


Fig. 6. Willingness to eat food scale (from left to right: 1 = *really don't want to eat it*, 2 = *don't want to eat it*, 3 = *maybe want to eat it*, 4 = *want to eat it*, 5 = *really want to eat it*).

($b = -0.57, p = .032$), suggesting that children were more willing to eat clean foods than contaminated foods, and of germ rating ($b = -0.21, p = .018$), suggesting that children were less willing to eat foods they rated as germier. There were also significant two-way interactions between age and food type ($b = -0.34, p = .008$), between age and language ($b = 0.12, p = .016$), and between age and germ rating ($b = -0.11, p = .002$), and there was a significant three-way interaction among age, food type, and germ rating ($b = 0.12, p = .036$). These interactions indicate that with age children attended less to the cultural identity of the actor providing the food (interaction between age and language) and more to the contamination status of the food (interactions between age and food type and between age and germ rating). As in Study 1, children's germiness ratings became more predictive of their willingness to try the food across development (see Figs. 7 and 8). The main effects of age ($b = 0.08, p = .29$) and language ($b = -0.16, p = .19$) and the interaction between food type and germ rating ($b = -0.10, p = .42$) were not significant.

Germ ratings

Next, we ran a multiple linear regression on children's germiness ratings with age (continuous in years), the language spoken by the actor (native vs. foreign), and type of food (clean vs. contaminated) and their interactions as predictors. The three-way interaction among age, food type, and language was significant, so all effects were retained in the model. Although there were no significant main effects of age ($b = -0.04, p = .35$) or language ($b = 0.02, p = .89$), there was a significant main effect of food type ($b = 0.56, p < .001$), such that children rated contaminated foods as significantly germier ($M = 2.03, SD = 0.99$) than clean foods ($M = 1.46, SD = 1.06$), $t(342) = 5.18, p < .001$. However, this was qualified by a significant two-way interaction between age and food type ($b = 0.20, p = .002$) and a significant three-way interaction among age, language, and food type ($b = -0.24, p = .009$). These interactions reveal that the effect of age on germiness ratings varied based on whether the food was native or foreign, as well as whether the food was clean or contaminated. Follow-up analyses on the effect of age on germ ratings in each condition revealed no significant age effects for germ ratings of native clean foods or foreign clean foods ($ps > .15$) and no significant age effect for germ ratings of foreign

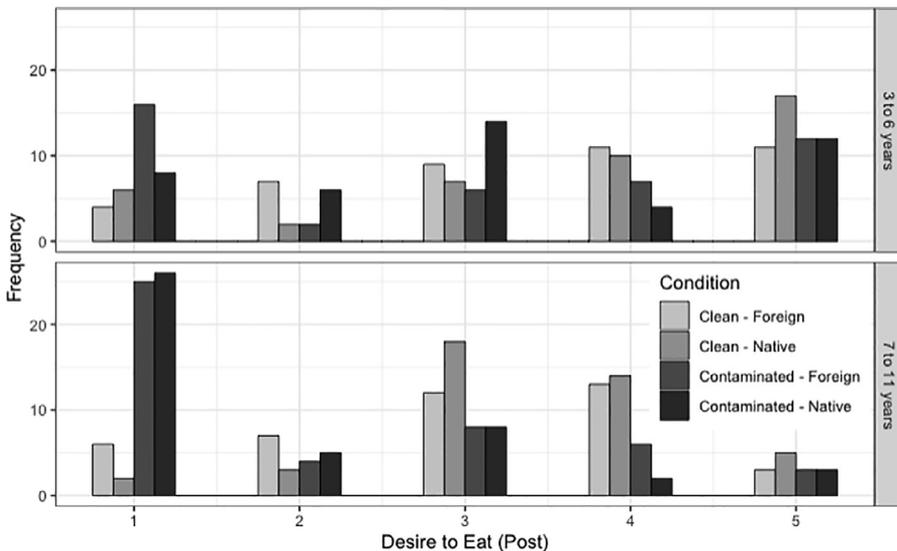


Fig. 7. Children's desire to eat. Younger children (top panel) differentiated between native and foreign speakers; they were more likely to provide the highest rating (5) for clean native foods than for clean foreign foods, and they were more likely to provide the lowest rating (1) for contaminated foreign foods than for contaminated native foods. Older children (bottom panel) attended mostly to contamination; they provided low ratings to contaminated foods and higher ratings to clean foods regardless of whether the foods were associated with native or foreign speakers.

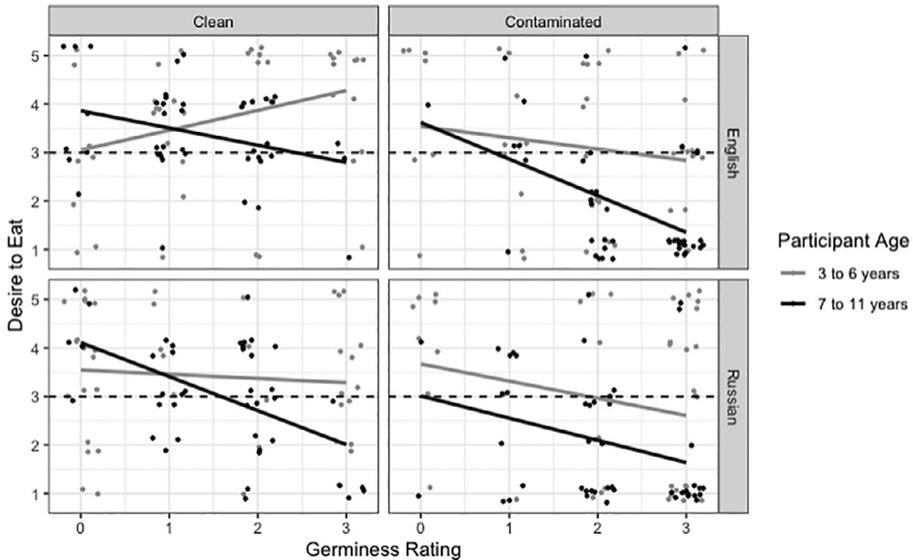


Fig. 8. The effect of age and germ rating on children's desire to eat. Children's desire to try the food (y axis) varied based on their germiness rating (x axis) as well as their age (light or dark lines). As can be seen by the negatively sloped lines, as children's germiness ratings of a food increased, their desire to eat that food decreased. The association between germiness ratings and food choice was stronger for older children (dark lines) compared with younger children (light lines).

contaminated foods ($p = .80$). However, there was a significant age effect for germ ratings of native contaminated foods ($b = 0.15, p < .001$), indicating that with age children became more likely to rate foods contaminated by a native speaker as germ (Fig. 9).

Consequences of contamination

To examine children's response to whether the food would make them sick, we ran binomial probability tests asking whether children responded "yes" or "no" when asked whether the food in each condition would make them sick. Results showed that children expected contaminated foods to make them sick regardless of the identity of the contaminator (Native–Contaminated: $n = 63$ of 88 children, binomial $p < .001$; Foreign–Contaminated: $n = 68$ of 89 children, binomial $p < .001$). However, children did not have expectations about whether clean foods would make them sick regardless of whether the food was associated with a native or foreign speaker (Native–Clean: $n = 44$ of 84 children, binomial $p = .74$; Foreign–Clean: $n = 36$ of 83 children, binomial $p = .27$).

Then, we ran a logistic regression on children's expectations of whether the food would make them sick with age (continuous in years, centered), germiness ratings of the food, type of food (clean vs. contaminated), language spoken by the actor (native vs. foreign), and their interactions as predictors. We reduced the model by removing nonsignificant higher-order interactions. The final model included all main effects as well as interactions between age and language and between age and food type. The results indicated a significant main effect of food type ($b = 0.90, p = .001$), replicating the finding that children expected contaminated foods to be more likely to make them sick. There was also a significant main effect of germiness rating ($b = 0.93, p < .001$), indicating that children who rated the food as germier were more likely to expect the food to make them sick. Although there was no significant main effect of age ($b = 0.11, p = .21$) or language ($b = -0.23, p = .37$), there was a significant interaction between age and language ($b = -0.27, p = .017$) as well as a significant interaction between age and type of food ($b = 0.26, p = .027$). These interactions indicate that older children were more likely than younger children to expect contaminated foods to make them sick, whereas younger children were more likely than older children to expect foreign foods to make them sick.

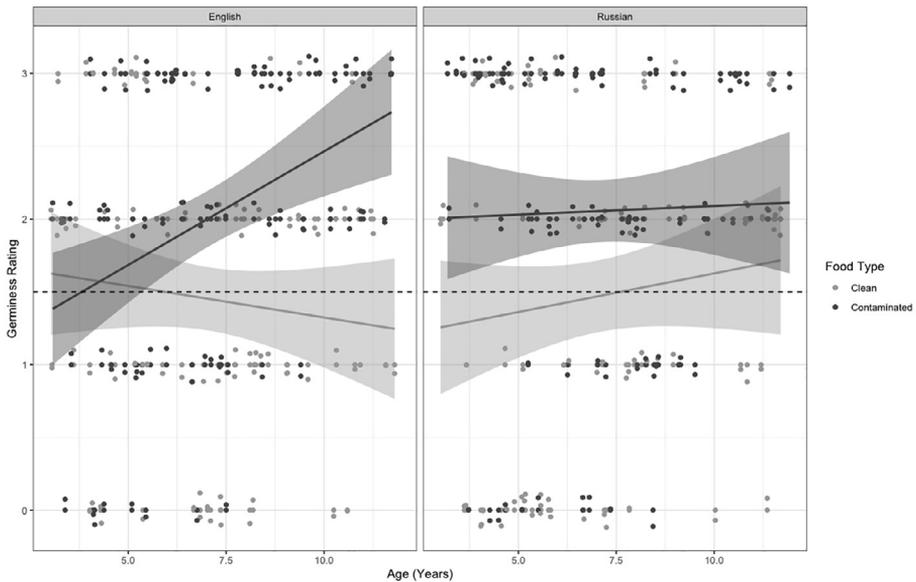


Fig. 9. Germiness ratings for Study 2. Children generally rated clean foods (light lines) as less gummy than contaminated foods (dark lines). Although children's germiness ratings for foreign (Russian) contaminated foods were stable across age, with age children became more likely to rate native (English) contaminated foods as gummy. These results replicate the findings of Studies 1a and 1b. Shaded areas around lines indicate 95% confidence intervals according to the linear model.

Discussion

In Study 2, we removed the forced-choice design of our previous studies to more clearly test how both language and contamination affect children's reasoning about foods. Overall, replicating previous research, the results suggest that children's food choices were driven by both language and contamination status. Interestingly, we found clear evidence that the impact of these two cues shifted across development. In particular, the significant interaction between age and language for both willingness to eat and expectations about sickness indicates that younger children were more attentive to language than older children. That is, younger children were more willing to eat native contaminated foods than foreign contaminated foods, and younger children were less likely to expect native contaminated foods to make them sick. On the other hand, children become more attentive to contamination status with age; significant interactions between age and type (clean vs. contaminated) for both willingness to eat and expectations about illness suggest that older children avoided contaminated foods even when those foods were associated with a native speaker.

We also replicated (from Study 1) that the only case in which age had a significant impact on germiness ratings was in the Native–Contaminated condition, where older children were more likely to rate the food as gummy. Thus, with age children became more likely to understand that even native foods can be contaminated and that when they are contaminated, they should be avoided. In addition, as seen in Studies 1a and 1b, the influence of germiness ratings on both children's willingness to eat the food and their expectations about illness increased with age, suggesting that older children were more likely to use their knowledge of germs to inform their avoidance behaviors.

General discussion

The current studies are the first to examine the influence of social group membership (native vs. foreign) and contamination understanding (germ ratings; avoidance of foods that have been sneezed in) on children's food selection behavior. Overall, reasoning about contamination improved with age

and, as it did, contamination reasoning best explained children's avoidance of contaminated foods. In some situations, children attended to both culture and contamination when deciding what to eat. Young children were more likely to avoid foreign (vs. native) foods. All children were more likely to avoid contaminated (vs. clean) foods, and in Study 1 children were significantly more likely to choose the clean food when it was associated with a native speaker (Study 1a) than when it was associated with a foreign speaker (Study 1b). However, children did not demonstrate a particularly heightened avoidance of foreign contamination. For example, in Study 2, in which the contamination status and cultural background associated with a food were fully crossed, there was no interaction between language and contamination status.

Interestingly, we did find that the extent to which children's food choices were driven by culture and contamination status shifted across development. Specifically, we replicated the previous research indicating that young children's food choices are influenced by social factors (Frazier, Gelman, Kaciroti, Russell, & Lumeng, 2012; Greenhalgh et al., 2009; Harper & Sanders, 1975; Hendy & Raudenbush, 2000; Shutts et al., 2009). In fact, younger children were more attentive to culture (indicated by model language) than older children. For example, younger children (a) rated foreign contaminated foods as germy but did not rate native contaminated foods as germy, (b) were less willing to eat foreign foods even when they were clean (Study 1b and Study 2), and (c) were more likely than older children to say that eating foreign foods would make them sick (Study 2).

Why do young children attend more to culture when making food choices than older children? One possibility is that although neither the speaker's cultural group nor the food's contamination status was visually apparent at test, it might have been easier for young children to attend to and encode cues of identity than of contamination. Future research could include additional questions or scales, such as independent measures of sociocultural knowledge and preferences for cultural ingroup members, in order to ask whether children who generally preferred their ingroup were also more likely to use group membership when making a food choice. For example, many children who choose more native speakers as friends, or who preferentially imitate and learn from native speakers (see Begus et al., 2016; Buttelmann et al., 2013; Kinzler et al., 2007), are also more likely to eat native foods. Another possibility is that young children's responses may be due to expectations about which foods are being offered by each speaker. Although the foods were always hidden from participants, young children are more likely to associate native (vs. foreign) speakers with familiar foods (e.g., DeJesus et al., 2019). This expectation, combined with the fact that young children tend to demonstrate neophobia (e.g., Cooke & Wardle, 2005), could have led young children to be generally wary of foreign foods and to assume that the native food was more likely to be familiar and preferred. As children's neophobia decreases with age, children may increasingly rely on other features of the foods to make food choices (e.g., contamination). Future studies could be explicit about which foods are presented and could include familiar and novel foods to ask more clearly about the role of neophobia.

Older children, on the other hand, did not want to eat contaminated foods regardless of the cultural group of the person offering those foods, thought contaminated foods were germy, and expected contaminated foods to make them sick. Interestingly, the largest age-related developments were seen for ratings of *native contaminated* foods; with age children became more likely to say that native contaminated foods would be germy, to expect native contaminated foods to make them sick, and to use their germiness ratings of a native contaminated food to guide their choice about whether to eat that food. Thus, rather than specifically showing early attention to foreign contamination, young children were relatively unlikely to expect native contamination to be dangerous.

Our research opens up many interesting future questions to consider. Notably, how do children's experiences affect their understanding of food contamination? Indeed, across cultures there are substantially different socialization practices surrounding food that can affect the ability to avoid contamination. For instance, some cultures socialize a belief system that includes both biological and supernatural explanations for illness (Legare, Evans, Rosengren, & Harris, 2012; Legare & Gelman, 2008), and children in these cultures may have a different understanding of the social nature of illness. Cultural belief systems also vary in their discussion of purity, which can affect food choice. Indeed, Hindu children in India (who are socialized to learn about the caste system, purity, and their role in food selection) showed some benefits in avoidance of contamination compared with children in the United States, although many similarities were also observed across groups (Hejmadi, Rozin, &

Siegal, 2004). In addition, children who live in places with greater food contamination risk may show an earlier ability to avoid dangerous foods. Indeed, in rural Uganda, where water and food contamination is common, children as young as 4 years showed some success at avoiding contaminants, although they still had vulnerabilities in avoiding water contamination (Gauvain & McLaughlin, 2016). Thus, examining children's beliefs across cultural contexts would add important insight into how socialization processes affect learning about germs and food avoidance.

Another interesting and timely future direction is to determine whether children's understanding of contamination and disease risk changes in cases in which there is heightened attention to contamination such as during global pandemics. In 2019–2020, children around the world suddenly experienced huge changes in their social lives in order to limit the spread of COVID-19, including staying home from school and avoiding interacting with other people outside their households. During this time, parents may also be engaging in more explicit instruction around germs and illness, ranging from discouraging children from touching their faces and mouths to explicitly discussing the risk of death from contracting COVID-19. Children's reaction to the specific stimuli used in these studies (i.e., people sneezing into food) may be perceived differently due to these new experiences in learning about germs and illness. Therefore, future research could ask whether children who have experienced more conversations and education about germs are better at avoiding native contamination even early in development. Although COVID-19 is primarily spread through person-to-person contact that results from *inhaling* respiratory droplets that contain the virus (CDC, 2020) and is unlikely to be transmitted through the digestive tract (Kutter, Spronken, Fraaij, Fouchier, & Herfst, 2018), it is possible that increased learning about illness and germs in general could change children's ability to avoid contaminated foods. Thus, future research should investigate the impact of the global pandemic on children's contamination-avoidant behaviors and compare their ability to avoid contaminated foods with their ability to avoid people whose symptoms suggest they are ill.

Overall, our studies emphasize the impact that social factors and contamination status have on children's reasoning about food, highlighting the complexity of children's contamination-avoidant behaviors. Children are capable of evaluating foods from various perspectives; they gradually shift their attention from social factors related to foods to contamination when deciding which foods to eat and which foods to avoid. Food is an inarguably important part of humans' lives; not only is food critical for providing the sustenance necessary for survival, it also is inherently social such that eating illuminates a plethora of information in regard to social identity and intergroup processes. By examining food within a social context, we can gain a better understanding of how humans make food choices and how people use these food choices to affiliate with others and establish important relationships within the social world.

Acknowledgment

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Appendix A

Studies 1a and 1b script

Hello! My name is _____ and I am going to show you some videos. In the videos you will see two people. Each person will tell a short story and try a snack. After the videos, I will ask you a few questions. Are you ready to start? Great!

[watch videos of language + eating food (with or without contamination)]

Question 1: If you could eat one of these foods, which one would you eat? This one [left] or this one [right]?

Question 2: Do you know what germs are?

[If child says “yes”: Ask “What are germs?” Wait for response. If child knows, say “That’s a great answer!” and move on to the scale. If child does not really know what germs are, move on by telling the child about germs.]

[If child says “no”: Say “That’s okay. I can tell you about germs! Germs are really small; we can’t see them, but they live all around us. They can be in the air, on the ground, and on your skin too. If germs get inside your body, they can sometimes make you feel sick. They can give you a stomachache, an itch, or a cold. They love to cause trouble!”]

Now we are going to use this scale to talk about how germy things are. This circle means that it is not germy at all. This circle means that it is a little bit germy. This circle means that it is germy. This circle means that it is really germy! Okay. So, which circle means something is not germy? Which circle means something is really germy?

Great! We are going to use this same scale to talk about the foods we saw.

Question 3: Using these pictures, can you point to how germy you think this food [left] is?

Question 4: Can you point to how germy you think this food [right] is?

Question 5: Which food would be more likely to make you feel sick if you ate it? This one [left] or this one [right]?

Question 6: Do you remember who sneezed in her food?

Study 2 script

Hello! My name is ____ and I am going to introduce you to this girl named Sara. Here is Sara!

Sara loves to eat her favorite snack. She thinks it’s really yummy. Now we are going to use this scale to talk about how much you would want to eat Sara’s snack.

This circle means you *really* don’t want to eat it. This circle means you don’t want to eat it. This circle means you may want to eat it. This circle means you do want to eat it. This circle means you *really* want to eat it!

Question 1: So, using this scale, how much do you want to eat Sara’s snack?

Now let’s watch Sara eat some of her favorite snack.

[watch video of language + eating food (with or without contamination)]

Okay. Now, let’s imagine Sara passes you this same exact bowl.

Question 2: Using the scale, how much do you want to eat the snack?

Question 3: Do you know what germs are?

[If child says “yes”: Ask “What are germs?” Wait for response. If child knows, say “That’s a great answer!” and move on to the scale. If child does not really know what germs are, move on by telling the child about germs.]

[If child says “no”: Say “That’s okay. I can tell you about germs! Germs are really small; we can’t see them, but they live all around us. They can be in the air, on the ground, and on your skin too. If germs get inside your body, they can sometimes make you feel sick. They can give you a stomachache, an itch, or a cold. They love to cause trouble!”]

Now we are going to use this scale to talk about how germy things are. This circle means that it is not germy at all. This circle means that it is a little bit germy. This circle means that it is germy. This circle means that it is really germy! Okay. So, which circle means something is not germy? Which circle means something is really germy?

Question 4: Using these pictures, can you tell me how germy Sara’s snack is?

Question 5: Do you think eating Sara’s snack would make you sick?

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