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Have your cake, and your asparagus, too: Young children expect variety-seeking behavior from agents with diverse desires

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ABSTRACT

While adults robustly seek variety and expect others to do so, it is unclear whether children expect others to enjoy and preferentially choose variety in the domain of food. Seventy-nine children encountered an agent, depicted by a puppet, who liked two diverse foods. The children themselves liked only one of these foods. Older children (M = 5;11) expected this agent to be happier with, and to preferentially choose, a serving of both foods rather than a serving of a single food type, consistent with variety-seeking preferences. Five- and 6-year-olds can therefore simultaneously represent others' diverse desires as co-existing and causing preferences for variety over homogeneity. In contrast, younger children (M = 4;0) did not robustly attribute variety-seeking preferences to this agent. Predictions of variety-seeking food preferences may relate to children's developing theory of mind abilities and could be harnessed in nutritional interventions to improve children's diets.

1. Introduction

The adage that "variety is the spice of life" is evident in adults' preferences and choices. In the realm of consumer behavior, adults often favor variety when selecting artifacts and foods (Echelbarger & Gelman, 2017; Inman, 2001; Kahn, 1995; McAlister & Pessemier, 1982; Simonson, 1990). For instance, imagine deciding to purchase two apples and two oranges instead of four units of a single fruit: Such an action would indicate a preference for variety (i.e., diversity of items in a set) over a preference for one specific fruit type or for homogeneity in general. Preferences for variety can emerge from motivations such as an inherent enjoyment of novelty or protecting against changes in one's future circumstances or preferences via diversification (Simonson, 1990). Here, we use the term "variety-seeking" food preferences to indicate a desire to consume diverse food items in close temporal proximity, in the same sitting (see Kahn, 1995).

In the domain of food in particular, variety-seeking may be especially relevant and even beneficial. Specifically, variety-seeking supports procuring adequate levels of nutrients and calories. A diverse diet is crucial to obtaining the full range of vitamins and other dietary components (such as fiber) that are found in different kinds of foods (Falciglia, Couch, Gribble, Pabst, & Frank, 2000; Lafraire, Rioux, Giboreau, & Picard, 2016; Nicklaus, 2009). Food variety also combats the effects of sensory-specific satiety, a phenomenon that refers to the diminishing hedonic value of foods that have been recently consumed (Brondel et al., 2009; Inman, 2001) and has been documented in adults, children, and animals (Ostojic, Shaw, Cheke, & Clayton, 2013; Rolls et al., 1981; Temple, Giacomelli,

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Roemmich, & Epstein, 2008). Food variety therefore allows for the sustained enjoyment of meals and sufficient caloric intake, which is a notable concern for growing bodies (but can also contribute to over-eating and obesity; see Raynor & Epstein, 2001). Because of food variety's importance to childhood nutrition, conceptual (Gripshover & Markman, 2013) and behavioral (Dovey & Martin, 2012) interventions have attempted to increase children's interest in eating diverse foods. Additionally, children often encounter situations in which multiple food options can be eaten in the same sitting, leading to complex decisions such as whether to have smaller portions of several foods instead of a larger portion of a single food. Understanding the motivations underlying such choices can therefore help researchers understand children's food selection process in real-world settings (Nguyen, Girgis, & Robinson, 2015).

Previous research in the field of nutrition has focused on the extent to which children's own dietary variety changes across development and is influenced by various parental and child factors (Albuquerque et al., 2018; Carruth et al., 1998; Nicklaus, Chabanet, Boggio, & Issanchou, 2007; Scott, Chih, & Oddy, 2012; Skinner, Carruth, Bounds, Ziegler, & Reidy, 2002). However, little is known about the *cognitive factors* underpinning variety-seeking expectations in the domain of food or how these factors may differently affect behavior as children mature. This is a matter of particular importance given a growing interest in how cognitive factors relate to children's decision-making regarding food and how such factors may encourage or inhibit healthy choices (see Dial & Musher-Eizenman, 2019; Lafraire et al., 2016).

Our study investigates 3–6-year-old children's attributions of variety-seeking food preferences to others. Specifically, we present children with an agent, depicted by a puppet, who has "diverse" tastes and enjoys both a food the children like and also a food the children dislike. We test whether children expect this puppet to be happier with, and to preferentially choose, variety rather than homogeneity. Such a pattern would be in line with expectations of variety-seeking preferences. In what follows we review evidence regarding children's 1) variety-seeking in the domains of food and artifacts and 2) understanding of others' desires and how they relate to emotions and choices, with a special focus on cognitive factors such as theory of mind abilities.

1.1. Children's variety-seeking behavior and cognition

In the domain of food, there is little evidence regarding whether children hold variety-seeking preferences themselves, and we are aware of no evidence that children attribute such preferences to others. As argued convincingly by Echelbarger and Gelman (2017), studies that may seemingly suggest variety-seeking in children could actually reflect preferences for a single item that happens to be represented in a diverse set. For example, a child who likes carrots but not broccoli may choose a plate with both vegetables over a plate with only broccoli or another disliked vegetable, but such a choice would be driven by a preference for carrots rather than a preference for variety on its own. A genuine variety-seeking preference would only be clearly indicated if a child chooses a plate with carrots and also another equally-liked vegetable over a plate with only carrots.

Zampollo, Kniffin, Wansink, & Shimizu, 2012 asked children and adults to indicate the pictures "they like the most" out of several plating arrangements. Children generally preferred plates with six or seven food elements, whereas adults preferred plates with three food elements. Such choices could indicate that children hold strong variety-seeking preferences that exceed even those of adults but could alternatively indicate mere aesthetically-based variety preferences, or simply preferences for individual food elements that were only represented on the diverse plates. Presenting children with a greater variety of food options has been shown to increase preschoolers' (Roe, Meengs, Birch, & Rolls, 2013) and elementary schoolers' (Just, Lund, & Price, 2012) overall consumption of fruits and vegetables; such findings may be compatible with, but do not clearly indicate, a preference for variety over homogeneity, for reasons mentioned above. In fact, Roe et al. (2013) found some evidence against variety-seeking specifically, but Just et al. (2012) found evidence that variety itself increases fruit and vegetable consumption above and beyond the mere fact that the presence of larger sets of items increases the likelihood that a single set contains a preferred food.

In the domain of artifacts, Echelbarger and Gelman (2017) document that children hold strong variety-seeking preferences themselves and attribute such preferences to others. To our knowledge, this study is the first, and perhaps only, clear evidence of variety-seeking in children. Here, children and adults were presented with unfamiliar objects of different kinds, presented via arrays of color photographs, and were asked to make selections of two objects they would like for themselves (Study 1) or another person (Study 3). Participants' selections were judged to indicate variety preferences when they included one object each of two different kinds over two objects of the same kind. Overall, 4- and 5-year-olds generally chose variety (i.e., objects of different kinds rather than objects of the same kind) for both themselves and another person at rates significantly above chance. Six- and 7-year-olds, as well as older children and adults, showed an even more robust pattern of variety-seeking for themselves and others. Participants chose variety for themselves and others at similarly high rates. These results persuasively show that, in the absence of prior information about others' preferences or the objects themselves, children expect others to prefer variety over homogeneity in the domain of artifacts. However, they leave open the question of children's expectations about others' choices in a context in which 1) prior information about others' preferences regarding objects is given and 2) the objects themselves are well-known. Such a context commonly occurs in daily life, particularly with the domain of food. Additionally, how children will expect others to *react* upon being given homogenous or diverse options remains unknown.

In the present study, children are asked to reason about two agents' emotional reactions to being given specific food options and the agents' choices between these options. The foods in question are ones for which the children hold strong opinions themselves. Importantly, our task asks children to reason about other agents both when their opinions are congruent with the children's own preferences and when they are in conflict; one of the agents has opinions that diverge from those of the children. While young children show general capacities to reason about others' emotions, preferences, desires, and the connections between them, the act of reasoning about the emotional reactions and choices of agents with different preferences may be difficult, particularly given theory of mind limitations in the early childhood years.

1.2. Children's theory of mind regarding emotions and desires

Children as young as 3 understand that emotions follow from goals, preferences, and desires. They know that others are happy when they achieve their goals, namely obtaining objects or outcomes they desire and avoiding objects or outcomes they do not want, and sad when the opposite occurs (Stein & Levine, 1989; Yuill, 1984). Additionally, they understand that preferences and desires can differ across individuals and circumstances. For instance, finding a generally attractive object, such as a dog, will not make you satisfied if you are looking for your rabbit instead (Wellman & Woolley, 1990).

The understanding that people may hold diverging taste-based desires regarding the same object emerges prior to the understanding that people may hold diverging fact-based beliefs about it, with a majority of 3–5-year-olds succeeding on tasks regarding differing desires (Flavell, Flavell, Green, & Moses, 1990; Wellman & Liu, 2004). A basic understanding that others may hold different desires from one's own appears to emerge around the age of 18 months, at which point most children are able to suppress egocentric desires regarding food and give an adult a food she likes, such as broccoli, even when children dislike that food and prefer a different food for themselves (Repacholi & Gopnik, 1997). By the age of 3, children also understand how desires and preferences (which can be thought of as consistent, enduring desires) influence others' choices; in turn, choices serve as evidence for others' desires and preferences, including those which differ from children's own (Fawcett & Markson, 2010a; Kushnir, Xu, & Wellman, 2010; Ma & Xu, 2011). Taken together, these findings suggest that 3–6-year-olds should be able to predict others' emotions and choices based on information about their likes and dislikes.

However, studies with diverse methods have found that young children struggle to reason about others' desires, emotions, and goals under some conditions. For example, children younger than 5 mistakenly choose gifts for adults that align with their own age-related preferences (e.g., stickers) instead of choosing gifts that adults are likely to want (e.g., business cards) (Atance, Bélanger, & Meltzoff, 2010; Jin, Li, He, & Shen, 2018), although 5-year-olds generally succeed in such tasks. Children 5 and younger may fail to appropriately consider others' desires when predicting their emotions or goals, particularly for two individuals who have opposing desires regarding a single object (Pons, Harris, & de Rosnay, 2004) or for individuals whose desires are unusual or vastly different from their own (Moore et al., 1995; Rieffe, Terwogt, Koops, Stegge, & Oomen, 2001). Preschoolers often view unconventional opinions, such as a dislike of ice cream, as mistaken or "silly," indicating further difficulties with egocentrism (Holubar & Markman, 2013). The aforementioned findings indicate that 3- and 4-year-olds may struggle to reason about the agent with "diverse tastes" that children encounter in the present study. In particular, an agent who likes one food that a child likes, and also one food that a child dislikes, poses a mentalizing conundrum. Such an agent is both like and unlike the child in terms of desires, and accurately representing this agent's goals requires simultaneously representing desires that children may view as unlikely to be held by a single individual. Additionally, even with an accurate understanding of this agent's desires, it is unclear whether children would attribute variety-seeking preferences to this agent.

The current study focuses on children's mentalizing predictions regarding a puppet with diverse tastes. If children are egocentric (pattern 1), they should predict that this "diverse tastes" agent will choose, and be happy with, only the food the children themselves like. Alternatively, the agent's liking of a food that children dislike could cause children to view this agent as fundamentally different from themselves. If so, children should predict that this agent will choose, and be happy with, only the food the children themselves dislike (pattern 2). Both patterns indicate theory of mind difficulties when representing an agent's diverse desires. If children instead succeed at representing both of this agent's desires, two other patterns may occur. Children may view the agent as equally happy with, and likely to choose, a) the child's liked food, b) the child's disliked food, or c) a combination of both foods (pattern 3). Such a "variety-tolerant" pattern would be consistent with the agent's preferences. However, it would not reflect an expectation of variety-seeking preferences. Alternatively, children may view this agent as happiest with a combination of both foods and likeliest to choose this option (pattern 4). Our prediction was that only older children would expect such "variety-seeking" preferences.

2. Method

2.1. Overview

Participants were trained on a food rating scale (*Food Rating Training Task*) and then rated foods previously identified by their parents as ones the participants strongly liked or strongly disliked (*Participants' Own Food Ratings and Food Choice*). Based on these "super yucky" to "super yummy" ratings, one food was chosen as the child's "liked" food and one food was chosen as the child's "disliked" food. Participants were next introduced to two puppets (*Puppet Introduction and Memory Check*). One puppet, referred to here as Matched Tastes, assigned the same ratings to these two foods as the child, thus demonstrating similarity in preferences. Another puppet, referred to here as Diverse Tastes, assigned the child's highest rating to both foods, thus demonstrating similar opinions regarding the "liked" food but dissimilar opinions regarding the "disliked" food. In the key portion of the study (*Emotion Prediction and Food Choice Prediction*), participants predicted each puppet's emotional reactions to being given four pieces of the "liked" food, four pieces of the "disliked" food, or two pieces of each ("50/50"), and finally predicted which of these three options each puppet would select if given a single choice.

To better illustrate the labels we will use throughout the manuscript, please consider the following example of a real participant's choices. The participant assigned a "super yummy" rating to apples and a "super yucky" rating to green beans. Thus, apples were the child's "liked" food and green beans were the child's "disliked" food. The Matched Tastes puppet assigned a "super yummy" rating to apples and a "super yucky" rating to green beans, thus exactly matching the child's ratings. The Diverse Tastes puppet assigned a "super yummy" rating to apples and also a "super yummy" rating to green beans, thus matching the child's rating regarding the

"liked" food but diverging from the child's rating regarding the "disliked" food. (Please note that the "liked" and "disliked" labels are made in reference to the child's own ratings; the Diverse Tastes puppet claims to enjoy the "disliked" food.) The participant predicted each puppet's emotional reactions to being given four pieces of apples (the "liked" food), four pieces of green beans (the "disliked" food) or two pieces of apples and two pieces of green beans ("50/50"), and finally predicted which of these three options each puppet would select if given a single choice.

2.2. Participants

Participants included 20 three-year-olds (M_{age} = 42.95 months, SD = 3.75; 13 boys), 21 four-year-olds (M = 53.62, SD = 3.04; 12 boys), 19 five-year-olds (M = 66.16, SD = 2.97; 10 boys), and 19 six-year-olds (M = 76.79, SD = 3.33; 11 boys). This age range was chosen because children undergo major changes in theory of mind abilities throughout these years (Wellman & Liu, 2004). For the sake of analyses, data were combined into age bins of younger children (3- and 4-year-olds) and older children (5- and 6-year-olds), as was planned before testing began. Participants were recruited and tested at our research laboratory (n = 3) and at four sites charging admission or tuition fees: two children's museums (n = 58), a preschool (n = 9), and a children's activity fair (n = 9), all located in Connecticut. All parents provided informed consent for their children, who, in turn, expressed their willingness to participate. Unfortunately, individual-level demographic information about our participants was not collected. Based on our knowledge of our research sites, we believe our sample consisted of predominantly (but not exclusively) White children from middle- or upper-middle-income backgrounds. This study was conducted in accordance with Yale University's Institutional Review Board guidelines and adhered to international standards for human subjects protections.

Thirty-five additional participants (18 three-year-olds, 9 four-year-olds, 3 five-year-olds, and 5 six-year-olds) were excluded due to developmental delay (n = 1), sibling interference (n = 1), lack of English proficiency (n = 2), boredom (n = 2), examiner error (n = 3), never using "super yummy" and "super yucky" in their own food ratings (n = 16; 7 of these participants assigned similar ratings to all foods), or other difficulties answering their own food rating and selection questions (n = 7) or memory check questions about the puppets (n = 3). Participants were assigned to one of four study administration orders, which varied the presentation order of the foods during the study, which puppet was introduced first, and whether yellow or orange was associated with each puppet; similar numbers of participants received each order in each age group. Children's ratings of Diverse Tastes' responses to the three food combinations, which constitute our key variables of interest, were similar across presentation orders (all $ps > .29$).

2.3. Procedure

2.3.1. Parental food selection

Prior to the study session, participants' parents were presented with a list of 19 foods and asked to select two foods the participant strongly liked and two foods the participant strongly disliked. These four foods were presented in subsequent tasks. The list included a range of fruits, vegetables, desserts, and savory items (Fawcett & Markson, 2010b).

2.3.2. Food rating training task

Each participant was seated across the table from the experimenter and familiarized with a five-point "super yucky" to "super yummy" cartoon face scale, oriented horizontally, used previously with children as young as 3 (Carraway-Stage, Spangler, Borges, & Goodell, 2014). Three points of the scale ("super yummy," "just okay," and "super yucky") were verbally labeled and explained twice. Participants' comprehension was next assessed via requests to point to the image corresponding to these verbal labels. Participants who failed to correctly point to a given image after two additional attempts were excluded from the sample.

2.3.3. Participant's own food ratings and food choice

Participants provided ratings for the four parentally-selected foods (except for two participants, who only rated two foods due to time constraints). The foods were presented separately, verbally labeled, and shown visually using full-color photographs, which were placed on small plates in front of the children. Participants were asked to rate a food as "yummy, yucky, or just okay." When participants responded with "yummy" or "yucky," they were asked to choose between "a little yummy [yucky] or super yummy [yucky]," thus yielding a five-point rating. The participants' highest-rated food (e.g., apples) and lowest-rated food (e.g., green beans) were identified as their "liked" and "disliked" foods, respectively, for use in the rest of the study. The experimenter randomly selected a single food when a participant gave identical ratings to two foods. Participants who did not assign a rating of "super yummy" (score of 5) to their liked food and a rating of "super yucky" (score of 1) to their disliked food were excluded from data analysis[2] .

Participants next chose between the "liked" (e.g., apples) and "disliked" food (e.g., green beans) for a snack that "tastes really good." This choice served to affirm the accuracy of participants' initial ratings and make their preferences salient for subsequent tasks (Mahajan & Wynn, 2012). By having the script emphasize that the decision was to be based on taste as opposed to nutrition, we sought to reduce the likelihood that participants would feel motivated to select a nutritious yet undesired food (see Nguyen et al.,

[2] Nine additional participants rated their liked food higher than their disliked food by at least two scale points but never assigned either the "super yummy" or "super yucky" rating. We excluded their data for the sake of clarity, ensuring that all participants expressed extreme likes and dislikes in this portion of the study, but note that our key results hold when the data from these participants are included as well. Please see Supplement 3 for results when these participants' data are included.

2015). Participants who chose the "disliked" food were excluded from the sample.

Next, photographs were shown depicting four bite-sized pieces of one food (shown via two separate photographs of two portions), four pieces of the other food, and, for the "50/50" option, two pieces of each. For "50/50," we wish to emphasize that the foods were presented verbally and visually as discrete items. This method of presentation reduced the likelihood that children would view this option as a *mix* of foods; children generally dislike unconventional combinations of foods and the individuals who consume them (DeJesus, Gerdin, Sullivan, & Kinzler, 2019). Participants then chose between all of the "liked" food, all of the "disliked" food, and "50/50." This second round of choices tested for the possibility that children's own decisions would be unduly motivated by a preference for food variety even when one food is disliked by the participant. All but two participants chose the "liked" food as their preferred snack.

2.3.4. Puppet introduction and memory check

Two child-like puppets were introduced to the participants. The puppets were identical with the exception of their scarf colors, either yellow or orange (Mahajan & Wynn, 2012) and were referred to by their scarf colors, e.g., "let's call him Yellow, because I gave him a yellow scarf to wear today." Emphasizing that the scarf colors were chosen by the experimenter, rather than the puppets, was intended to reduce the likelihood that children would view one puppet as more similar to themselves than the other puppet based on scarf color choice alone. Puppets were used instead of live human actors for several reasons. The use of puppets allowed testing to be conducted by a single person, rather than three, in locations with limited physical space. The puppets were more engaging for children than if, for instance, still photos of human faces had been used instead. Additionally, the use of puppets allowed for close control over their facial expressions and physical appearances, making it easier for "performances" to be similar across puppets and sessions; such features would have been more difficult to achieve had human actors been used. One limitation of our study is that we cannot be certain how children would have reacted had human actors been used instead of puppets. However, puppets are frequently used in developmental studies for children between the ages of 3 and 6 (Chernyak, Harris, & Cordes, 2019; Fawcett & Markson, 2010b; Reyes-Jaquez & Echols, 2013; Vaish, Hepach, & Tomasello, 2018). Such studies show that children readily interact with puppets, express social preferences about puppets, and even share resources with puppets at a cost to themselves, actions which would be unlikely if children did not view puppets as agentive social partners akin to human peers.

One puppet, labeled here as the Matched Tastes puppet, assigned the same ratings to the "liked" and "disliked" foods as the child (e.g., rated apples as "super yummy" and green beans as "super yucky"). The main reason behind the inclusion of Matched Tastes was to determine whether children can make appropriate emotional predictions regarding others who match their own preferences. The other puppet, labeled here as Diverse Tastes, assigned the "super yummy" rating to both foods. When expressing opinions about the "liked" food, each puppet nodded its head and pointed to the "super yummy" scale point. For the "disliked" food, Matched Tastes shook its head, closed its mouth, and pointed to the "super yucky" scale point, while Diverse Tastes nodded its head and pointed to "super yummy." The experimenter summarized the puppets' preferences (e.g., "Yellow likes [apples] and Yellow likes [green beans]"). Next, a memory check tested whether the participants recalled the puppets' food preferences (e.g., "which puppet likes [apples] and likes [green beans]?"), after which correct answers were reiterated. Participants who failed the memory check after two attempts were excluded from the sample.

2.3.5. Dependent variables: emotion prediction and food choice prediction

For the Emotion Prediction task, the puppets were described as "want[ing] to eat a tasty snack," and participants were asked to predict each puppet's reactions to different food options by using a new, five-point "super sad" (the saddest face, assigned a score of 1) to "super happy" (the happiest face, assigned a score of 5) scale, depicting five cartoon faces oriented horizontally. Because of previous research indicating children's proficiency with matching faces to "happy" and "sad" emotions (Rieffe et al., 2001; Stein & Levine, 1989), and to reduce testing time and boredom, no training task was used for this scale, although the scale points were labeled by the experimenter. Participants rated each puppet's reactions to each food option separately ("liked," "disliked," and "50/50," with presentation order varying across script versions). For each option, the experimenter asked if the puppet would be "happy, just okay, or sad." When participants responded with "happy" or "sad," they were asked whether the puppet would be "a little happy [sad] or super happy [sad]," thus yielding a five-point rating. Next, in the Food Choice Prediction task, participants were simultaneously presented with the three food options for one puppet and asked to predict which option this puppet would choose. The Emotion Prediction and Food Choice Prediction tasks were repeated for the second puppet.

3. Results

3.1. Emotion prediction task

A 2 (age group: younger or older) x 2 (puppet type: Matched Tastes or Diverse Tastes) x 3 (food option: "liked," "disliked," or "50/50") mixed-design analysis of variance (ANOVA) was conducted with age as the between-subjects factor, puppet type and food option as the within-subjects factors, and participants' Emotion Prediction rating as the dependent measure. Greenhouse-Geisser corrections were applied due to a violation of sphericity for food option ($p = .002$), with adjusted significance values reported. Since a significant three-way interaction was found, $F(2, 154) = 3.94$, $p = .022$, $\eta_p^2 = .050$, results will be reported with separate ANOVAs for each food option. Many of the relevant means for cells from the following analyses are shown in Fig. 1; means that are not shown in Fig. 1 are reported in the text.

For the "disliked" food (e.g., green beans), the main effect for age ($p = .22$) and the age x puppet type interaction were not

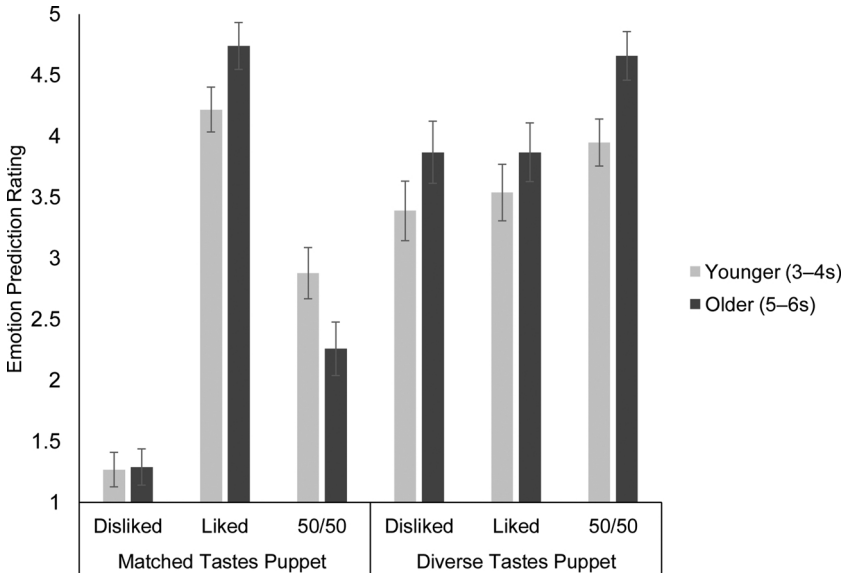

Fig. 1. Mean Emotion Prediction ratings for each age group, food option, and puppet type. Participants predicted each puppet's emotional reaction to each food option on a scale from 1 (super sad) to 5 (super happy). Error bars indicate ± 1 *SEM*.

significant (p = .27). The main effect for puppet type was significant, $F(1, 77) = 129.24$, $p < .001$, $\eta_p^2 = .63$, such that participants rated Diverse Tastes ($M = 3.62$, $SD = 1.57$) as significantly happier than Matched Tastes ($M = 1.28$, $SD = .91$); recall that only Diverse Tastes enjoyed the "disliked" food. For the "liked" food (e.g., apples), the main effect for age (p = .10) and the age x puppet type interaction (p = .58) were not significant. The main effect for puppet type was significant, $F(1, 77) = 21.10$, $p < .001$, $\eta_p^2 = .22$, such that participants rated Matched Tastes ($M = 4.47$, $SD = 1.21$) as significantly happier than Diverse Tastes ($M = 3.70$, $SD = 1.49$); recall that Matched Tastes enjoyed only the child's "liked" food, whereas Diverse Tastes enjoyed the child's "disliked" food as well as the child's "liked" food.

For "50/50" (e.g., both green beans and apples) the main effect for age was not significant (p = .83). There was a significant main effect for puppet type, $F(1, 77) = 78.09$, $p < .001$, $\eta_p^2 = .50$, such that participants rated Diverse Tastes ($M = 4.29$, $SD = 1.28$) as significantly happier than Matched Tastes ($M = 2.58$, $SD = 1.37$). This main effect was qualified by a significant age x puppet type interaction, $F(1, 77) = 11.34$, p = .001, $\eta_p^2 = .13$. Thus, follow-up t tests compared the scores of younger and older children for each puppet separately, with a Bonferroni-adjusted α of .025 and significance level adjustments due to variance heterogeneity. Older children rated Matched Tastes as marginally less happy than did younger children, $t(77) = 2.06$, p = .043, Cohen's d = .46, but rated Diverse Tastes as significantly happier than did younger children, $t(77) = 2.58$, p = .012, d = .58.

Given our focus on variety-seeking preferences, additional analyses were conducted for Diverse Tastes. (As shown in Fig. 1, both age groups assigned appropriate ratings for Matched Tastes' responses to the "liked" and "disliked" foods.) The main effect for age was significant, $F(1, 77) = 5.60$, p = .02, $\eta_p^2 = .07$; older children ($M = 4.13$, $SD = 1.15$) assigned happier ratings than did younger children ($M = 3.63$, $SD = 1.64$). The main effect for food option was also significant, $F(2, 154) = 6.19$, p = .003, $\eta_p^2 = .07$. Follow-up comparisons, with a Bonferroni-adjusted α of .025, found that children rated Diverse Tastes as significantly happier with "50/50" ($M = 4.29$, $SD = 1.28$) than the "liked" food ($M = 3.70$, $SD = 1.49$), p = .008, or the "disliked" food ($M = 3.62$, $SD = 1.57$), p = .004. The age x food option interaction was not significant, p = .67. In spite of this non-significant interaction, separate ANOVAs were conducted for each age group separately, as exploratory analyses. This was done to determine if each age group made emotional predictions aligned with variety-seeking preferences. Because these analyses are exploratory, they should be interpreted with caution. For older children, the main effect for food type was significant, $F(2, 74) = 6.83$, p = .002, $\eta_p^2 = .16$. Follow-up comparisons, with a Bonferroni-adjusted α of .025, found that older children assigned significantly higher ratings to "50/50" than the "liked" food (p = .005) or "disliked" food (p = .006), consistent with variety-seeking attributions (pattern 4, as described in the Introduction). For younger children, however, the main effect for food type was not significant, p = .23. Thus, while the overall pattern was qualitatively similar in both age groups, only older children made robust variety-seeking attributions.

Each child's emotional predictions for Matched Tastes were grouped as correct or incorrect, based on adherence to the puppet's stated preferences. "Correct" responding required rating Matched Tastes as happier with the "liked" food than the "disliked" food, with "50/50" rated as neither happier than the "liked" food nor sadder than the "disliked" food. Seventy-eight percent of the younger children (n = 32) and 87 % of older children (n = 33) met this threshold (Supplementary Table 1). For Diverse Tastes, it is difficult to straightforwardly classify a set of predictions as "correct" or not due to subjectivity regarding the value of variety. Instead, responses were placed into one of six categories as follows: attributions of preference for the "liked" food, preference for the "disliked" food, preference for homogeneity of any kind, preference for variety, no preference for any food option, or other patterns. Please see Supplementary Table 2.

3.2. Food choice prediction task

Separate chi-square goodness-of-fit tests were conducted for each age group to determine whether predictions of Matched Tastes' food choice differed significantly from chance. Younger children made predictions at a rate that differed significantly from chance, χ^2 (2, N = 40) = 48.65, p < .001, with 82.9 % (n = 34) correctly choosing the "liked" food, 2.4 % (n = 1) choosing the "disliked" food, and 12.2 % (n = 5) choosing "50/50." (One younger child was not asked this question due to experimenter error.) Older children made predictions at a rate that differed significantly from chance, χ^2 (1, N = 38) = 30.42, p < .001, with 94.7 % (n = 36) correctly choosing the "liked" food, and 5.3 % (n = 2) choosing "50/50;" none chose the "disliked" food. For Diverse Tastes, younger children made predictions at a rate no different from chance, χ^2 (2, N = 41) = .93, p = .63, with 26.8 % (n = 11) choosing the "liked" food, 34.1 % (n = 14) choosing the "disliked" food, and 39.0 % (n = 16) choosing "50/50" (in line with the "variety-tolerant" pattern 3). Older children chose at a rate significantly different from chance, χ^2 (2, N = 38) = 24.68, p < .001, with 18.4 % (n = 7) choosing the "liked" food, 10.5 % (n = 4) choosing the "disliked" food, and 71.1 % (n = 27) choosing "50/50," consistent with variety-seeking preferences (in line with pattern 4). A chi-square test of independence found a significant association between age group and food choice prediction for Diverse Tastes, χ^2 (2, N = 79) = 9.16, p = .01, consistent with a developmental shift in variety-seeking attributions.

4. Discussion

Overall, both age groups made sensible emotional and food choice predictions regarding Matched Tastes. Children predicted that Matched Tastes would be sad with the "disliked" food and happy with the "liked" food. This is unsurprising given the clear evidence provided by Matched Tastes, young children's general abilities to predict others' emotions and choices based on their stated desires (Stein & Levine, 1989), and the overlap between Matched Tastes' preferences and children's own, allowing for participants to reason about Matched Tastes via analogy to the self (see Mitchell, 2009). However, the results for Matched Tastes provide an important context for interpreting children's predictions regarding Diverse Tastes. For instance, younger children predicted that Matched Tastes would be marginally happier with "50/50" than did older children. (Strictly speaking, neither pattern is more correct than the other; there is no "right answer" regarding the extent to which being given both a liked and a disliked food should make one happy or sad.) These results indicate that older children's happier ratings for Diverse Tastes' reaction to "50/50" compared to those of younger children are not because older children *always* assign happier ratings to variety.

We now turn to Diverse Tastes, the focus of our study. We did not find evidence of egocentrism in younger or older children. Egocentrism would be suggested if children predicted that Diverse Tastes would be unhappy with the "disliked" food and would avoid it as a snack. While we did not expect older children to show egocentrism, it is somewhat surprising that younger children did not, given the mixed evidence regarding this topic in the literature (Atance et al., 2010; Moore et al., 1995; Rieffe et al., 2001; Wellman & Liu, 2004). Egocentric reasoning may have been mitigated here through the clarity with which the puppets' preferences were conveyed and the fact that Diverse Tastes' preferences were not entirely dissimilar from those of the participants. Instead, younger children showed an overall pattern that could be classified as "variety-tolerant" (pattern 3). Younger children assigned similar scores to Diverse Tastes' reactions to all three food options. While "50/50" received the highest scores, and thus matched the general pattern of the older children, there was no significant main effect of food type for this age group. Most dramatically, for the food choice predictions, younger children expected Diverse Tastes to be similarly likely to choose any of the food options. It is difficult to determine whether younger children who chose the "liked" or "disliked" food as Diverse Tastes' preferred snack viewed this food as the puppet's "true" preference (which could indicate difficulties representing diverse desires) or if they viewed any of the options as sensible and picked randomly between them. For older children, however, a consistent and clear pattern of variety-seeking attributions (pattern 4) emerged for both Emotion Predictions and Food Choice Predictions.

We now turn to some alternative explanations for why this pattern emerged in general, and especially in older children. One possibility is that older children favored "50/50" for Diverse Tastes solely out of paternalistic motivations to provide a healthy food (the "disliked" food was often, but not always, healthier than the "liked" food). We find this unlikely. Children did not show such a pattern for Matched Tastes (i.e., they almost never chose the "disliked" food for this puppet), nor for their own choices regarding themselves. Moreover, judgments of tastiness generally dominate young children's own food choices (Nguyen et al., 2015), and the script instructed participants to select foods based on this dimension. While the "50/50" option could be viewed as hedge against uncertainty regarding Matched Tastes' preferences, such an interpretation would not explain why older children often assigned higher ratings to "50/50," and lower ratings to the other options, rather than assigning equal ratings to all three in the Emotion Prediction task. Do older children simply expect more variability from others than younger children, a pattern which could be related to, if not synonymous with, variety-seeking expectations? Kalish (2002) found that adults often expected others to act consistently, whereas children were likelier to expect variability in others' behaviors and choices from one day to the next. Importantly, older children (6- through 8-year-olds) did not generally expect more variability than younger children (4- through 5-year-olds). Thus, our pattern of robust variety-seeking attributions only in older children cannot be explained by a supposition that children increasingly expect others to exhibit variability as they grow older. Additionally, neither age group was unduly optimistic about variety; the "50/50" option was only rated highly for Diverse Tastes, indicating that children's predictions regarding variety were appropriately constrained by the puppets' stated preferences.

Why, then, did older children more robustly predict variety-seeking from Diverse Tastes than younger children? We speculate that, under certain conditions, attributions of variety-seeking place high demands on children's theory of mind abilities. Consider the computational burdens of reasoning about agents with diverse desires. Beyond the demands imposed by suppressing egocentric

desires, there might be additional demands caused by reasoning about two simultaneous positive desires, analogous in some ways to difficulties with reasoning about false beliefs (see Wellman & Liu, 2004). Reasoning about someone who likes broccoli *and* crackers may be demanding in different ways than reasoning about someone who likes broccoli and dislikes crackers; the first requires the simultaneous representation of both objects when reasoning about positive desires (wanting broccoli, A, and crackers, B), and the second does not (wanting only broccoli, A). Additionally, attributions of variety-seeking require a transformation of two positive preferences into a combined desire for both objects; one does not only represent wanting broccoli (A) and wanting crackers (B) but wanting broccoli and crackers (AB) more than either choice separately. Unfortunately, we did not assess children's performance on standard theory of mind tests (e.g., false belief tasks) or executive function tests and thus we cannot determine whether performance on such measures may be associated with the extent of children's variety-seeking expectations. (The length of our procedure, particularly for the youngest children, would have complicated efforts to conduct additional measures, although future studies could examine such associations.) However, since children's theory of mind improves dramatically throughout early childhood (Wellman & Liu, 2004), it is safe to assume that our older children had better theory of mind abilities than younger children.

Another possibility, which could operate in parallel with the explanation above, is that children gain more firsthand experience with the hedonic benefits of variety and disadvantages of homogeneity (e.g., boredom from repeatedly consuming the same food) as they grow older. Such experience could be abstracted into general rules and then applied to new situations involving others. Recent research outside the domain of food found that children occasionally reference concepts related to the law of diminishing marginal utility when explaining others' actions, in ways that reveal an understanding of homogeneity's disadvantages (Ahl & Dunham, 2019; Ahl, Duong, & Dunham, 2019). In these studies, some children stated that someone with many toys of the same kind has more than they need and therefore can give one toy away at a minimal cost to themselves. Such statements accord with the idea that having many units of the same good causes one to place less value on each individual unit. Seven- and 8-year-olds made more references to such concepts than 4- and 5-year-olds. This age difference could suggest an increasing sensitivity to this concept with age, consistent with the present findings. Alternatively, this difference could merely reflect the fact that older children have better verbal abilities, allowing them to express concepts that younger children understand but do not articulate. Whether sensitivity to diminishing marginal utility truly increases with age, in a manner that could explain our results, remains an open question.

Our results largely accord with those of Echelbarger and Gelman (2017) but cannot be compared directly because of differences in our age groups. The present study had age groups of 3- and 4-year-olds and 5- and 6-year-olds, while Echelbarger and Gelman (2017) had age groups of 4- and 5-year-olds and 6- and 7-year-olds, as well as older children and adults. However, Echelbarger and Gelman (2017) found variety-seeking expectations in both 4- and 5-year-olds and 6- and 7-year-olds (with more robust findings for this age group) in the domain of artifacts; we found a similarly robust pattern in 5- and 6-year-olds, but not 3- and 4-year-olds, in the domain of food. We believe that we did not see strong variety-seeking expectations in younger children because we asked children to reason about others in light of information about their preferences; Echelbarger and Gelman (2017) studied variety-seeking without presenting such information and thus imposed fewer theory of mind demands upon participants.

Our study has several limitations. We believe we lacked the statistical power to detect a small effect of an age by food option interaction in the Emotion Prediction rating analyses for Diverse Tastes. The age-related differences we found on this measure must therefore be treated with caution. We note that future research investigating age-related differences in variety-seeking will likely require large sample sizes to see significant effects on such measures. The Food Choice Prediction results are clearer, however. We had a rather high rate of exclusion, particularly for younger children. Our exclusions may have caused us to underestimate children's egocentrism, since children who may have made egocentric predictions had they been included may have been overrepresented in the participants eliminated from the sample due to comprehension check failures. Our study did not employ a fully counter-balanced design. We note, however, that we did not see significant effects for presentation order regarding Diverse Tastes' choices, and the distribution of presentation orders was similar across both age groups, meaning that presentation order could not account for the age-related differences we found. We believe the fact that children encountered the "liked," "disliked," and "50/50" food options themselves, prior to the introduction of the puppets, made each food option salient before the key dependent variables were queried, thus reducing the influence of presentation order on children's predictions.

We do not know how children would respond regarding a puppet with diverse tastes that match children's own, such as a child who likes both apples and crackers encountering a puppet who likes both foods; would even young children robustly expect variety-seeking in such cases? Relatedly, we do not know how children would respond regarding a puppet in the absence of prior information about their preferences. What we can safely conclude, however, is that 5- and 6-year-old children make variety-seeking predictions in a task that is substantially more difficult than the aforementioned examples and represents a more stringent test of this phenomenon. Further studies could ask children to make inferences about agents' emotions and choices under varying levels of knowledge about their preferences and similarities to children's own preferences. Whether children generalize a pattern of diverse tastes or variety-seeking from one set of foods to another, or from the domain of food to another domain, is another topic for further study. For instance, would children infer that an agent choosing a set of two different foods would also choose a set of two different toys?

It is unclear whether children would show similar levels of variety-seeking preferences for their own food options as they show for others'; this is also a topic for further study. On one hand, studies with adult participants find that adults expect others to choose variety more often than they choose variety themselves (Ratner & Kahn, 2002) and predict that others will tire from repeatedly consuming the same food more quickly than themselves (Choi, Kim, Choi, & Yi, 2006). However, some of the mechanisms that are hypothesized to cause such self-other asymmetries in adults (e.g., adults' different estimates of the time between consumption events for the self vs. others) seem unlikely to be operative in young children. Echelbarger and Gelman (2017) found that children choose variety for themselves and others at similar rates. In line with this study, we predict that older children in particular would seek variety for themselves.

The question of whether food is a unique knowledge domain has been a matter of considerable discussion (Rioux, Leglaye, & Lafraire, 2018; Shutts, Kinzler, & DeJesus, 2013). We do not know the extent to which our pattern of variety-seeking predictions given information about others' preferences is specific to food. For example, had we presented artifacts rather than food, would children have responded differently? However, we do believe that food is particularly useful and relevant to the study of diverse desires and variety-seeking. Food is a domain that provokes strong positive and negative emotions in children, including disgust; indeed, children sometimes reject certain foods entirely (Lafraire et al., 2016). It is difficult to imagine another domain in which young children would readily assign extremely positive and extremely negative ratings and would rather have nothing at all than an object they dislike.

Variety-seeking is a topic of major real-world significance to children's diets. Our study finds evidence for an abstract belief that variety is preferable to homogeneity even in young children. By the ages of 5 and 6, children hold a general expectation that others will enjoy and seek variety when selecting foods for their hedonic value. While this study focused on food selection based on taste, our findings on hedonic variety-seeking have the potential to be applied to nutrition promotion. Our findings suggest that interventions encouraging the consumption of diverse foods already have a built-in advantage: Children may be particularly receptive to messaging that emphasizes the hedonic value of food variety. This is especially important given the effectiveness of appeals to hedonic value when encouraging children to eat healthy foods (see Albuquerque et al., 2018, for a review). Given that 5- and 6-year-olds expect others to choose variety, social norms appeals, such as a reminder that lots of other kids like variety, would seem plausible to children and could help combat picky eating. An interactive or storybook-based task in which children are asked to imagine how someone who likes two different foods would feel if they are given both of them would likely lead to variety-seeking responses, which could springboard a discussion of variety in children's own diets (see Kelemen, Emmons, Seston Schillaci, & Ganea, 2014, on storybook-based interventions). However, it is important to recognize that the health benefits of diverse foods are predicated on the foods themselves being nutritious. Since meals with food variety can lead to higher food intake than meals lacking in variety (Raynor & Epstein, 2001) care must be taken to encourage healthy variety-seeking choices. While the abstract belief that variety is enjoyable may emerge early in development even without explicit instruction, learning to seek the *right kinds* of variety requires considerable guidance from adults.

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Appendix A. Supplementary data

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