Title
Children Use Language Membership When Reasoning About Food Contamination

Author
Lee, Diane

Publication Date
2019

UNIVERSITY OF CALIFORNIA

Santa Barbara

Children Use Language Membership When Reasoning About Food Contamination

A Thesis submitted in partial satisfaction of the
requirements for the degree Master of Arts
in Psychological & Brain Sciences

by

Diane J. Lee

Committee in charge:
Professor Zoe Liberman, Chair
Professor Leda Cosmides
Professor Brenda Major

September 2019

The thesis of Diane J. Lee is approved.

Brenda Major

Leda Cosmides

Zoe Liberman, Committee Chair

September 2019

Children Use Language Membership When Reasoning About Food Contamination

by

Diane J. Lee

ABSTRACT

Children Use Language Membership When Reasoning About Food Contamination

by

Diane J. Lee

Food choice is cultural (Fischler, 1988; Millstone & Lang, 2002; Rozin & Rozin, 1981). Indeed, even infants prefer foods liked by members of their group (Shutts et al., 2009) and expect culture to guide food choices (Liberman et al., 2016). People learn not only what to eat, but also what to avoid. Previous work suggests that children do not avoid contaminated foods until 8 years of age (Rozin et al., 1986). Combining these lines of research, we ask how children reason about foods that are contaminated by someone from within versus outside their culture. In Studies 1 & 2, we presented 3- to 11-year-olds with videos of a native speaker and a foreign speaker each liking a food, but varied whose food was contaminated: the foreign speaker's food (Study 1), or the native speaker's food (Study 2). In Study 3, children were randomly assigned to watch videos of one speaker (either native or foreign) eat one food (either clean or contaminated) to better understand the mechanisms driving children's food choices. By 3-years-old, children rated contaminated food as germy and were better at avoiding it when the contamination came from a foreign speaker. However, when contaminated food came from a native speaker, children were not as adept in their understanding of contamination. Children reported that contaminated food from a native speaker was germy and likely to make them sick by 5- to 7-years-old, but did not accurately avoid it until around 7- to 9-years-old.

TABLE OF CONTENTS

LIST OF FIGURES & TABLES

I. Introduction

In order to successfully navigate the world, people need to learn what (and whom) to approach or avoid. In particular, there should be systems in place that help humans approach things that may lead to benefits and to avoid things that are harmful or costly. Although strategies for adjudicating between costs and benefits are essential across all domains, they may be particularly important for decisions about food. Because humans are omnivores and can eat a wide variety of substances, there must be mechanisms in place for selecting proper foods to eat (e.g., those that provide appropriate nutrition and energy) and for avoiding ingesting potentially dangerous items (e.g., poisonous substances, non-foods, or foods that may harbor foodborne illnesses) (Fischler, 1988).

There are several reasons why humans may decide not to consume a particular substance: the food may not be available, or what is available may be poisonous, culturally disgusting, inedible, or contaminated (Birch, Fisher, & Grimm-Thomas, 1999; Oaten, Stevenson, & Case, 2009; Rozin, 1986; Rozin & Fallon, 1980; Rozin & Kalat, 1971; Siegal, Fadda, & Overton, 2011). Specifically, when it comes to the problem of avoiding contaminated food, the individual must first determine that something is a food and typically can be consumed. Then, they must figure out whether the particular instance of food is safe to eat (vs. contaminated).

When humans end up failing at choosing the appropriate foods, there are 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, 2019). In particular, ingesting harmful pathogens from contaminated foods continues to pose a substantial threat. Even within the general population of the United States, the CDC estimates that 48 million cases of foodborne diseases occur each year, with approximately 128,000 of these cases leading to hospitalizations, and 3,000 of them leading to deaths. While it is necessary to avoid contaminated foods across the lifespan, children appear to be at an increased risk: children under two-years-old are the most likely age group to accidentally poison themselves (Cashdan, 1994), and children under the age of five have the highest incidence rates of certain foodborne infections (e.g., eColi, Salmonella) compared to any other age group (CDC, 2019). As children are a particularly vulnerable population, it is crucial to understand how children come to learn and reason about contaminated foods.

Despite the serious repercussions of ingesting harmful foods, prior research suggests that young children may know surprisingly little about contamination. Young children appear largely indiscriminate when deciding what to eat – they will put substances into their mouths that adults would find disgusting, such as imitation feces and sterilized insects (Rozin, Millman, & Nemeroff, 1986). Even slightly older children, 4- to 7-year-olds, indicate a desire to drink their favorite beverage after seeing that it was contaminated, as long as the contaminant (e.g., flies, a used comb) had been physically removed (Rozin, Fallon, & Augustoni-Ziskind, 1985). Thus, it would seem that it is not until fairly late in development – by around 8 years of age – that children have a mature taxonomy of what counts as food, and can accurately avoid ingesting harmful substances.

However, other research suggests that there are cases in which children appear more advanced in their reasoning about contaminated foods. In particular, DeJesus, Shutts, & Kinzler (2015) presented contaminated foods within a social interaction paradigm. Children watched two actors eat and enjoy foods from separate bowls. One actor contaminated her food (with a sneeze and saliva), and the other did not. Following the videos, when the same bowls of food were presented to the children, 5- to 8-year-old children (but not 3- and 4-year-old children) ate more of the clean food than the contaminated food, and rated the clean food as yummier. While a considerable amount of past studies on contamination have presented single contaminated foods with little to no social context (Rozin et al., 1986; Springer & Belk, 1994; Kalish, 1996), contextualizing food contamination within a social interaction may align more closely to the kinds of occurrences humans come across in day-to-day life, and may provide the necessary scaffolding that young children use when reasoning about food contamination.

Indeed, for humans, food choice and eating are inherently social. Early in ontogeny, humans do not make their own food choices; instead, infants are breastfed by a caregiver and are provided with the appropriate foods to eat. Even in adulthood, the act of preparing and consuming foods is often done in the company of others, and different cultures possess social customs and rituals when it comes to food (e.g., Fischler, 1988; Millstone & Lang, 2002; Rozin & Rozin, 1981). Specific cultures possess unique customs regarding how food is prepared (Korsmeyer, 2005), which foods are sacred (e.g., Grunfeld, 1975), and how meals are shared (Anderson, 2005). Due to the social nature in which we learn about food, children may be best equipped to learn about what foods to consume and avoid through social means. Indeed, children eat more food when someone is eating the same food with them (Addessi, Galloway, Visalberghi, & Birch, 2005), or after watching a peer reach for the food (Bevelander, Answhutz, & Engels, 2013). Furthermore, the particular choices children make are social: they are more likely to approach foods being eaten by an enthusiastic (vs. silent) model (Hendy & Raudenbush, 2000), or by people in their social group (Frazier, Gelman, Kaciroti, Russell, & Lumeng, 2012). In fact, infants appear to understand the social significance of food choice in the first year of life: they expect two individuals who speak the same language to share food preferences (Liberman, Woodward, Sullivan, & Kinzler, 2016), and prefer to eat foods that have been liked by native language speakers (Shutts, Kinzler, McKee, & Spelke, 2009) or by prosocial characters (Hamlin & Wynn, 2012). Seeing the powerful influence of social factors on children's cognition and behavior when it comes to food, it may be that contamination from a person may be easier to track than other types of contamination (e.g., objects, insects), and certain people may be more relevant than others when deciding what to eat.

In our current study, we build on the method from DeJesus et al. (2015) and present contamination within an even stronger socio-cultural context. Specifically, we manipulated the group membership of the person who contaminated her food by presenting children with one model who spoke their native language (English), and one model who spoke a foreign language (Russian). Language has been shown to be an early-emerging social category used to determine those in our ingroup vs. outgroup: starting in early infancy, we prefer those who speak our native language over those who speak a foreign language (Kinzler, Dupoux, & Spelke, 2007). Across studies, we counterbalanced whether the outgroup (foreign) model contaminated her food (Study 1), or whether the ingroup (native) model contaminated her food (Study 2). After seeing the models sample their foods, we assessed children's hypothetical desire to eat these foods as well as their thoughts on the foods' germiness and the foods' potential to cause illness. We were interested in whether the group membership of the contaminator would influence children's ability to avoid contamination. That is, results from previous studies (DeJesus et al., 2015; Kalish, 1999; Siegal, 1988) indicate that children can avoid contaminated foods by at least 5-years-old. But, are children able to avoid contaminated food from a foreign speaker at even earlier ages? And, do children have trouble avoiding a contaminated food from a native speaker even at older ages?

Furthermore, by directly asking children about their knowledge of germs and illness, we wanted to better understand children's reasoning when deciding whether to eat or avoid a contaminated food. For instance, when children fail to avoid a contaminated food, is it because they do not understand that contaminated foods carry germs which can make them sick? By examining differences in how children assess germiness and potential illness in regards to clean and contaminated foods, we aim to further clarify the mechanism by which children learn about food contamination.

II. General Method

All studies were conducted at the MOXI Wolf Museum of Exploration + Innovation in Santa Barbara, California, between January 2018 and March 2019. Research assistants recruited 3- to 11-year-old children who were visiting the museum. To compare our findings to past research on children's reasoning about food contamination (DeJesus et al., 2015), children were divided into two-year age groups: 3- to 4-year-olds, 5- to 6-year-olds, 7- to 8-year-olds, and 9- to 11-year-olds. Due to variability in the daily number of visitors and participants, the stopping criterion for data collection was when we obtained at least 20 participants per age group for each study. In accordance with procedures approved by the University of California, Santa Barbara Institutional Review Board (Protocol # 1-17-0996), we obtained verbal assent from each child before he or she participated.

For children who chose to participate, an experimenter explained to the participant that they would watch videos of people trying foods, and then they would be asked some questions. Participants sat at a table and watched videos play on a 13-inch Lenovo Ideapad 710S laptop while wearing headphones. The videos featured two female actors who were native bilingual speakers of English and Russian. In introductory videos, each actor introduced herself by saying a short vignette unrelated to food in either English or Russian, depending on the study (see Appendix for full scripts). Then, in eating videos, each actor ate and enjoyed a snack from an opaque bowl, so children could not see exactly what the snack was. Some of the eating videos presented clean foods: The actor ate a bite and expressed positivity (saying, “Oh! Mmh!”), and ate a second bite. Other videos presented contaminated foods: The actor ate a bite and expressed positivity (also by saying, “Oh! Mmh!”), but then sneezed into the bowl and licked her fingers before eating a second bite with the same hand. Because the introductory videos were separate from the eating videos, we could present either actor as speaking a native (English) or foreign (Russian) language, and as associated with either clean or contaminated food.

After watching a video or videos (see specific Studies for details), a still image of the actor(s) facing forward with their bowl(s) remained on the screen as a reference point for the subsequent questions (See Figure 1).

Figure 1. Example of the image that participants referenced while answering questions.

Participants were first asked whether they wanted to eat the food(s) presented. In Studies 1 & 2, children made a forced-choice decision about which of the two presented foods they preferred to eat, and in Study 3 they rated (using a scale) how much they’d want to try the food. All eating decisions were hypothetical: children were not given any food to eat during the study, and they never explicitly knew what the food was.

Next, we asked the children if they knew what germs were. If they did not, we provided a brief explanation about germs (see Appendix for script). Afterwards, children were shown a four-point germ scale (0 = not germy, 1 = a little germy, 2 = germy, 3 = really germy; See Figure 2), and were asked to rate the “germiness” of each presented food.

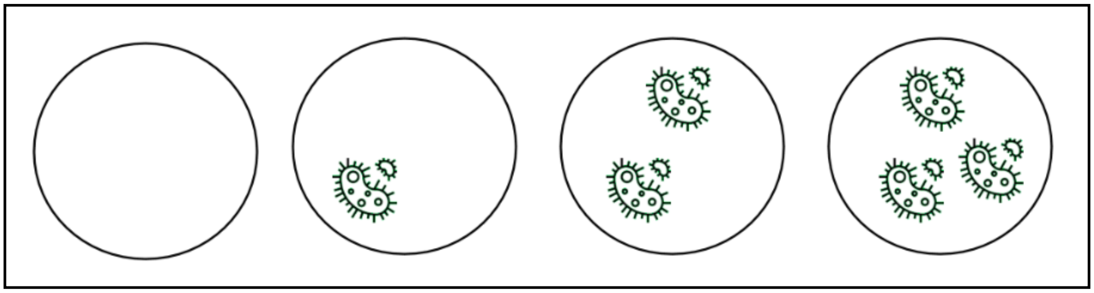


Figure 2. Germ Scale. From left to right, 0= not germy, 1= a little germy, 2= germy, 3= really germy).

Finally, we asked children whether eating the presented food(s) would make them sick. In Studies 1 & 2, children made a forced-choice decision about which of the two foods would be more likely to make them sick, and in Study 3 they were asked whether one food would make them sick, and could respond by saying “Yes” or “No.” In Studies 1 & 2, as a comprehension check, children were asked to identify which actor sneezed into her food. Participants were thanked and given a sticker for their participation.

III. Study 1

A. Participants

Eighty-eight 3- to 11-year-old monolingual English-speaking children participated in Study 1. Based on previous research (e.g., DeJesus et al., 2015), children were divided into two-year age groups. Specifically, we tested twenty 3- to 4-year-olds (*n* = 11 females, M_{age} =

3.98 years, range = 3.04 – 4.99 years), twenty-four 5- to 6-year-olds (*n* = 15 females, M_{age} = 6.01 years, range = 5.03 – 6.71 years), twenty-two 7- to 8-year-olds (*n* = 11 females, M_{age} = 8.15 years, range = 7.1 – 8.95 years), and twenty-two 9- to 11-year-olds (*n* = 16 females, M_{age} = 10.47 years, range = 9.16 – 11.83 years). Eight more children were tested but excluded from analyses due to experimental error (*n* = 3) and losing attention (*n* = 5).

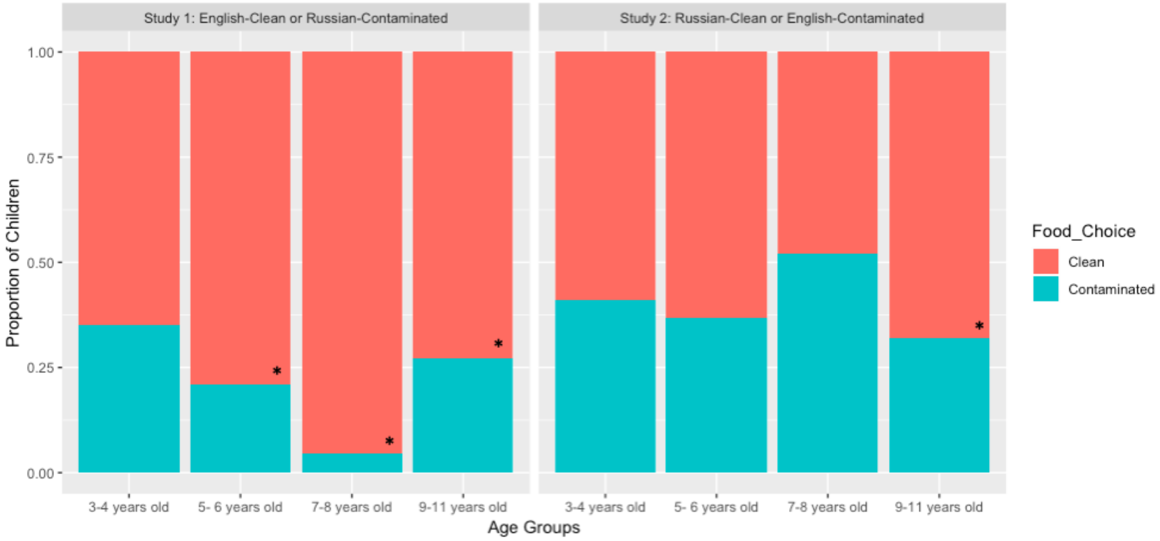
B. Procedure

Children were presented with two sets of videos. In the first set, the actors introduced themselves in order to provide information about their identity. Specifically, one actor spoke English (native) and one spoke Russian (foreign). The actor's statements did not provide any other information about themselves, or about the foods that they would eat. For example, an actress would say, "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 color: red, orange, yellow, green, blue, and purple," or the equivalent phrase in Russian. In the second set of videos, each actor ate from one of two opaque bowls of food. The Russian speaker ate a bite of food from one of the two bowls, liked it, and then contaminated it by sneezing into the bowl, and licking her fingers before taking a second bite. The English speaker ate a bite from the other bowl, liked it, and took a second bite. We refer to this food as "clean" because none of the actions provide evidence of contamination. Across subjects, we counterbalanced which of the two actors was presented as the English-speaker and which actor was presented eating first.

After the videos ended, a still image of both actors and the bowls from which they sampled appeared on the screen (See Figure 1). The experimenter referenced the still image while asking the test questions. First, children were asked to point to which of the two foods (forced choice) they preferred to eat. Then, after the child's basic understanding of germs was confirmed, the participant was asked to rate how "germy" they thought each of the foods was, on the four-point germ scale (see Figure 2). Next, children were asked to choose which food would be more likely to make them feel sick if they ate it (forced choice). Finally, children were asked to recall which actor sneezed into her food (forced choice) to check their overall comprehension of the study.

IV. Results

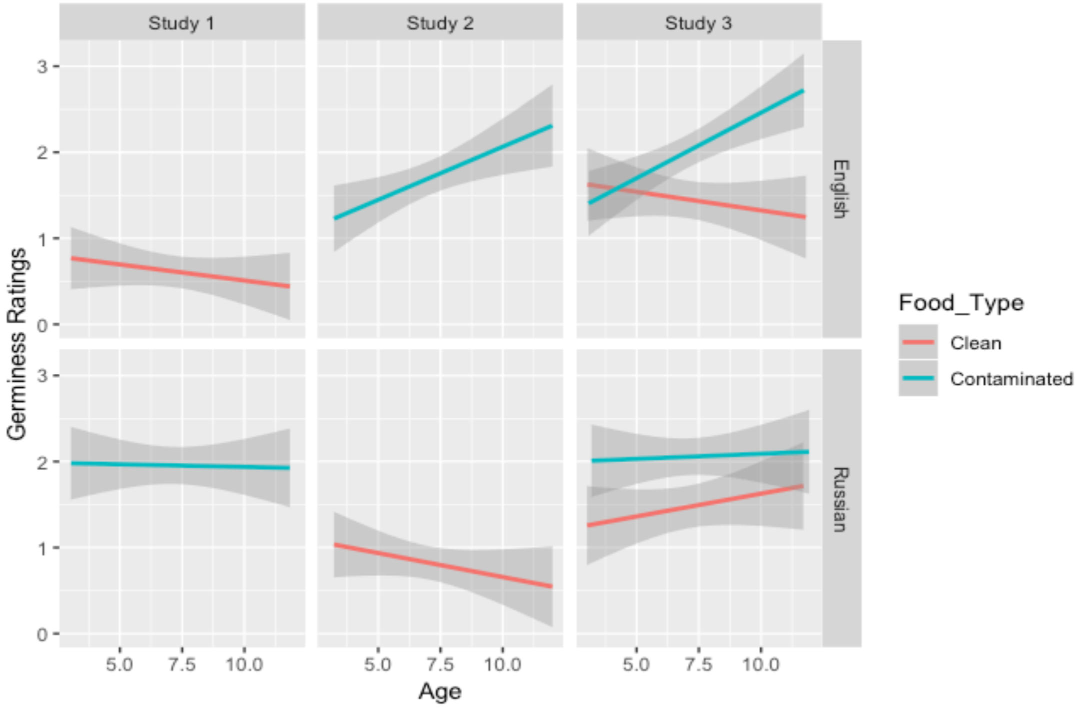
Using our comprehension check, we found that 85 of 88 children were able to recall which actor sneezed into their bowl. Results were the same regardless of whether children passed the comprehension check, so the data analysis includes all of the children tested. We first investigated participants' likelihood of saying they would prefer to try the clean food from the native speaker instead of the contaminated food from the foreign speaker. To do so, we conducted binomial probability tests comparing the number of participants who chose the clean food (eaten by the English speaker) to chance. Overall, children were more likely to choose the clean food ($n = 69$) than they were to choose the contaminated food ($n = 19$, binomial $p < .001$). A logistic regression on children's choice with age (continuous in years) as a predictor revealed no significant effect of age ($b = .09$, $p = .39$). However, based on age differences seen in previous research on contamination (e.g., DeJesus et al., 2015; Kalish, 1999; Solomon & Cassimatis, 1999), and on our a-priori hypotheses, we also investigated each of the age groups separately. Although 3- to 4-year-olds were at chance at choosing between the clean ($n = 13$) and the contaminated ($n = 7$) foods (binomial $p = .26$), each of the older age groups chose the clean food at rates above chance (5- to 6-year-olds: $n = 19$ of 24; binomial $p = .025$; 7- to 8-year-olds: $n = 21$ of 22; binomial $p < .001$; 9- to 11-year-olds: $n = 16$ of 22; binomial $p = .05$; See Figure 3a). Therefore, at least by 5 years of age, children indicate that they would prefer to try a clean food (eaten by a native speaker) over a contaminated food (eaten by a foreign speaker). This finding replicates results by DeJesus et al. (2015).



(a) (b)

Figure 3. Children's food choices across Study 1 (Panel a) & Study 2 (Panel b).

Next, we asked whether participants rated the contaminated food as more likely to have germs. To do so, we ran a multiple linear regression on germy ratings with age (continuous in years) and food type (clean vs. contaminated) as predictors. Results revealed a significant effect of food type (*b* = 1.12, *p* = .012), such that contaminated foods were given higher germiness ratings. The model revealed no significant effect of age (*b* = -0.04, *p* = 0.362; See Figure 4a).



(a) (b) (c)

Figure 4. Germiness ratings across Study 1 (Panel a), Study 2 (Panel b), & Study 3 (Panel c) as a function of food type (clean vs. contaminated), language spoken by the actor (English vs. Russian), and participant age.

In fact, according to paired-sample t-tests on children's germiness ratings of the clean and contaminated foods, children overall rated the contaminated food as significantly germier (M = 1.95; SD = 1.0) than the clean food (M = 0.61; SD = 0.86; $t(87) = 8.90$; $p < .001$). Indeed, even 3- to 4-year-olds, the youngest group tested, rated the contaminated food (M = 2.10; SD = 1.17) as significantly germier than the clean food (M = 0.85; SD = 1.14; $t(19)$ = 3.26; p = .004). Older children also rated the contaminated food as significantly germier (5- to 6-year-olds: M = 1.83; SD = 1.09; 7- to 8-year-olds: M = 1.91; SD = 0.81; 9- to 11-year-olds: M = 2.0; SD = 0.98) than the clean food (5- to 6-year-olds: M = 0.63; SD = 1.06; $t(23)$ = 3.39; p = . 002; 7- to 8-year-olds: M = 0.41; SD = 0.59; $t(21)$ = 6.65; $p < .001$; 9- to 11-

year-olds: *M* = 0.59; *SD* = 0.50*;* *t*(21) = 6.27; *p* < .001). Therefore, as early as 3-years-old, children understand that contaminated foods (eaten by foreign speakers) are germier than clean foods (eaten by native speakers).

Finally, we examined whether children associated contaminated food with an increased likelihood of getting sick than clean food. In order to do so, we conducted binomial probability tests comparing the number of participants who chose the contaminated food as more likely to get them sick to chance. Overall, children were more likely to choose the contaminated food (*n* = 70) than the clean food (*n* = 18, binomial *p* < .001). A logistic regression on children's choices with age as a predictor revealed a significant effect of age (*b* = .47, *p* = .001), such that older children were more likely to understand that contaminated foods may make them sick. These results can be clearly seen when each age group is tested separately. Mirroring the results for choosing a potential food to eat, 3- to 4-year-olds were at chance at choosing between the contaminated (*n* = 9) and the clean (*n* = 11) foods (binomial *p* > .99), whereas all older age groups chose the contaminated food as the one more likely to make them sick at rates above chance (5- to 6-year-olds: *n* = 21 of 24; binomial *p* < .001; 7- to 8-year-olds: *n* = 20 of 22; binomial *p* < .001; 9- to 11-year-olds: *n* = 20 of 22; binomial *p* < .001). By 5-years-old, children understand that contaminated foods (eaten by a foreign speaker) are more likely to get them sick over a clean food (eaten by a native speaker).

V. Discussion

Children in the youngest age group (3- to 4-years-old) were at chance when choosing between contaminated food and clean food. However, this chance performance does not seem to be due to a lack of understanding of which food is contaminated, and therefore germier. Even 3- to 4-year-olds rate the food contaminated by the Russian speaker as germier than the clean food eaten by the English speaker. Although 3- to 4-year-old children know that contaminated food is “germier” than clean food, they may not necessarily understand that there is a link between consuming germy food and illness. In fact, preschoolers did not expect the germy food to be more likely to make them sick. These results are in line with previous research on children’s early understanding of germs. Young children do not have a fully formed biological model of what germs are, and how they can act on their host (Kalish, 1999). Instead, young children may have a more physical conception of illness, whereby it is caused by some kind of material transfer (Au, Sidle, & Rollins, 1993). And, although young children are good at referencing germs when they are providing explanations for why someone became sick, their predictions of what might cause illness are not as fully developed (Legare, Wellman, & Gelman, 2009).

Our findings also replicate previous results suggesting that by 5-years-old, children are able to avoid contaminated foods (DeJesus et al., 2015; Kalish, 1999; Siegal, 1988). 5- to 11-year-olds in our study (1) were more interested in trying clean foods, (2) rated clean foods as less germy, and (3) expected contaminated foods to make them sick. Thus, these children appear to understand that the contamination may lead to germs which in turn may cause illness.

However, in this study, the clean food was presented by a native speaker, and the contaminated food was presented by a foreign speaker. A large body of research suggests that children prefer people who speak their native language (Kinzler, Spelke, & Dupoux, 2007), and that children associate language with food choice (e.g., Liberman et al., 2016), leading them to eat foods eaten by native speakers (e.g., Fraizer et al., 2012; Shutts et al., 2009). Therefore, it is possible that children in our study preferred the clean food because it was eaten by a native speaker (rather than because they completely understand contamination). In Study 2, we instead gave children the choice between a contaminated food eaten by a native speaker, and a clean food eaten by a foreign speaker. If 5-year-old children can reason effectively about all contaminated foods, then they should continue to prefer the clean food, even though it is presented by a foreign speaker. On the other hand, because food choice is culturally constrained (DeJesus, Shutts, & Kinzler, 2015), it may be more difficult for children to avoid contaminated foods when the contamination comes from a member of their own group.

VI. Study 2

A. Participants

We tested one hundred and two 3- to 11-year-old monolingual English-speaking children in this study. Specifically, we recruited twenty-two 3- to 4-year-olds (*n* = 14 females, M_{age} = 3.98 years, range = 3.22 – 4.76 years), thirty 5- to 6-year-olds (*n* = 13 females, M_{age} = 6.01 years, range = 5.03 – 6.97 years), twenty-five 7- to 8-year-olds (*n* = 12 females, M_{age} = 7.95 years, range = 7.06 – 8.97 years), and twenty-five 9- to 11-year-olds (*n* = 13 females, M_{age} = 9.96 years, range = 9.05 – 11.99 years) from Santa Barbara, California. Six more children were tested but excluded from analyses due to experimental error (*n* = 1) and losing attention (*n* = 5).

B. Procedure

Study 2 was identical to Study 1, except that the English (native) speaker contaminated her food (by sneezing into it, and licking her fingers), and the Russian (foreign) speaker did not.

VII. Results

Again, using our comprehension check, we found that 98 of 102 children were able to recall which actor sneezed into their bowl. Results were the same regardless of whether children passed the comprehension check, so the data analysis includes all of the children tested. As in Study 1, we first conducted binomial probability tests comparing the number of participants who chose the clean food (eaten by the Russian speaker) to chance. Overall, children were more likely to choose the clean food (n = 62) than they were to choose the contaminated food (n = 40, binomial p = .037). Although, a logistic regression on children's choices with age as a continuous factor did not reveal a significant effect of age (b = -0.08, p = .38), we analyzed the age groups separately in order to compare the results to Study 1, and to previous research. These analyses suggest that the oldest children were driving the above-chance selections of the clean food. That is, 9- to 11-year-olds were significantly above chance at choosing the clean food (n = 18) over the contaminated food (n = 7; binomial p = .043). However, all of the younger age groups were at chance when choosing between the clean and contaminated foods (3- to 4-year-olds: n = 13 of 22 chose the clean food, binomial p = .52; 5- to 6-year-olds: n = 19 of 30 chose the clean food, binomial p = .20; 7- to 8-year-olds: n = 12 of 25 chose the clean food, binomial p > .99; See Figure 3b). Therefore, children do not prefer clean food offered by a foreign speaker over contaminated food from a native speaker until 9 years of age. Instead, children from 3- to 8-years-old choose between these foods at chance.

Next, we investigated children's germiness ratings. In order to do so, we ran a multiple linear regression on children's germiness rating with age (continuous in years) and food type (clean vs. contaminated). Results revealed no significant effect of food type (b = .384, p = .4). However, there was a significant effect of age (b = .123, p = 0.005), such that older children gave higher germiness ratings than younger children. But, this main effect was qualified by a significant interaction between age and food type ($b = -.179$, $p = .004$), such that older children were more likely to rate the contaminated food (from the native speaker) as germy (See Figure 4b). According to paired-sample t-tests comparing children's germiness ratings of the clean and contaminated foods, across the entire sample, children gave significantly higher germiness ratings to the contaminated food ($M = 1.7$; $SD = 1.03$) than to the clean food ($M = 0.82$; $SD = 0.99$; $t(101) = 5.56$; $p < .001$). By 5 years of age, children rated the contaminated food as significantly germier (5- to 6-year-olds: $M = 1.67$; $SD = 1.09$; 7- to 8-year-olds: $M = 1.76$; $SD = 0.83$; 9- to 11-year-olds: $M = 2.04$; $SD = 0.89$) than the clean food (5- to 6-year-olds: $M = 0.77$; $SD = 1.04$; $t(29) = 2.88$; $p = .007$; 7- to 8-year-olds: $M = 0.64$; $SD = 0.91$; $t(24) = 3.71$; $p = .001$; 9- to 11-year-olds: $M = 0.8$; $SD = 0.91$; $t(24) = 4.55$; $p < .001$). This effect, however, was not present in the youngest group of children tested: 3- to 4-year-olds rated the contaminated food eaten by the native speaker ($M = 1.27$; $SD = 1.20$) as equally germy to the clean food eaten by the foreign speaker ($M = 1.14$; $SD = 1.08$; $t(21) = 0.4$; $p = 0.69$).

Finally, we examined whether children associated contaminated food with an increased likelihood of getting sick over clean food. Again, we conducted binomial probability tests to ask if participants were above chance at indicating that contaminated food would be more likely to get them sick. Overall, children were more likely to choose the contaminated food ($n = 79$) than the clean food ($n = 23$, binomial $p < .001$). However, a logistic regression on children's choices with age as a continuous factor revealed a significant effect of age ($b = -.3$, $p = .01$). All older age groups chose the contaminated food as the one more likely to make them sick at rates above chance (5- to 6-year-olds: $n = 24$ of 30; binomial $p < .001$; 7- to 8-year-olds: $n = 20$ of 25; binomial $p = .002$; 9- to 11-year-olds: $n = 22$ of 25; binomial p

< .001). However, 3- to 4-year-olds were at chance at choosing between the contaminated (n = 13) and the clean (n = 9) foods (binomial p = .52). Thus, by 5-years-old, children understand that contaminated foods (eaten by a native speaker) are more likely to get them sick over a clean food (eaten by a foreign speaker).

VIII. Discussion

The results from Study 2 contrast from those in Study 1 in a few interesting ways. First, while even 3- to 4-year-old children understood that the contaminated food from a foreign speaker was more germy than clean food from a native speaker (Study 1), they rated contaminated food from a native speaker and clean food from a foreign speaker as equally germy. This suggests that young children may use social group membership when reasoning about germs: they see contamination from the ingroup as less germy than contamination from the outgroup. In fact, although children understand that a contaminated food from a native speaker is more germy and more likely to make you sick than clean food from a foreign speaker by 5-years-old, they do not prefer the clean food at above chance rates when it has been eaten by a foreign speaker until they are 9-years-old. Thus, our results suggest that 5- to 8-year-old children also show a deficit when reasoning about contamination from an ingroup member. One potential explanation could be that because children typically learn to eat what other ingroup members eat, even older children may be influenced by these social cues of shared language. Indeed, food is social from infancy: 14-month-old monolingual infants expect same-language speakers to prefer the same foods, but not different-language speakers (Liberman et al., 2016). Furthermore, modeling (conforming one's eating behaviors to another) is one of the primary determinants of eating behavior (Cruwys et al., 2015). Our study provides strong evidence that children learn what to eat through social context, and use language as a cue to determine who to model. Therefore, up until 8 years of age, both language and contamination influence children's decisions on which foods to eat.

Our first two studies used forced-choice methods: children chose whether they preferred to eat a clean or contaminated food, and which food was more likely to make them sick. Because of this methodological detail, it is not clear exactly which features are driving children's decisions. Do children show an increased interest in clean foods eaten by native speakers (driving them to approach clean native foods)? Do children show a particular vigilance to foreign contamination (driving them to avoid foreign contaminated foods)? Or, do children have both of these motivations? In Study 3, we randomly assigned participants to see one actor (presented as either a native or foreign speaker) eat one food (either clean or contaminated). We first obtained a baseline rating of how much participants wanted to try the food, then, after seeing an event in which the speaker interacts with the food, we asked participants to rate how much they wanted to eat the food, how germy the food was, and whether or not the food would make them sick. If children approach clean foods liked by native speakers, then we expect their ratings for how much they want to try the food to increase from baseline in the Native-Clean condition (in which a native speaker likes, and does not contaminate a food). Similarly, if children avoid contaminated foods eaten by a foreign speaker, then we expect their ratings for how much they want to try the food to decrease from baseline in the Foreign-Contaminated condition (in which a foreign speaker likes, and contaminates a food). We also include Native-Contaminated and Foreign-Clean conditions to compare the effects of contamination vs. group membership information on children's eating behaviors. For instance, it is possible that in this simplified version (in which children only reason about one food), there will be attention to contamination even at younger ages (e.g., 3- to 4-year-olds), and even when the contamination comes from a native speaker.

IX. Study 3

A. Participants

The participants in Study 3 were three hundred and forty-four 3- to 11-year-old monolingual English-speaking children. There were seventy-nine 3- to 4-year-olds (*n* = 46 females, M_{age} = 4.06 years, range = 3.01 – 4.93 years), ninety-two 5- to 6-year-olds (*n* = 50 females, M_{age} = 5.88 years, range = 5.08 – 6.96 years), ninety 7- to 8-year-olds (*n* = 48 females, M_{age} = 7.86 years, range = 7.01 – 8.96 years), and eighty-three 9- to 11-year-olds (*n* = 42 females, M_{age} = 10.45 years, range = 9.01 – 11.93 years) from Santa Barbara, California. Twenty-eight more children were tested but excluded from analyses due to experimental error (*n* = 4), not completing the study (*n* = 11), parental interference (*n* = 12), and for having previously completed a different version of the study (*n* = 1). Children were randomly assigned to one of four conditions: Native-Clean, Native-Contaminated, Foreign-Clean, or Foreign-Contaminated.

B. Procedure

To examine how children reason about each combination of language and contamination status more specifically, here we presented children with only one actor, eating one food. Therefore, unlike in Studies 1 & 2, children did not make forced-choice judgments about which of the actor's food they preferred, but instead made judgments about a single food.

We first showed children a still picture of a person with an opaque bowl of food, and asked them to rate how much they wanted to try the food on a five-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; See Figure 5).

Figure 5. Desire to eat food scale. From left to right, 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).

Then, we presented an introductory video where the actor spoke English or Russian, and an eating video where she enjoyed her food with or without contaminating it. Afterwards, we asked children to use the same five-point scale to tell us how much they wanted to try the food. Then, as in Studies 1 & 2, we asked the children to use the germ scale to rate how germy the food was, and to report whether or not they expected that eating the food would make them sick.

X. Results

We first investigated how much children's willingness to try the food changed after watching the actor try the food, based on whether the actor spoke English or Russian, and whether the actor contaminated the food or not. In order to do so, we calculated a difference score for each participant by subtracting the rating they gave the food on the five-point scale before watching the videos of the actor speaking and trying the food from the rating they gave the food on the same scale after watching the videos. Therefore, a positive difference score indicated that the child was *more* willing to try the food after seeing the actor eat it, while a negative difference score indicated the child was *less* willing to try the food.

Overall, children who were assigned to clean conditions (where the actor did not contaminate her food) had more positive difference scores (*M* = 0.12; *SD* = 1.11) than children who were assigned to contaminated conditions (*M* = -0.8, *SD* = 1.43; *t*(342) = 6.6; *p* < .001), suggesting that children in general were sensitive to the contamination and were more interested in eating clean foods.

We next investigated whether the identity of the actor impacted these differences by analyzing results for each condition at each predetermined age group. Across almost all age groups, children assigned to the Native-Clean condition (i.e., children who watched the English speaker eat clean food) were equally willing to try the food before and after watching the actor eat. That is, difference scores were generally not different from zero (3- to 4-year-olds: *M* = .15, *SD* = 1.14, *t*(19) = .59, *p* = .56; 7- to 8-year-olds: *M* = .24, *SD* = .89, *t*(20) = 1.23, *p* = .23; 9- to 11-year-olds: *M* = -.14, *SD* = 1.06, *t*(21) = 2.85, *p* = .01), with the exception of 5- to 6-year-olds who became more willing to try the food (*M* = .77, *SD* = 1.27, *t*(21) = 2.85, *p* = .01). It is possible that children's responses to the Native-Clean food is somewhat of a baseline, such that children expect a model providing them with information to be from their group, and to engage in conventional behaviors (e.g., to refrain from sneezing into their food).

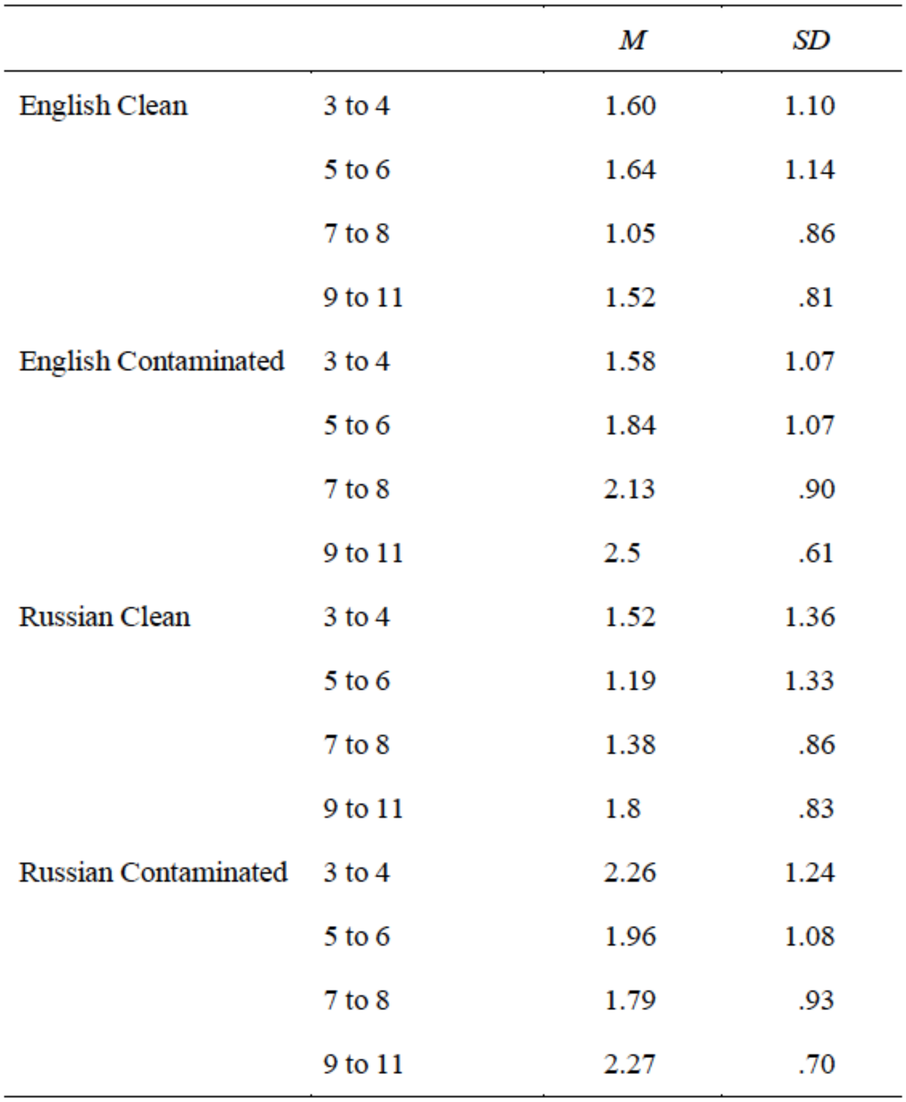
If children are generally able to avoid contaminated foods, then they should be less willing to eat a food after seeing it contaminated. For children in the Native-Contaminated condition, negative difference scores would indicate an understanding that the contaminated food should be avoided (e.g., they want to eat it less after seeing the contamination). Although older children's difference scores were significantly below zero (7- to 8-year-olds: *M* = -.83, *SD* = 1.4, *t*(23) = 2.91, *p* = .008; 9- to 11-year-olds: *M* = -1.6, *SD* = .82, *t*(19) = 8.72, *p* < .001), younger children did not change their willingness to try the food after seeing it be contaminated (3- to 4-year-olds: *M* = .11, *SD* = .99, *t*(18) = .46, *p* = .65; 5- to 6-year-olds: *M* = -.44, *SD* = 1.39, *t*(24) = 1.59, *p* = .13). Thus, younger children appear to be willing to try food eaten by a Native speaker, regardless of whether it is clean or contaminated, but older children understand that the contaminated food should be avoided.

If children's food choices are generally driven by the presence versus absence of contamination, then they should be willing to eat clean foods, even when those foods are presented by a foreign speaker. Indeed, similar to our results in the Native-Clean condition, children's willingness to try food in the Foreign-Clean condition did not significantly differ from zero at any age group (3- to 4-year-olds: *M* = -.33, *SD* = .97, *t*(20) = 1.58, *p* = .13; 5- to 6-year-olds: *M* = -.05, *SD* = 1.28, *t*(20) = .17, *p* = .87; 7- to 8-year-olds: *M* = .19, *SD* = .87, *t*(20) = 1.0, *p* = .33; 9- to 11-year-olds: *M* = .10, *SD* = 1.17, *t*(19) = .38, *p* = .71). Therefore, although children may prefer to follow the preferences of ingroup members when made to choose between a food eaten by an ingroup member and a food eaten by an outgroup member (e.g., Fraizer et al., 2012; Shutts et al., 2009), without this forced-choice context, children appear equally likely to try food associated with an ingroup or outgroup member, as long as it is clean.

Finally, because the Foreign-Contaminated condition involves both contaminated food and a foreign speaker, it may be the most likely food for children to avoid. In fact, children across all age groups in the Foreign-Contaminated condition were significantly (or marginally, in the case of 5- to 6-year-olds) less willing to try the food at test compared to baseline (3- to 4-year-olds: *M* = -1.2, *SD* = 1.47, *t*(18) = 3.58, *p* = .002; 5- to 6-year-olds: *M* = -.63, *SD* = 1.79, *t*(23) = 1.71, *p* = .10; 7- to 8-year-olds: *M* = -.92, *SD* = 1.61, *t*(23) = 2.78, *p* = .01; 9- to 11-year-olds: *M* = -.91, *SD* = 1.2, *t*(21) = 3.58, *p* = .002). Comparing these results to the Native-Contaminated condition, younger children (3- to 6-year-olds) are better at avoiding contaminated food when the contamination comes from a foreign language speaker than when it comes from a native language speaker.

Next, we measured children's rating of how germy the food was, depending on the condition (See Table 1 for average germiness ratings across all conditions).

Table 1. Average germiness ratings across all conditions within each predetermined age group.



		M	*SD*
English Clean	3 to 4	1.60	1.10
	5 to 6	1.64	1.14
	7 to 8	1.05	.86
	9 to 11	1.52	.81
English Contaminated	3 to 4	1.58	1.07
	5 to 6	1.84	1.07
	7 to 8	2.13	.90
	9 to 11	2.5	.61
Russian Clean	3 to 4	1.52	1.36
	5 to 6	1.19	1.33
	7 to 8	1.38	.86
	9 to 11	1.8	.83
Russian Contaminated	3 to 4	2.26	1.24
	5 to 6	1.96	1.08
	7 to 8	1.79	.93
	9 to 11	2.27	.70

To test this, we ran a multiple linear regression to measure whether the age of the participant (continuous in years), the language spoken by the actor (English vs. Russian), and the type of food (Clean vs. Contaminated) predicted germiness ratings. Although there were no significant main effects of age ($b = -.04$, $p = .35$) or language ($b = .02$, $p = .89$) on germiness ratings, results revealed a significant main effect of food type ($b = .56$, $p < .001$), such that children rated contaminated foods as significantly germier ($M = 2.03$; $SD = .99$) than clean foods ($M = 1.46$; $SD = 1.06$; $t(342) = 5.18$; $p < .001$). However, this significant main effect of food type was qualified by a significant two-way interaction of age and food type ($b = .20$, $p = .002$), and a significant three-way interaction of age, language, and food type ($b = -.24$, $p = .009$; See Figure 4c). These interactions reveal that younger children rated contaminated foods as less germy than older children, particularly when the food was contaminated by a native speaker. In fact, younger children (3- to 6-year-olds) only appear to understand that contaminated food is germy when it is contaminated by a foreign speaker. That is, they rated the Foreign-Contaminated food as germier than the Foreign-Clean food ($t(83) = 2.72$, $p = .008$), but rated the Native-Contaminated food as equally germy to the Native-Clean food ($t(84) = .46$, $p = .64$). On the other hand, older children (7- to 11-year-olds) rated contaminated food as germier than clean food regardless of whether the speaker who ate the food was native ($t(84) = 5.65$, $p < .001$) or foreign ($t(85) = 2.36$, $p = .02$).

Finally, we measured whether children thought eating the food was likely to make them sick, based on whether it was presented by an actor speaking English or Russian, and whether it was clean or contaminated. Similar to the previous studies, we conducted binomial probability tests comparing the number of participants who indicated that they thought the food would get them sick if they ate it. Overall, children did not think clean food would make them sick (Native-Clean: $n = 44$ of 84, binomial $p = .74$; Foreign-Clean: n

= 36 of 83, binomial $p > .99$). On the other hand, children were above chance at reporting that the contaminated food would make them sick regardless of language condition (Native-Contaminated: $n = 63$ of 88, binomial $p < .001$; Foreign-Contaminated: $n = 68$ of 89, binomial $p < .001$). Because a logistic regression on children's responses with age as a predictor revealed a significant effect of age ($b = .09$, $p = .048$), we examined each of our predetermined age groups separately. Older children (7- to 11-year-olds) were above chance at reporting that a contaminated food would make them sick regardless of the identity of the contaminator (7- to 8-year-olds: Native-Contaminated: $n = 18$ of 24, binomial $p = .02$; Foreign-Contaminated: $n = 20$ of 24, binomial $p = .002$; 9- to 11-year-olds: Native-Contaminated: $n = 20$ of 20, binomial $p < .001$; Foreign-Contaminated: $n = 16$ of 22, binomial $p = .052$). 5- to 6-year-olds reported that contaminated foods from a foreign speaker would make them sick ($n = 20$ of 24; binomial $p = .002$), but were at chance when asked about contaminated foods from a native speaker ($n = 17$ of 25, binomial $p = .11$). The youngest children, 3- to 4-year-olds, did not understand that contaminated food could make them sick, regardless of whether the contamination was from a native ($n = 8$ of 19, binomial $p > .99$) or foreign ($n = 12$ of 19, binomial $p = .36$) speaker.

XI. Discussion

In Study 3, we aimed to remove the forced-choice element of our previous studies in order to see what was driving the results. Overall, children's willingness to try contaminated food significantly decreased from baseline, while children's willingness to try clean food did not differ significantly from zero. Therefore, children's food choices were driven by an active avoidance of contaminated foods (i.e., a decrease in willingness to try contaminated food), rather than an active approach towards clean foods (i.e., an increase in willingness to try clean food). Furthermore, we found that children's earlier ability to understand contamination from a foreign speaker (compared to a native speaker) persisted across multiple measures. In fact, children accurately avoided contaminated food from a foreign speaker starting from the youngest age group tested (3- to 4-year-olds), but did not avoid contaminated food from a native speaker until later in development, around 7 years of age. Thus, replicating our results from Studies 1 & 2, children were able to avoid contaminated foods earlier on when given the additional social cue of group membership, as opposed to only contamination information.

Importantly, while information on social group membership helps young children avoid contaminated foods from outgroup members, these same social cues may impede their ability to avoid contaminated foods from ingroup members. In fact, young children (3- to 6-year-olds) had more difficulty associating contaminated foods with germs when the contamination came from a native speaker, compared to a foreign speaker. And, 5- to 6-year-olds performed at chance when asked whether eating Native-Contaminated food would make them sick, but understood that eating Foreign-Contaminated food would. In fact, it was only after 7 years of age that children consistently rated contaminated foods as (1) germier, (2) more likely to make you sick, and (3) something to avoid, regardless of whether it came from a native or foreign speaker.

Replicating results from Studies 1 & 2, our findings indicate that children lack a mature understanding of contamination until at least 7-years-old, and likely do not possess a fully-formed biological model of contamination until around that time (Carey, 1985a; Kalish, 1999). Until then, young children may use available social cues to inform their food choices, looking to ingroup members when deciding whether to try a snack.

XII. General Discussion

Across the three studies, we found that children's reasoning about contamination was impacted by the social identity of the person contaminating the food. Specifically, children exhibited an early understanding that contaminated food was germy and could make them sick, when the contamination came from a foreign speaker, but were less adept at reasoning about contamination from a native speaker. Indeed, by 3 years of age, children rated contaminated food as germy (Studies 1 & 3), and were better able to report that they should avoid eating that food (Study 3) when the contamination came from a foreign speaker. On the other hand, when a native speaker contaminated her food and then offered it, children were not as sophisticated in their understanding of contamination. Although children could report that contaminated food from a native speaker was germy and likely to make them sick, by age 5 (Study 2) or 7 (Study 3), they did not accurately avoid it until later in development (around 7-years-old in Study 3, and 9-years-old in Study 2).

If children understand that contaminated food (from a native speaker) is germy and more likely to make them sick, why do they not avoid it? One possibility is that when making food choices, children are more attentive to social cues than they are to contamination. Indeed, previous work has highlighted the sociality of food: culture constrains food choice (e.g., Fischler, 1988; Millstone & Lang, 2002; Rozin & Rozin, 1981), and eating together can convey and build trust and intimacy (Miller, Rozin, & Fiske, 2009; Wooley & Fishbach, 2019). In the same vein, the social identity of the person offering the food has an impact on eating behaviors: infants and children are more likely to accept novel foods offered by their mothers compared to strangers (Harper & Sanders, 1975), children eat more unfamiliar food if the food is endorsed by their peers (Greenhalgh et al., 2009), and children are more likely to eat foods offered by people of their own gender, age, and language background (e.g., Hendy & Raudenbush, 2000; Frazier et al., 2012; Shutts et al., 2009). Here, we replicate the finding that children are drawn to foods liked by native speakers: children found it more difficult to avoid contamination when the food was associated with a member of their social group.

In addition to the general draw that children may feel towards foods associated with their own group, children may have a harder time avoiding contamination from ingroup compared to outgroup members because of a behavioral immune system. For example, researchers have proposed that humans may have evolved specific psychological adaptations that facilitate negative perceptions and avoidance of outgroup members, due to the possibility that foreign outgroup members could be carriers of novel pathogens and parasites (Faulkner et al, 2004; Kurzban & Leary, 2001). Past ecological work supports this: long-term field studies of host-pathogen relationships show an engaged process of coevolution between local parasites and hosts, but not with parasites from outside ecologies (Thompson et al., 1997; Thompson & Burdon, 1992). In the human biological immune system, individuals exhibit increased immunological responses to local pathogens, but are vulnerable to foreign parasites due to the lack of coevolution within the same ecological community (Thompson, 1999). As a result, newly introduced pathogens can be extremely harmful to a host, and researchers have proposed that our evolved behavioral immune system may facilitate an avoidance of these potentially fatal pathogens. According to this theory, humans may have psychological adaptations to see contamination from foreign speakers as relatively more harmful, leading people to be more capable of actively avoiding contamination from people outside of one's own cultural group.

Our research opens up many interesting future questions to consider. In the current studies, all questions were hypothetical in nature and were asked after children watched videos of actors trying foods. Future research should incorporate an actual food choice paradigm to better capture the mechanisms through which children decide to approach or avoid contaminated foods. For example, measuring differences in the amount of food actually eaten, as well as facial expressions during consumption, could tell us more about differences in appetite or disgust as a function of contamination (clean vs. contaminated) and group membership (native vs. foreign; see DeJesus et al., 2015). For example, emotional elements may play a role in children's food choices, in which case children may show more disgust when a foreign speaker contaminates her food. Furthermore, while we were able to ask children questions that gauged their knowledge of germs and illness in relation to contaminated foods, our methodologies did not capture the causal processes in which children incorporate these concepts before deciding which foods to eat. For example, do children understand that contamination is caused by a transfer of germs and that these germs themselves are what can make them potentially ill? Future research should incorporate a design in which children's causal explanations can be examined in order to better illuminate the process through which children learn and reason about contamination (see Legare, Wellman, & Gelman, 2009). One possible way to do this is by separating a fictional story about contamination into separate components (e.g., contamination, germs, illness) and randomly assigning participants to hear only certain parts of the story (e.g., contamination and germs, germs and illness, contamination and illness, all three parts). Afterwards, by asking children to explain what happened before or predict what would happen after these events, we can gain a better understanding of how children reason about the role of germs in contamination and illness across development.

Overall, our studies highlight the significant impact of social factors on children's reasoning about food, including behaviors relevant for avoiding contamination.

Furthermore, by asking about germs and illness, we were able to rule out the possibility that children's failure to avoid contaminated foods was due to a lack of awareness that contaminated food contains more germs. Even when children can report that a contaminated food is germy, they do not always report that they would avoid eating the food.

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 regards to social identity and intergroup processes. By examining food within a social context, we can gain a better understanding of how we learn which foods to eat and avoid, and also how we use food to affiliate with others and establish ourselves within our social world.

References

1. Addessi E., Galloway A., Visalberghi E., & Birch L. L. (2005). Specific social influences on the acceptance of novel foods in 2-5-year-old children. Appetite; 45: 264–271.

2. Anderson, E. N. (2005). Everyone eats: Understanding food and culture. New York: New York University Press.

3. Au, T. K., Siddle, A. L., & Rollins, K. B. (1993). Developing an intuitive understanding of conservation and contamination: Invisible particles as a plausible mechanism. *Developmental Psychology*, 29, 286–299.

4. Bevelander K. E., Anschütz D. J., & Engels R. C. (2013). Social norms in food intake among normal weight and overweight children. *Appetite*, 58 (3), pp. 864-872.

5. Birch, L., Fisher, J., & Grimm-Thomas, K. (1999). Children and food. M. Siegal, C.C. Peterson (Eds.), *Children's understanding of biology and health*, Cambridge University Press, Cambridge, England pp. 161-182.

6. Cashdan, E. (1994). A sensitive period for learning about food. *Human Nature*, 5(3), 279-291.

7. Centers for Disease Control and Prevention, (2019).

8. Cruwys, T., Bevelander, K. E., & Hermans, R. (2015). Social modeling of eating: A review of when and why social influence affects food intake and choice. *Appetite*. 86. 3-18.

9. DeJesus J. M., Shutts K., & Kinzler K. D. (2015). Eww she sneezed! Contamination context affects children's food preferences and consumption. *Appetite*. 2014; 87: 303-9.

10. Faulkner, J., Schaller, M., Park, J. H., & Duncan, L. A. (2004). Evolved disease-avoidance mechanisms and contemporary xenophobic attitudes. *Group Processes & Intergroup Relations*, 7, 333–353.

11. Fischler, C. (1988). Food, self and identity. Information (International Social Science Council), 27(2), 275–292.

12. Frazier, B. N., Gelman, S. A., Kaciroti, N., Russell, J. W., & Lumeng, J. C. (2012). I'll have what she's having: the impact of model characteristics on children's food choices. *Developmental Science*, 15(1), 87-98.

13. Greenhalgh, J., Dowey, A. J., Horne, P. J., Lowe, C. F., Griffiths, J. H., & Whitaker, C. J. (2009). Positive and negative peer modeling effects on young children’s consumption of novel blue foods. *Appetite*, 52, 646–653.

14. Grunfeld, I. (1975). Dietary Laws Regarding Plants and Vegetables, with Particular Reference to the Produce of the Holy Land. Soncino Press, London.

15. Hamlin, K. J. & Wynn, K. (2012). Who knows what's good to eat? Infants fail to match the food preferences of antisocial others. *Cognitive Development*, Volume 27, Issue 3.

16. Harper, L. V. & Sanders, K. M. (1975). The effect of adults' eating on young children's acceptance of unfamiliar foods. *Journal of Experimental Child Psychology*, 20, 206–214.

17. Hendy, H. M. & Raudenbush, B. (2000). Effectiveness of teacher modeling to encourage food acceptance in preschool children. *Appetite*, 33, pp. 1-16.

18. Kalish, C. W. (1999). What young children know about contamination and contagion and what that tells us about their concepts of illness. In M. Siegal & C. C. Peterson (Eds.), *Children's understanding of biology and health* (pp. 99–130). New York: Cambridge University Press.

19. Kalish, C. W. (1996). Preschoolers' understanding of germs as invisible mechanisms. *Cognitive Development*, 11(1), 83-106.

20. Kinzler, K., Dupoux, E., & Spelke, E. (2007). The Native Language of Social Cognition. Proceedings of the National Academy of Sciences of the United States of America. 104. 12577-80.

21. Korsmeyer, S. (2005). The Taste Culture Reader: Experiencing Food and Drink, 2nd edition. New York: Bloomsbury, 2016.

22. Kurzban, R. & Leary, M. R. (2001). Evolutionary origins of stigmatization: The functions of social exclusion. *Psychological Bulletin*, 123, 187-208.

23. Legare, C. H., Wellman, H. M., & Gelman, S. A. (2008). Evidence for an explanation advantage in naïve biological reasoning. *Cognitive Psychology*, 58(2), 177-94.

24. Liberman, Z., Woodward, A., Sullivan, K. R., & Kinzler, K. D. (2016). Early emerging system for reasoning about the social nature of food. Proceedings of the National Academy of Sciences of the United States of America. 113.

25. Miller, L., Rozin, P., & Fiske, A. P. (1998). Food sharing and feeding another person suggest intimacy; two studies of American college students. *European Journal of Social Psychology*, 28, 423–436.

26. Millstone, E. & Lang (2002). The atlas of food: who eats what, where, and why. Berkeley, Calif.: University of California Press.

27. Oaten, M., Stevenson, R. J., & Case, T. I. (2009). Disgust as a disease-avoidance mechanism. *Psychological Bulletin*, 135(2), 303-321.

28. Rozin, P. (1976). The selection of foods by rats, humans, and other animals. In J. Rosenblatt, R. A. Hinde, C. Beer & E. Shaw (Eds.), *Advances in the Study of Behavior* (Vol. 6). New York: Academic Press.

29. Rozin, P., & Fallon, A. E. (1980). The psychological categorization of foods and non foods: A preliminary taxonomy of food rejections. *Appetite*, 1, 193-201.

30. Rozin, P. & Kalat, J. W. (1971). Specific hungers and poison avoidance as adaptive specializations of learning. *Psychological Review*, 78,459-486.

31. Rozin, P., Millman, L., & Nemeroff, C. (1986). Operation of the Laws of Sympathetic Magic in Disgust and Other Domains. *Journal of Personality and Social Psychology*. 50. 703-712.

32. Rozin, E. & Rozin, P. (1981). Culinary themes and variations. *Natural History*, 90(2), 6-14.

33. Rozin, P., Fallon, A., & Augustoni-Ziskind, M. L. (1985). The Child's Conception of Food. The Development of Contamination Sensitivity to "Disgusting" Substances. *Developmental Psychology*. 21. 1075-1079.

34. Shutts, K., Kinzler, K. D., McKee, C., & Spelke, E. (2009). Social Information Guides Infants' Selection of Foods. *Journal of Cognition and Development*, 10:1-2, 1-17.

35. Siegal, M. (1988). Children's Knowledge of Contagion and Contamination as Causes of Illness. *Child Development*, 59(5), 1353-1359.

36. Siegal, M., Fadda, R., & Overton, P. G. (2011). Contamination sensitivity and the development of disease-avoidant behaviour. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, 366(1583), 3427-32.

37. Springer, K. & Belk, A. (1994). The role of physical contact and association in early contamination sensitivity. Developme*ntal Psychology*, 30, 864-868.

38. Thompson, J. N. (1999). Specific hypotheses on the geographic mosaic of coevolution. *American Naturalist*, 153, S1-S14.

39. Thompson, J. N. & Burdon, J. J. (1992). Gene-for-gene coevolution between plants and parasites. *Nature* (London) 360:121–125.

40. Thompson, J. N., Cunningham, B. M., Segraves, K. A., Althoff, D. M., & Wagner, D. (1997). Plant polyploidy and insect/plant interactions. *American Naturalist* 150: 730–743.

Appendix

Study 1 & 2 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)?

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! OK. 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 2: Using these pictures, can your point to how germy you think this food (left) is?

Question 3 Can you point to how germy you think this food (right) is?

Question 4: Which food would be more likely to make you feel sick if you ate it? This one (left) or this one (right)?

Question 5: Do you remember who sneezed in her food?

Study 3 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)]

OK. 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?

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! OK. So, which circle means something is not germy? Which circle means something is really germy?

Question 3: Using these pictures, can you tell me how germy Sara’s snack is?

Question 4: Do you think eating Sara’s snack would make you sick?