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Research report

Eww she sneezed! Contamination context affects children's food preferences and consumption ☆

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A B S T R A C T

Does contextual information about disgust influence children's food consumption and subjective experience of taste? Three- to eight-year-old children ($N = 60$) were presented with two identical foods, yet children were led to believe that one food had been contaminated by sneezing and licking, while the other was clean. When given the opportunity to eat the foods, 5- to 8-year-old children consumed more clean food and rated the clean food's taste more positively; younger children did not distinguish between the foods. The relation between contamination and subjective taste held even among children who ate both foods and had direct evidence that they were identical. These data indicate that children's consumption behavior and food preferences are influenced by information external to foods themselves.

Introduction

Food preferences vary widely across cultures. Substances that are viewed as staples or delicacies in some cultures are sometimes considered disgusting and unacceptable to eat in others. For example, insects are part of the daily diet in some cultures, but other cultures treat the consumption of insects as revolting (Van Huis et al., 2013). Moreover, religious prohibitions of particular foods (e.g., pork, shellfish) are often justified on the basis of cleanliness: Observant members of some religious groups abstain from eating the flesh of animals that are considered to be unclean in order to avoid contamination, whereas people from different religious or cultural backgrounds regularly eat those same foods and do not find them offensive (Rozin, Haidt, & McCauley, 2000). Given that people from different cultures are presumably not born with radically different gustatory systems, adapting one's own taste preferences and food choices to match those endorsed by one's culture is an important problem of development.

The present research explores the impact of context – any information external to a food itself and not related to the food's actual ingredients or composition – on children's evaluation and consumption of foods. In this case, children learned that one food had been ostensibly contaminated. Critically, the foods presented to children showed no visible signs of contamination, thus allowing us to test the impact of a disgust context on children's consideration of otherwise identical foods.

Previous research provides ample evidence that children are sensitive to the sensory properties of foods. Beginning as newborns, children like foods that are sweet and salty and dislike foods that are sour and bitter (Birch, 1990, 1999; Desor, Maller, & Turner, 1973; Mennella, Lukasewycz, Griffith, & Beauchamp, 2011; Ventura & Mennella, 2011). The same innate taste biases are observed across cultures and may have evolved to encourage consumption of high-calorie foods that are beneficial for early physical growth (Birch, 1999; Coldwell, Oswald, & Reed, 2009; Ventura & Mennella, 2011). In addition to innate taste biases, infants' and children's preferences are guided by a bias for familiar flavors (Aldridge, Dovey, & Halford, 2009; Hausner, Nicklaus, Issanchou, Mølgaard, & Møller, 2010; Mennella, Jagnow, & Beauchamp, 2001). For example, infants prefer flavors to which they have been exposed prenatally (Mennella et al., 2001; see also Hausner et al., 2010), and children are more likely to eat a food whose flavor matches one they have experienced before (Birch & Marlin, 1982; Liem & de Graaf, 2004; Liem & Mennella, 2002).

Nonetheless, sensory properties alone do not always provide sufficient information to decide if something is good to eat. For example, edible plants and mushrooms can look similar to poisonous ones, especially to naïve foragers. Ingesting various items in order to discover which substances are safe and which are dangerous could therefore expose the body to unpleasant or even lethal consequences (see Wertz

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& Wynn, 2014a, 2014b). Furthermore, foods that are prohibited by particular cultural or religious norms might share many overlapping sensory properties with foods that are considered appropriate to eat (e.g., beef vs. pork for Muslims vs. Hindus), so missing key pieces of cultural knowledge could leave individuals open to errors and penalties from their cultural group. In these situations, contextual information is necessary to discern what is safe or acceptable to eat from what is dangerous or unacceptable to eat. As such, attending to the environment in which a food is presented, the reaction of a person after eating a food, or the group membership of the person eating a food might all be useful strategies when learning what to eat.

For adults, it is clear that contextual information (including social, political, and religious knowledge) influences food selection and taste preferences; this influence is observed in adults' behavior and neural response to foods (e.g., Bohannon, Goldstein, & Herschkowitsch, 2010; De Araujo, Rolls, Velazco, Margot, & Cayeux, 2005; Herman, Roth, & Polivy, 2003; Lee, Frederick, & Ariely, 2006; McClure et al., 2004; McFerran, Dahl, Fitzsimons, & Morales, 2010; Morrot, Brochet, & Dubourdieu, 2001; Rozin et al., 2000). Yet, prior research with children suggests that learning what foods to avoid might occur over a protracted period of development. As illustration, children younger than two years of age are more likely than any other age group to accidentally ingest toxic substances (Cashdan, 1994). Research by Rozin and colleagues suggests that reasoning about contaminated, disgusting, or dangerous foods requires children to understand the presence and operation of invisible entities – a notion that might be particularly difficult for young children to comprehend (e.g., Rozin & Fallon, 1987). For instance, when presented with vignettes describing events that could contaminate a glass of juice (e.g., introducing a bug, hair, or poison), 3- to 5-year-old children were willing to endorse the juice as acceptable to drink if the contaminating item was simply removed. Older children and adults were less likely to endorse the juice as safe to drink and many maintained this belief even after the glass had been washed (Fallon, Rozin, & Pliner, 1984). In a related series of demonstrations, children under five years of age were sometimes willing to eat disgusting substances or contaminated items (e.g., imitation feces made from limburger cheese and peanut butter or juice containing a human hair; Rozin, Fallon, & Augustoni-Ziskind, 1985; Rozin, Hammer, Oster, Horowitz, & Marmora, 1986).

While studies on the development of disgust find that young children fail to use important contextual cues to guide their eating behavior and evaluation of foods, research in domains outside of the disgust literature suggests that, in some situations, young children are sensitive to contextual information when approaching foods. Researchers interested in social cognition and marketing have found that context can influence children's eating behavior and evaluations of foods in the preschool and early school years. Specifically, the presence of social partners or the behaviors of social models influences children's food choices. For instance, increasing social interaction while eating (e.g., providing positive attention from caregivers or manipulating the size or composition of a participating peer group) increases infants' and children's food consumption (Lumeng & Hillman, 2007; Lumeng, Patil, & Blass, 2007; Salvy, Vartanian, Coelho, Jarrin, & Pliner, 2008). Additionally, children look to social models for input when deciding whether to eat an unfamiliar or previously disliked food (Addessi, Galloway, Visalberghi, & Birch, 2005; Birch, 1980; Birch, Zimmerman, & Hind, 1980; Greenhalgh et al., 2009; Harper & Sanders, 1975), and they are particularly swayed by models whose social group membership (e.g., gender or age) matches their own (Birch et al., 1980; Duncker, 1938; Frazier, Gelman, Kaciroti, Russell, & Lumeng, 2012; Hendy & Raudenbush, 2000; Shutts, Banaji, & Spelke, 2010). Related research conducted in the field of food marketing suggests that children prefer foods whose packaging features familiar brand labels (e.g., McDonald's) and pictures of popular cartoon characters (e.g., characters from *Sesame Street*) to foods that are not accompanied by familiar brands or popular characters (Kotler, Schiffman, & Hanson, 2012; Lapierre, Vaala, & Linebarger, 2011; Levin & Levin, 2010; Roberto, Baik, Harris, & Brownell, 2010; Robinson, Borzekowski, Matheson, & Kraemer, 2007).

The present research investigated 3- to 8-year-old children's food consumption and evaluation of taste for ostensibly clean versus contaminated foods. Past studies examining children's understanding of contamination have typically presented children with single foods in isolation, often in situations where the foods' actual physical properties differ (e.g., Rozin et al., 1985; Rozin et al., 1986; Stevenson, Oaten, Case, Repacholi, & Wagland, 2010) or have elicited hypothetical judgments rather than providing children with real foods to taste (e.g., Au, Sidle, & Rollins, 1993; Fallon et al., 1984). The current method employs insights gained from both the social cognition and food marketing literatures: Here we provide children with an opportunity to compare clean and contaminated foods that have identical physical properties to one another, and then we measure children's evaluation and actual consumption of real foods. Our method may more sensitively assess children's avoidance of contaminated foods and could shed light on how different contexts can alter children's eating behavior and attitudes about foods.

In the present study, we manipulated whether foods appeared to be clean or contaminated: Children watched videos in which two actors each ate and positively endorsed a food; one actor also contaminated her food by sneezing in it. Then, the two actors appeared to hand the foods directly to the child, creating the illusion that participants could actually eat the same foods they saw offered by the actors onscreen. Clean and contaminated foods featured the same substance (applesauce, a generally familiar and appealing food), thus any differences in children's consumption or evaluations could not be driven by intrinsic properties of the foods.

Method

Participants

Participants included 60 children (28 boys, 32 girls; $M = 5.92$ years, range = 3.15–8.61 years) from the Chicago area. There were 20 children in each of three age groups: 3- to 4-year-olds, 5- to 6-year-olds, and 7- to 8-year-olds. Children were excluded if they did not want to complete the full study ($N = 4$) or if their parents interfered with the study (e.g., encouraged or discouraged children from eating; $N = 2$).

Parents of participants were asked to report at what time their child had last eaten, how much their child liked applesauce, and how often their child ate applesauce. All but one parent completed this questionnaire.

Materials and procedure

Upon entering the testing room, the experimenter introduced participants to a video of two female actors whose images were projected onto a large screen (172 cm × 61 cm). Pre-recorded videos showed each actor seated at a table with a bowl and spoon in front of her; one bowl was red and the other was blue. The experimenter introduced the actors and the procedure to the participant, saying, "You are going to see them try some snacks, and then you will get a chance to try the same snacks yourself."

Children then watched familiarization videos in which each actor (in sequential order) ate the food in front of her. Both actors appeared to enjoy the food they ate; they both smiled and said, "Mmm! Maybe you want to try some." One actor put an unused spoon into her bowl after eating, saying, "Here is a new spoon for you." The other actor licked her spoon, sneezed into her bowl, and put her used spoon into her bowl after eating, saying, "I'll leave my spoon

Fig. 1. Still frames of video presentation. One actor ate her food from a blue bowl and did not sneeze (Frame 1); the other actor ate her food from a red bowl and sneezed into the bowl (Frame 2). Each actor handed her bowl forward (Frame 3) and remained on screen for the remainder of the session (Frame 4).

in here for you." Each familiarization video played for approximately 15 s. Children then saw a final video in which both actors lowered their bowls toward the bottom of the screen (see Fig. 1).

In the testing room, a white foam core box sat on a large table in front of the screen. The box was situated such that, from the participant's perspective, the actors in the video appeared to lower their bowls into the box. The red and blue bowls shown onscreen were hidden inside the box and were each loaded with a single-serving cup (approximately 111 grams) of Mott's® Natural Applesauce and a plastic spoon. A still frame of both actors (without their bowls) remained onscreen for the remainder of the session.

After the bowl-lowering event, the experimenter opened the box to reveal bowls that were identical to those in the videos (see Fig. 2). The bowls were attached to a tray that sat on top of a track, which enabled the experimenter to push the tray forward toward the participant. The experimenter pushed the foods toward the child and said, "Go ahead and try what you want." Children were given 30 s to try the foods. The experimenter sat in the back of the room and read a magazine while the child ate. If children questioned the experimenter or commented about the foods, the experimenter responded neutrally by saying, "ok" or "you can do whatever you want," and did not encourage or discourage children from eating either food.

After 30 s, children were asked to evaluate the foods. All participants were asked to indicate which food was "more yummy." If children responded that the foods tasted the same, this answer was also accepted. Next, participants rated each food on a 5-point Likert scale composed of cartoon faces with different expressions that increased in positivity from left ("not yummy at all") to right ("really really yummy").

After answering the evaluation questions, children were allowed to continue eating until they told the experimenter they were finished. Test sessions were videotaped so that children's eating behavior could be coded offline.

Design

The lateral position and bowl color of the contaminating actor were counterbalanced across participants. Half of participants saw Actor A sneeze, while the other half saw Actor B sneeze. Test questions were presented in the same order to all participants and the experimenter always asked children to evaluate the bowl on the left first.

Results

Consumption

Six out of 60 participants did not consume either food (four 3- to 4-year-olds, two 5- to 6-year-olds). Among the remaining 54 participants who ate at least one food, 34 participants ate both foods (eleven 3- to 4-year-olds, fourteen 5- to 6-year-olds, and nine 7- to 8-year-olds), 17 ate only the clean food (two 3- to 4-year-olds, four 5- to 6-year-olds, and eleven 7- to 8-year-olds), and 3 ate only the contaminated food (3- to 4-year-olds only). Examining children's first bite taken, 5- to 6-year-olds and 7- to 8-year-olds were more likely to eat the clean food before the contaminated food (15/18 and 16/20 respectively; binomial test: $ps < .01$), but 3- to 4-year-olds were more likely to eat the contaminated food first (13/16; $p = .02$).[1]

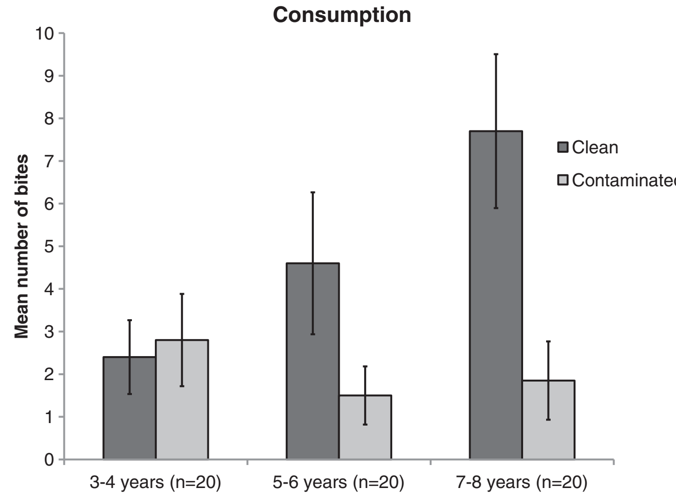

Fig. 3. Children's consumption by age group.

Children's consumption was measured as the number of bites they took of each food during the test session.[2] A repeated-measures ANOVA including food type as a within-subjects factor and age group and gender as between-subjects factors revealed a significant effect of food type (clean vs. contaminated), $F(1, 54) = 11.3$, $p = .001$, $\eta_p^2 = 0.17$, and a significant interaction between food type and age group, $F(2, 54) = 4.86$, $p = .01$, $\eta_p^2 = 0.15$. Children ate significantly more clean food than contaminated food ($M_{clean} = 4.9$ bites, $M_{contam} = 2.07$ bites), $t(59) = 3.17$, $p = .002$, $d = 0.41$. This effect held for 5- to 8-year-old children (5–6-years: $t(19) = 1.97$, $p = .06$, $d = 0.44$; 7–8-years: $t(19) = 3.18$, $p = .005$, $d = 0.71$), but not for 3- to 4-year-old children, $t(19) = -.49$, $p = .63$, $d = 0.11$ (see Fig. 3). Interestingly, the positive effect we observed among 5- to 8-year-old children was not driven exclusively by the participants who only ate a single food. Among 5- to 8-year-old children, the 23 children who sampled both foods ate more clean food than contaminated food ($M_{clean} = 4.26$ bites, $M_{contam} = 2.91$ bites), $t(22) = 2.47$, $p = .02$, $d = 0.52$. There was no main effect of gender or interaction between gender and food type on children's consumption, $p = .96$ and $.49$, respectively.

Evaluation

Forced-choice

Seven of the 60 participants responded that the foods tasted the same when asked which food was "more yummy" (two 3- to 4-year-olds, two 5- to 6-year-olds, three 7- to 8-year-olds). Among the 53 children who did select one food as more yummy, 5- to 8-year-old children selected the clean food (5- to 6-years: 16/18; 7- to 8-years: 14/17; binomial test: both $ps < .01$), while 3- to 4-year-old children showed no preference between the foods (7/18 chose clean, $p = .48$).

Fig. 2. Stimuli and box apparatus from the participant's view at test.

[1] Though we observed a significant difference in 3- to 4-year-old children's first choice (in favor of the contaminated food), they did not differentiate between the clean and contaminated foods for any other measure.

[2] We also measured children's consumption in grams for all but two of the participants. Grams and bites taken were highly correlated ($rs > .9$, $ps < .001$); consistent main results were observed if analyses were conducted using grams rather than bites.

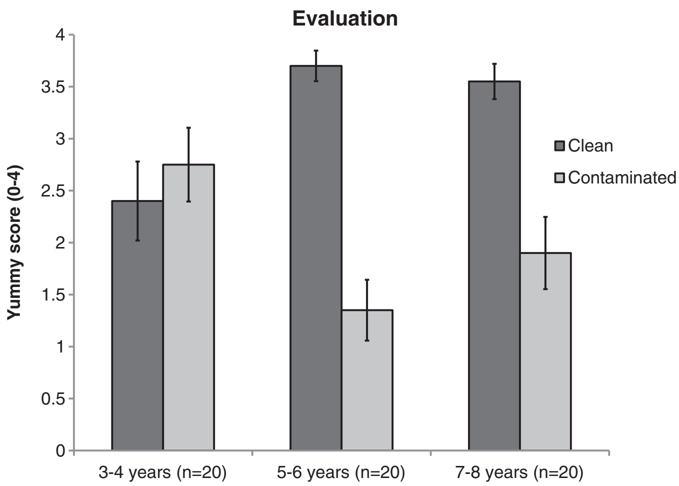

Fig. 4. Children's responses on the Likert evaluation scale by age group.

Scale ratings

A repeated-measures ANOVA including food type as a within-subjects factor and age group and gender as between-subjects factors revealed a significant effect of food type (clean vs. contaminated), $F(1, 54) = 24.3$, $p < .001$, $\eta_p^2 = 0.31$, and a significant interaction between food type and age group, $F(2, 54) = 12.5$, $p < .001$, $\eta_p^2 = 0.32$. Children rated clean foods as yummier than contaminated foods (min = 0, max = 4; $M_{clean} = 3.22$, $M_{contam} = 2.39$), $t(59) = 4.18$, $p < .001$, $d = 0.54$. This effect again held for participants in the older age groups (5- to 6-years: $t(19) = 6.32$, $p < .0001$, $d = 1.41$; 7- to 8-years: $t(19) = 4.28$, $p < .0001$, $d = 0.96$), but not for 3- to 4-year-old children, $t(19) = -.64$, $p = .53$, $d = 0.14$ (see Fig. 4).

To explore whether 5- to 8-year-old children's positive evaluation of clean foods held even among children who sampled both (identical) foods, we conducted a separate analysis on the scale ratings of 5- to 8-year-olds who ate both foods and found the same effects: Even children who ate both foods (and thus had actual sensory input providing evidence that the two foods were identical) rated the clean food as more yummy than the contaminated food ($M_{clean} = 3.61$, $M_{contam} = 2.17$), $t(22) = 3.98$, $p = .001$, $d = 0.83$. Again, we found no main effect of gender or interaction between gender and food type (clean vs. contaminated) on children's evaluations, $p = .98$ and .65, respectively.

Parent questionnaire

We asked parents to estimate how recently children had eaten before they arrived for their appointment. Three parents did not report when their child had last eaten and two children had fasted overnight (and thus were excluded from analyses as outliers). Children on average had not eaten for approximately two hours before test ($N = 55$, $M = 138$ minutes, $SE = 10.63$). Time fasted was not significantly correlated with the amount of clean ($r = 0.12$, $p = .37$) or contaminated ($r = 0.15$, $p = .27$) food that children consumed.

We also asked parents to indicate how much their children liked applesauce and how often they ate applesauce. Parents were provided with a 7-point scale for each question, ranging from "1 – hates applesauce" to "7 – loves applesauce" for liking and "1 – never" to "7 – daily" for frequency. When asked how much their children like applesauce, 52/59 chose "4" (neutral) or higher on the scale; among these, 25 chose "7" (loves applesauce). Additionally, 48/59 parents reported that their children ate applesauce at least occasionally ("4" or higher on the frequency scale). Although reported enjoyment of applesauce was correlated with reported frequency of eating ($r = 0.85$, $p < .001$), neither was significantly correlated with the amount of clean or contaminated food that children ate in the study ($ps > .18$) or with children's evaluations of clean and contaminated food in the study ($ps > .65$).

Discussion

Five- to 8-year-old children who were given two foods and led to believe one food was clean while another was contaminated ate more of the "clean" than the "contaminated" food, and also rated the former as yummier than the latter. Thus, children's food consumption and evaluations are sensitive to contextual information about contamination. The present research dovetails with previous evidence showing that contextual information can serve as a powerful guide to children's food consumption and evaluation, but extends past research in important ways. In the present study, children had the opportunity to consume and evaluate two real foods (rather than judging hypothetical food choices) that only differed on the basis of presented information about contamination. Children could choose whether or not to eat each food and the foods were identical and equally familiar to children, so the differences in children's consumption and evaluation documented here could not be based on any intrinsic properties of the foods. Instead of recruiting sensory information alone, 5- to 8-year-old children in the present research used contextual information (whether foods were supposedly clean or contaminated) to guide the amount of food they consumed and their evaluations of each food. These findings go beyond past research documenting the development of children's reasoning about contamination to show that subtle cues can effectively impact children's choice, consumption, and evaluation of otherwise identical foods.

The present research also provides converging evidence that children's sensitivity to contamination increases with age. While children between 5 and 8 years of age avoided contaminated foods and evaluated contaminated foods as tasting worse than clean foods, 3- and 4-year-old children did not differentiate between clean and contaminated foods in this study. How should the performance of the youngest participants be interpreted? One possibility is that 3- to 4-year-old children are not very sensitive to information about disgust and contamination. Understanding contamination requires that children realize that two perceptually similar items can be different and that nonvisible particles such as germs can be present and cause illness – and past research demonstrates that 3- and 4-year-old children find such concepts difficult to understand (Au et al., 1993; Fallon et al., 1984; Rozin et al., 1986; Stevenson et al., 2010). In light of these issues, the fact that foods looked identical at test may have made responding to them differently especially difficult. An alternative explanation for the performance of 3- and 4-year-old children here is that our method failed to detect young children's sensitivity to disgust information. For example, 3- and 4-year-old children may not have actually believed that the presented foods were the exact same foods eaten by the actors in the videos; in this case, they would have had no reason to prefer one food over the other. Yet, studies using a similar video presentation method have revealed discriminatory food selection behavior on the part of 12-month-old infants (Shutts, Kinzler, McKee, & Spelke, 2009), therefore we think it is likely that 3- and 4-year-old children in theory could have distinguished between the two foods in our displays. It is nonetheless possible that alternative measures or tasks could reveal evidence of disgust sensitivity earlier in development than we report here: As one example, 18-month-old to 6-year-old children avoid foods that have been in contact with a disliked food (Brown & Harris, 2012; Brown, Harris, Bell, & Lines, 2012). Thus, future research investigating the situations in which contamination sensitivity may emerge earlier than 5 years of age will be fruitful for future research.

Relatedly, future research is necessary to understand the scope of contexts that might either decrease or heighten children's sensitivity to contamination. For instance, asking children to fast before the test session, or providing an especially desirable contaminated food, may decrease children's motivation to avoid contaminated foods. The identity of the informant providing information about foods may also influence children's disgust sensitivity. Children may be more likely to avoid contaminated foods when information about the food's contamination has been provided by people that children know (e.g., parents or siblings) or by people that children view as members of their ingroup. Yet, previous research suggests that children accept foods that were eaten by peers, teachers, and people who share participants' social group membership, rather than less familiar individuals (e.g., Birch et al., 1980; Frazier et al., 2012; Hendy & Raudenbush, 2000; Salvy et al., 2008; Shutts et al., 2010; Shutts et al., 2009). Thus, children might be willing to overlook contamination information if it is presented in a supportive social context. Studies that investigate how different informants, foods, or states of satiety affect children's consumption and evaluations of clean and contaminated foods, and whether that impact differs across development, would be fruitful topics for future research.

The current approach may present opportunities for developmental psychologists to contribute to efforts to improve public health. Childhood obesity has increased at alarming rates in recent years and being overweight in childhood is linked to health concerns later in life (Cunningham, Kramer, & Narayan, 2014; Freedman et al., 2005; Nader et al., 2006; Ogden, Carroll, Curtin, Lamb, & Flegal, 2010), but basic research conducted by developmental psychologists has the potential to create new tools to address these issues. The methods used in this study may be especially useful to provide insight into children's developing beliefs about food and eating because they demonstrate that subtle manipulations could have important consequences for children's food choices. Even though both actors in the present study positively endorsed their foods and presented a familiar food that children typically like to eat (applesauce), children differentiated between clean and contaminated foods. As a further illustration of the subtleties in young children's reasoning, other research reveals that young children are capable of surprisingly sophisticated reasoning about nutrition and disease transmission when provided with a strong conceptual framework, which can in turn increase children's healthy behaviors, including eating healthy foods and sanitizing their hands before preparing meals (Au et al., 2008; Gripshover & Markman, 2013). Children's reliance on contextual information when consuming and evaluating foods might be similarly observed in contexts that promote healthy food choices, potentially resulting in an increase in children's intake and enjoyment of healthy foods.

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