Cognitive Development 48 (2018) 289–301

Contents lists available at ScienceDirect

Cognitive Development

journal homepage: www.elsevier.com/locate/cogdev

Shape or substance? Children's strategy when labeling a food and its healthfulness

Helana Girgis[a,b,*], Simone P. Nguyen[a]

[a] Department of Psychology, University of North Carolina Wilmington, USA
[b] Department of Psychology, Hartwick College, USA

ARTICLE INFO

Keywords:
Children
Categorization strategies
Substance
Appearance
Food

ABSTRACT

The goal of this research was to examine which properties children use to identify a food and its healthfulness when its appearance and substance do not match. In Study 1 (N = 40), 3- to 6-year-olds saw a drawing of a food (its shape, e.g., apple) with a flap that opened to a different food (its substance, e.g., candy). Participants were asked the name of the food, whether it was healthy, and to explain their responses. Study (N = 46) demonstrated the transformation of the food's substance into its shape. For both studies, older children were consistent in identifying a food and its healthfulness by its substance and did so more than younger children. These results fit into the existing literature on children's categorization strategies within core knowledge areas and provide insight into initiatives aimed at promoting children's health and safety.

1. Introduction

Categorization is essential to identifying and understanding objects in our world and their interconnected, complex relationships. Indeed, categorization is an integral part of a human's ability to function and interact within society and the world at large. Decades of research have examined the development of children's categorization in three core areas: natural kinds, artifacts, and human kinds (see Gelman & Koenig, 2003; Wellman & Gelman, 1992). One area that has not received as much attention is children's categorization abilities within the domain of food. Past research has revealed, though, that children as young as 4 years can categorize foods as healthy and unhealthy, which improves with age (Holub & Musher-Eizenman, 2010; Lafraire, Rioux, Roque, Giboreau, & Picard, 2016; Nguyen, 2007; Nguyen & Murphy, 2003; Rioux, Picard, & Lafraire, 2016; Tatlow-Golden, Hennessy, Dean, & Hollywood, 2013). Preschoolers can also make inductive inferences about the properties of familiar foods, including those based on biological systems (Nguyen & Murphy, 2003; Nguyen, 2008; Rioux, Lafraire, & Picard, 2017; Thibaut, Nguyen, & Murphy, 2016). Preschoolers are therefore knowledgeable about healthy and unhealthy foods (see Schultz & Danford, 2016 for an overview of the development of children's knowledge of food and eating), but there has been little research to date on *how* children come to their category decisions.

What strategies do children use to label a food and decide whether it is healthy to eat? Do these strategies change over time? One strategy children may use is a food's appearance or visible shape. For example, items that have the shape of an apple are identified as 'apple' and healthy to eat. Alternatively, children may use a food's substance, or internal properties. For example, candy shaped to look like an apple, is still labeled 'candy' and unhealthy to eat. It could also be that children use different strategies when deciding a food's label versus its healthfulness (e.g., using substance for one but not the other). We recognize that most foods we encounter on a daily basis match in appearance and health. For example, we assume that a food that looks like a cake is actually a cake and

* Corresponding author at: Department of Psychology, Hartwick College, USA.
E-mail address: girgish@hartwick.edu (H. Girgis).

https://doi.org/10.1016/j.cogdev.2018.08.003
Received 15 December 2017; Received in revised form 31 July 2018; Accepted 4 August 2018
0885-2014/

unhealthy. Yet, do we base these decisions on a food's appearance or its internal properties? This is similar to investigations in children's strategies in other domains as well; if we see an animal that looks like a skunk, we assume it is a skunk. However, if we were told that this skunk has the insides of a raccoon, then we say it is a raccoon because its insides define its category membership (Keil, 1992). Interestingly, even within the body of research on children's broader knowledge of food, a thorough review of the existing literature has revealed very few empirical studies specific to how children are identifying foods: whether it is by its shape or by its substance. Using terms from the core knowledge perspective, please note that our use of the term 'substance', 'internal properties' and 'ingredients' all refer to the same items, which are the non-obvious insides of the food as opposed to the outsides or physical appearance of the food. The substance refers to the essence of the item, the "nonvisible part… or quality in each individual or category member… [which] is inherent" (Gelman, 2003, p. 306).

The primary goal of this research is to understand the strategy that children employ to categorize a food and its healthfulness. There is minimal research to date that has specifically examined *how* children reason about food, which is of critical theoretical value and fills a gap in the literature. Research in children's categorization strategies in other areas supports the possibility that children will use a food's internal properties to label it. According to the core knowledge perspective, children create cohesive, albeit naïve, theories of their physical, natural, and social worlds (see Hirschfeld, 1995; Medin & Ortony, 1989; Murphy & Medin, 1985; Wellman & Gelman, 1992). These concepts are then developed and constrained by how these worlds operate. This is the reason that older 4-year-olds are able to categorize novel members of natural kinds by their internal properties rather than by their appearance, (Ahn, 1998; Bailenson, Shum, Atran, Medin, & Coley, 2002; Diesendruck, 2001; Gelman & Markman, 1986; Gelman & Wellman, 1991) and use function or the creator's label, rather than shape, to categorize novel artifacts (Diesendruck & Peretz, 2013; German & Johnson, 2002; Gopnik & Sobel, 2000; Jaswal, 2006; Kalish & Gelman, 1992; Kemler Nelson, Frankenfield, Morris, & Blair, 2000). This evidence suggests that young children may identify a food and its healthfulness by its internal properties rather than its external shape when they do not match. This strategy employs more than the use of a physical appearance, but a naïve understanding that internal properties are the reliable indicator of category membership.

However, we cannot assume that children's categorization strategies are the same across domains. Past research has questioned whether there is a separate reasoning system for food (Rozin, 1990, 1996; Siegal, 1995; Shutts, Kinzler, McKee, & Spelke, 2009; Shutts, Kinzler, & DeJesus, 2013; Wertz & Wynn, 2014a, 2014b). With only a few innate constraints to avoid ingesting rotten or poisonous foods, such as taste aversion (Garcia & Koelling, 1966; Garcia, McGowan, Ervin, & Koelling, 1968) or preference for sweet versus bitter foods (see Birch, 1999; Ventura & Mennella, 2011), children rely heavily on external sources for information about foods' labels and healthfulness. For example, children learn about food through explicit instruction from the relevant members of the child's culture, such as family members, friends, media and teachers (Nguyen, Gordon, Chevalier, & Girgis, 2016; Nguyen, 2012; VanderBorght & Jaswal, 2009). Young children are attentive and model eating behaviors more often from mothers, peers, models of the same gender and those with a positive attitude; this early exposure develops life-long eating preferences and habits (e.g., Birch & Fisher, 1997; DeJesus et al., 2018; Frazier, Gelman, Kaciroti, Russell, & Lumeng, 2012; Harper & Sanders, 1975; Shutts et al., 2009). Taken together, the necessity of food for survival, the negative consequences for eating rotten, poisonous and/or unhealthy foods, and the heavy reliance on informants for children's knowledge of food, make it unique from other domains and of critical importance to understand how children decide what a food is and whether it is healthy. We believe the present research will add to the growing literature on how children conceptualize foods and whether this conceptualization follows a similar developmental trend to other core domains.

With the sharp increase in foods that appear healthy but are unhealthy and similarity between poisonous substances and manufactured foods, it is critical to understand the developmental trend of when children use a food's internal properties to identify it. Therefore, a secondary goal of this research is to inform our understanding of young children's increased risk of unintentional poisonings and children's knowledge of the healthfulness of deceptive foods. There are a number of products that appear similar to food, but are harmful if ingested. A few examples are bottled kitchen cleaners that look like bottled sports drinks or juice, laundry detergent pods that look like candy, and smokeless tobacco products that look like mints or juice (Carolinas Poison Center, 2018; Connolly et al., 2010; Schwebel et al., 2017; Valdez et al., 2014; Wang, Roosevelt, & Heard, 2013). According to the National Poison Data System (NPDS, 2016), poisoning is the leading cause of injury-related deaths in the United States with 46% of reported unintentional poisonings occuring in children less than 6-years-old.

In addition, accurately identifying a food's health status is a necessary first step when deciding to eat healthfully. It is difficult to make an informed decision to eat healthy foods if one does not know which foods are healthy and unhealthy. Some previous research has found in certain contexts, menu labeling (adding calorie counts on menus in fast food restaurants) and a nutritional score that categorize foods as healthy or unhealthy can reduce caloric intake (Bollinger, Leslie, & Sorensen, 2011; Lobstein & Davies, 2008; Roberto, Larsen, Agnew, Baik, & Brownell, 2010; Zlatevska, Neumann, & Dubelaar, 2018). A person who believes that they are eating healthy foods, but are actually eating unhealthy ones are at an increased risk (at the very least) for weight gain. This is concerning because in the past 30 years, there has been a 60% increase in obesity rates for children and obese children are at an increased risk for maintaining their obesity into adulthood (de Onis, Blössner, & Borghi, 2010; Puhl & Latner, 2007). As compared to their normal weight counterparts, research has found strong correlations between obesity and significant health consequences (e.g., diabetes), poorer academic performance and increased externalizing/internalizing behaviors (Centers for Disease Control & Prevention, 2018; Datar, Sturm, & Magnabosco, 2004; Puhl & Latner, 2007). Thus, it is of value to know when children begin to use internal properties to identify foods in terms of informing interventions to help reduce the risk of obesity.

2. Current research

Previous research reveals that under certain circumstances, children can use internal properties to categorize a food and its healthfulness when its shape and substance match. Preschoolers used color, texture, and smell (internal properties) rather than shape (external property) to categorize novel objects labeled food, but did not for novel objects labeled toys, instead using their shape (Lavin & Hall, 2001; Marcario, 1991; Santos, Hauser, & Spelke, 2002). Nguyen and McCullough (2009) found that 4-year-olds could accurately identify a food's healthfulness using a single modality, such as touch (e.g., food's texture), smell, or recordings of another person eating it. In a simple, but clever study, Krause and Saarnio (1993) examined preschoolers' ability to accurately identify deceptive non-foods (e.g., lollipop shaped pen, candy shaped magnet) as both a non-food and inedible. Using an appearance-reality task, children were asked 1) what the deceptive non-food looked like, 2) if it really and truly was the object's appearance or something else, and 3) could the researcher eat it if he/she was very hungry. The authors found a majority of 3-year-olds did not answer the questions correctly, though about half of the 4-and 5-year-olds did.

Building on the extant appearance-reality literature (e.g., Deák, 2006; Flavell, Green, Flavell, Watson, & Campione, 1986; Moll & Tomasello, 2012; Siegal & Share, 1990), this research focuses on whether children consider a food's external properties (i.e., shape) or internal properties (i.e., ingredients) when identifying a deceptive food. This is the first investigation we are aware of to examine children's strategies specific to categorizing a food by its label and healthfulness. Therefore, we also tested the possibility that children's strategies varied by a food's healthfulness. For example, children may be more likely to pay attention to internal properties for unhealthy foods if they think these are more likely to be human-made (e.g., processed) as compared to healthy foods, which are more likely to be natural. Alternatively, it could be that children are more likely to pay attention to internal properties for healthy or natural foods as they do natural kinds, understanding that internal properties define its category membership as opposed to unhealthy or processed foods.

To test whether children use a food's shape or substance to label it, we devised an appearance-reality task similar to the one in Krause and Saarnio (1993). We presented drawings of foods that had the shape of one food (e.g., apple) and a flap in the middle of the drawing that opened up to a different food, its substance (e.g., candy). After labeling the food's shape, substance, and whether it was healthy or unhealthy, we then asked children what the food really was and if it was healthy to eat.

Since categorization strategies using internal properties emerge at approximately age 4 years in other domains, we tested 3- to 6-year-olds in order to examine if and how these strategies develop with age. Based on previous research, we predicted that the older age group would use a food's internal properties to label it and its healthfulness and would do so more than the younger age group.

3. Study 1

3.1. Methods

3.1.1. Participants

Participants included 40 three- to six-year-olds (*range* = 3.34 to 6.47 years) who were divided into a younger ($n = 20$, $M_{age} = 4.05$ years, 13 females) and older ($n = 20$, $M_{age} = 5.88$ years, 10 females) age group. An additional group of 20 children ($M_{age} = 4.16$ years, *range* = 3.50–4.90 years, 11 females) assisted with stimuli selection for the study. Children were recruited from preschools and elementary schools located in a predominately middle-class, European American city in the southeastern United States.

3.1.2. Materials

We created the stimuli and procedure in accordance with our primary goal of this research: to examine, within the core knowledge perspective, whether the strategies used to identify deceptive foods were similar to those used in other domains. To do this, we presented the food as children would most likely encounter it: attending to the physical characteristics (or shape) of the food first and then biting/slicing into its ingredients (or substance) second. Previous research has established that color is one of the primary properties of foods that young children use when categorizing them (see Lavin & Hall, 2001; Marcario, 1991; Santos et al., 2002). Therefore, in this task, it was essential to control for food color. Realistically, the ingredients of deceptive foods are often pureed, mashed, or processed, in order for it to be molded into a different shaped food. Yet, we needed to ensure that young children could visually identify both parts of the food. Hence, we used black and white drawings of a 'whole' food for both the shape and the substance. Since these were whole foods, we devised the stimuli and procedure to ensure that children thought the food's substance was its ingredients rather than a second food. We purposefully placed a flap in the middle of the shape of the food as Newman and Keil (2008) found that up to age 6 years, children believed the substance of a natural kind is located in its center rather than spread throughout. Additionally, previous research has revealed that 3- and 4-year-olds believe that the structure of substances are homogenous and attribute stable properties to it (Au, 1994; Dickinson, 1987; Smith, Carey, & Wiser, 1985). The instructions and trial wording was specifically designed with the terms 'outside' and 'inside' to highlight the outside, or shape, of the food and then the insides, or the ingredients, of the foods. This was to emphasize the 'food' was one type on the outside, but the ingredients were different on the inside.

The stimuli included 16 black and white food drawings. These drawings were selected from a larger set of drawings that were initially tested on 20 children who were asked to identify 41 different foods. Only foods that children could correctly identify 80% of the time were selected as a part of the stimuli for this study. There were four healthy foods, consisting of two fruits and two vegetables (apple, orange, carrot, and corn) and four unhealthy foods, consisting of two desserts and two savory foods (cake, popsicle, hamburger, and hotdog). These foods comprised the shape. Each food drawing was approximately 6 in. with a 2 in. × 2 in. window flap in the center that revealed the substance inside of the food's shape. The foods that made up the substance were broccoli and wrapped hard candy. The wrapped hard candy met the goal of being a black and white drawing of an unhealthy food that was recognizable to children as young as 3 years. Unlike our healthy foods, which were natural, our unhealthy foods were processed. Processed foods are created through some type of human intervention, through either mixing multiple ingredients or applying a chemical reaction of some kind (e.g., cooking it). We recognize that the candy is not a single ingredient, but is made of cooked sugar and syrup itself. We likened this to other unhealthy foods which are deceptive, like chocolate shaped to look like a fruit (ingredients of sugar, cocoa powder, and butter), gum drops shaped liked berries (ingredients of cooked sugar, syrup, and gelatin) and marzipan shaped liked vegetables (ingredients of sugar and almonds).

For each food, there was one version in which the healthfulness of the shape and substances of the foods mismatched (e.g., healthy apple shape with unhealthy candy substance) and one version in which the healthfulness of the shape and substance of the foods matched (e.g., healthy apple shape with healthy broccoli substance). Please see Appendix A for the list of stimuli and Appendix B for sample stimuli and protocol. The matched versions were included for two reasons. The first was to ensure children understood the procedure. If children's answers did not match the healthfulness of the food's substance, and therefore its shape, it would indicate issues with the wording of the questions or procedure. Secondly, children might attend to the food's substance because the health mismatch of the food's shape and substance is surprising and draws children's attention to it. Children's correct answers to the label of the food on the matched versions would increase the confidence that children are strategically using substance to identify a food.

3.1.3. Procedure

Participants were tested individually for approximately 15 minutes by a researcher either in an empty room or in a quiet area of their classroom.

To begin, the researcher defined healthy and unhealthy foods (i.e., "Healthy foods are foods that give your body what it needs. They help you grow, give you long lasting energy, and keep you from getting sick. Unhealthy foods are foods that do ***not*** give your body what it needs. They do ***not*** help you grow, do ***not*** give you long lasting energy, and do ***not*** keep you from getting sick."). Participants were asked follow-up questions to ensure they understood the definitions and provided corrective feedback as necessary.

Following this, the researcher told participants a story to explain the task and types of images they would see; "This morning I went to a healthy food store and bought some healthy foods and I went to an unhealthy food store and bought some unhealthy foods. So, at the healthy and unhealthy food stores, I found some very strange foods! Some were filled with broccoli, which is healthy. Some were filled with candy, which is unhealthy. But I mixed up my bags, so I don't know which foods came from which store! Can you help me find which foods are healthy and which are unhealthy? We'll look at pictures of food and then we'll look inside of the food and see what they are made up of and I'll ask you if they are healthy or not."

We tried to be as explicit as possible both visually and verbally in defining the shape and the substance of the food. This can sometimes lead to creating stimuli that may not be realistic, but the goal is that it concretely presents the options to young children with an explanation for why this particular stimuli set exists. We used this storyline to explain why there would be these 'strange' foods that had a different substance from its shape. Other research that has examined categorization strategies of preschoolers have utilized similar designs (for example see Keil, 1992; Gelman & Wellman, 1991; Taylor, 1996).

The researcher then presented participants with 16 drawings of the food, one at a time, in a task designed to be similar to an appearance-reality task (see Deák, 2006, for a discussion regarding the development of appearance-reality tasks). The researcher introduced each food by labeling the shape (e.g., "See this, this looks like a healthy apple. This apple looks healthy. It looks like a healthy apple on the outside"). The researcher then lifted up the flap and labeled the substance (e.g., "Now let's look inside and see what this is made up of inside. Yikes! It's made up of candy. Look, see all the unhealthy candy inside of it? This candy is unhealthy)".

The researcher then asked children the label question (e.g., "Hmm, so, what is this really and truly? Is this really and truly a healthy apple or is it really and truly unhealthy candy?" Participants could answer either "healthy apple" or "unhealthy candy"). This question determined whether the participant believed the food's label was based on its shape or substance.

Next, the researcher asked the health question, "To have a healthy body, would you eat this food?" Participants could respond with either "yes" or "no." This question determined whether the participant believed the food's healthfulness was based on its shape or substance. The researcher then asked participants to provide an explanation for their answer to the health question (i.e., "Why?").

The label and health questions were presented in a fixed order. The 16 trials and shape/substance terms in the label question were counterbalanced and presented in one of two random orders.

4. Results

To provide a complete picture of children's categorization strategies, we analyzed the label and health questions separately and combined. We first analyzed the label and health question separately in order to investigate any differences in categorization strategies between the two, given that a food's label and healthfulness are different properties. It could be children's strategies do not develop simultaneously, that one of these is more intrinsic to the food's category membership than the other. Our second analysis examined children's responses to the label and health questions combined. Most adults apply one strategy when determining a food's label and healthfulness; they are not often using shape for one and substance for the other or alternating between the two across food types. In order to have a full understanding of how children are categorizing foods, it was necessary to examine when children are employing an adult-like approach to identifying foods – a single strategy using the food's label and the food's internal properties to determine its health. With this combined analysis, we could determine how many children identified the health of the food based on the label they gave it (e.g., saying the food was healthy when they labeled it broccoli).

For the separate analysis: if participants selected the food's substance for its label, we scored it with a 1 (i.e., broccoli or candy), and if participants selected the food's shape for its label, we scored it with a 0. We used the same scoring system for the health question: participants' selection of a food's substance for its healthfulness was scored with a 1 (e.g, apple with candy inside is unhealthy), while selection of a food's shape for its healthfulness is scored with a 0 (e.g., apple with candy inside is healthy). Since we were also interested in whether the healthfulness of how the food appeared (its shape) affected categorization strategies, we created two summary variables based on the appearance of the food's healthfulness for each test question. There were 8 healthy trials and 8 unhealthy trials, therefore for each summary variable participants could have a score ranging from 0 (all shape responses) to 8 (all substance responses). We coverted the score into a percent (divided by 8 per summary variable) for ease of understanding and presentation. We ran 2 × 2 (Age [younger age group, older age group] × Health [healthy trials, unhealthy trials]) ANOVA for each test question.

4.1. Label question

The ANOVA revealed a main effect of Health, $F(1, 38) = 5.69$, $p = .02$, $\eta_p^2 = .13$, such that participants used the food's substance for its label more often for unhealthy shaped foods ($M = 64\%$) than for healthy shaped foods ($M = 54\%$) and a main effect of Age, $F(1, 38) = 15.37$, $p < .001$, $\eta_p^2 = .28$, such that older children ($M = 74\%$) used the food's substance more than younger children ($M = 44\%$). No other effects were found. Participants' performance was compared to chance. A one sample *t*-test (test value = 50%) revealed younger children were at chance in their responses to healthy foods ($M = 43\%$) and unhealthy foods ($M = 46\%$), *p's* > .26, while older children's substance responses were above chance levels for healthy ($M = 65\%$), $t(19) = 2.30$, $p = .03$, and unhealthy foods ($M = 83\%$), $t(19) = 6.99$, $p < .001$.

4.2. Health question

The ANOVA revealed a main effect of Age, $F(1, 38) = 26.31$, $p < .001$, $\eta_p^2 = .40$, such that older children ($M = 92\%$) used a food's substance to identify its healthfulness more often than younger children ($M = 64\%$). No other effects were found. Participants' performance was compared to chance. A one sample *t*-test (test value 50%) revealed younger children were at above chance levels in identifying the food's healthfulness by its substance for healthy foods, $t(19) = 2.83$, $p = .01$, and unhealthy foods, $t(19) = 2.92$, $p = .009$, as were older children for healthy, $t(19) = 11.9$, $p < .001$, and unhealthy foods, $t(19) = 12.4$, $p < .001$.

4.3. Label and health questions

For the combined analysis: we scored substance responses to both the label and health question (i.e., candy and unhealthy or brococoli and healthy) with a 1 and we scored shape responses to either or both the label and health questions with a 0. We created two summary variables for healthy shaped foods and unhealthy shaped foods by summing scores across these trials, which we then turned into a percent by dividing the total number of responses by the number of trials per summary variables (which were 8 trials for each summary variable). A one sample *t*-test (test value = 50%) compared participant responses to chance, which revealed younger participants selected the food's substance for both its label and healthfulness at below chance levels for both healthy foods ($M = 28\%$), $t(19) = -3.71$, $p = .001$, and unhealthy foods ($M = 31\%$), $t(19) = -2.72$, $p = .01$. However, the older age group selected the food's substance for both its label and healthfulness at above chance levels for both healthy foods ($M = 66\%$), $t(19) = 2.19$, $p = .04$, and unhealthy foods ($M = 80\%$), $t(19) = 5.56$, $p < .001$.

4.4. Explanation responses

We coded the explanation responses in the following manner: 1) internal properties, wherein children referenced the food's substance by either its name or health status, including how it could affect your body, and/or ingredients (e.g., "because it's filled with broccoli", "cuz it has sugar inside of it", "because it makes you strong"; 2) external properties, wherein children referenced the food's shape by either its name or health status, including how it could affect your body, and/or ingredients (e.g., "because it helps your body grow and I really like carrots"; "because it's junk food", "because I like apples"); and 3) irrelevant; wherein children referenced neither or refused to answer (e.g., "because I like to squish a finger in it", "because it's so yummy", "I don't know"). Since the explanation responses were why participants answered as they did to the health question, we only included those to the mismatched trials. This was to confirm that explanation responses were specific to the substance, since explanations in the matched trials could have referred to the either the food's substance or shape (e.g., broccoli inside of an apple). Using this coding strategy ensured that we did not under- or over-estimate responses that supported participants' use of the food's susbstance to explain its healthfulness. We summed and then averaged responses for each explanation type (substance, shape, irrelevant) and turned this into a percent for ease of understanding and presentation.

We ran a one-way ANOVA with Age as the between subjects factor and Explanation Type (substance, shape, irrelevant) as the dependent variables. This analysis revealed older participants were more likely to reference substance for their explanations to the health question than younger participants, $F(1, 38) = 30.37$, $p < .001$, and older participants were less likely to make irrelevant explanations compared to younger participants, $F(1, 38) = 29.80$, $p < .001$. There were no differences between the age groups for their explanations that referenced shape, $p = .92$. Participant responses were compared to chance as well. A one-sample t-test was conducted with the test value set at 33% as there were 3 possible explanations participants could provide. The younger age group was below chance when explaining their responses to the health questions with the food's shape ($M = 21\%$), $t(19) = -2.18$, $p = .04$, but were at chance level for irrelevant explanations ($M = 49.3\%$), $p = .64$ and substance explanations ($M = 29\%$), $p = .08$. None of the older children used irrelevant explanations for their answers to the health questions. Older children's shape explanations were below chance ($M = 22\%$), $t(19) = -2.62$, $p = .01$, while substance based explanations were above chance ($M = 78\%$), $t(19) = 10.63$, $p < .001$.

Lastly, we examined whether participants who selected the substance of the food for its healthfulness were also more likely to reference the substance of the food to explain their responses to the health question (e.g., 'it's unhealthy' was most likely explained by referencing properties of the candy). A Pearson's correlation revealed a strong positive correlation for substance responses to the health question and substance based explanations for both younger participants, $r = .90$, $p < .001$, and older participants, $r = .73$, $p < .001$.

5. Discussion

The results revealed the older age group selected the food's substance for its label and healthfulness more often than the younger age group did. Moreover, older children explained their responses to the healthfulness of the food using its substance and did so more than younger children. It appears that children who selected the food's substance for its healthfulness were doing so intentionally, as there was a strong positive correlation between these responses and substance based explanations. When examining responses to the food's label and healthfulness separately, it appears that younger children were employing different strategies when identifying the food's label (not using shape or substance consistently) as opposed to its healthfulness (using substance consistently). It could be that children attend more to internal properties when determining a food's healthfulness. One reason for this is that a food's healthfulness is not as easily (or obviously) indicated by its shape as a food's label. When examining children's responses to the health and label questions combined, we found that the older children applied a single strategy, using the food's substance to identify its label, which in turn was used to identify its healthfulness. These patterns of results are supported by the older age group's reference to the properties of the food's substance (e.g., its ingredients or its name) to explain why the food was healthy or unhealthy. In addition, the initial perception of a food's healthfulness influenced how children reasoned about its label. When foods appeared healthy, children were more likely to use its internal properties to label it, but did not do this for foods that appeared unhealthy. From the pattern of responses, though, it appears that this is mostly due to the differences in the older age group's responses. It could be children are aware that unhealthy foods were processed foods, which have some component of human intervention (e.g., mixing of ingredients, application of chemical compounds or processes), thus were more attentive to their internal properties when labeling them.

While there is a cognitive bias towards thinking about the natural world in terms of essences (e.g., internal properties that make the category member part of that category), this continues to develop as children incorporate their growing knowledge of the item to construct a more sophisticated representation of the category (Gelman, 2003). This more sophisticated representation and reasoning about foods appears in children around age 5 years; thinking about food by its category membership (internal properties) rather than its perceptual characteristics (shape) when the food's shape and substance do not match. This appreciation for internal properties is well documented in previous research examining children's categorization strategies in the natural world, usually occurring in older 4-year-olds (for example see Ahn, 1998; Keil, 1992; Gelman & Markman, 1986; Gelman & Davidson, 2013; Gelman & Meyer, 2011; Gelman & Wellman, 1991; Taylor, 1996).

There is some concern that methodological limitations may have influenced the younger age group's responses, though. The repetitive labeling of the healthfulness of the food's shape and substance in each trial may have unnecessarily complicated the descriptions, especially as these foods are familiar to most children. In addition, the wording of the health question may have prompted younger children to focus on the latter part of the question (e.g., "To have a healthy body, *would you eat this*?"). Lastly, younger participants may not have fully understood the relationship between the shape and substance of the food in the drawings. Based on these limitations, the younger age group may have chosen the less ambiguous property, shape, to label the food and its healthfulness.

6. Study 2

The goal of Study 2 was to simplify the description of the stimuli and provide an explicit transformation of how the substance of the food was found inside its shape. These changes were implemented to determine if younger children could use a food's internal properties for its label and healthfulness.

6.1. Methods

6.1.1. Participants

Participants included 46 three- to six-year-olds (*range* = 3.50–6.52 years) who were divided into a younger ($n = 26$, $M_{age} = 4.30$ years, 16 females) and older ($n = 20$, $M_{age} = 5.70$ years, 10 females) age group. Children were recruited from preschools and elementary schools in a predominately middle-class, European American city in the southeastern United States. None of the children had participated in Study 1.

6.1.2. Materials

The materials were identical to Study 1 except for three new drawings of a chef taking the substance (e.g., candy) and turning it into the food's shape (e.g., apple). These drawings consisted of: 1) a chef holding a knife over the shape of the food (e.g., apple), 2) the chef slicing the food shape in half, (e.g., the chef slicing the apple in half), and 3) the chef placing the substance food into the halves of the food shape (e.g., the chef putting candy into both halves of the apple). All images were taken from internet sites (e.g., Google Images) and Microsoft Paint was used to manipulate them. See Appendix C for sample stimuli and protocol.

6.1.3. Procedure

The procedure was identical to Study 1 except for the simplified description of the foods and the drawings of the chef's transformation of the food's substance into its shape.

For each trial, the researcher pointed to and explained what the chef was doing in each of the three drawings (e.g., "Here is the cook with an apple. Here is the cook cutting open the apple. Here the cook is filling it inside with candy!"). Following the three drawings, the researcher showed the same picture of the food shape with the flap opening to the food substance from Study 1. When labeling the food's shape and substance, the researcher stated the food's name and healthfulness only once instead of multiple times (e.g., "See this. It looks like a healthy apple on the outside" and "Now let's look inside and see what this is made up of inside. But it has unhealthy candy"). The label question was changed to, "So is this really and truly (shape, e.g., an apple) or (substance, e.g., candy)?" The health question was changed to, "Should people eat this food to have a healthy body?" We replaced the term 'you' with 'people' and 'healthy body' was placed at the end of the sentence to emphasize the healthfulness of the food. Children were also asked, "Why?" to explore the rationale for their answers to the health question. Shape and substance terms were counterbalanced across trials.

7. Results

The data were scored and analyzed in the same manner as in Study 1 for both the separate and combined analyses.

7.1. Label question

The ANOVA revealed a main effect of Age, $F(1, 44) = 4.61$, $p = .03$, $\eta_p^2 = .09$, such that the older age group was more likely to use the food's substance to label it as compared to the younger age group. No other effects were found. Participants' performance was compared to chance. A one sample t-test (test value = 50%) revealed younger and older children were at chance in their substance responses to healthy foods and unhealthy foods, p's > .06. See Fig. 1 for substance responses to the label question by age for Study 1 and 2.

7.2. Health question

The ANOVA revealed a main effect of Age, $F(1,44) = 5.04$, $p = .03$, $\eta_p^2 = .10$, such that the older age group was more likely to use the food's substance to identify its healthfulness compared to the younger age group. No other effects were found. Participants' performance was compared to chance. A one sample t-test (test value = 50%) revealed that younger children were at chance in their substance responses to healthy foods and unhealthy foods, p's > .3, while older children were above chance in using substance to identify both healthy foods, $t(19) = 4.95$, $p < .001$, and unhealthy foods, $t(19) = 5.53$, $p < .001$. See Fig. 2 for substance responses to health question by age for Study 1 and 2.

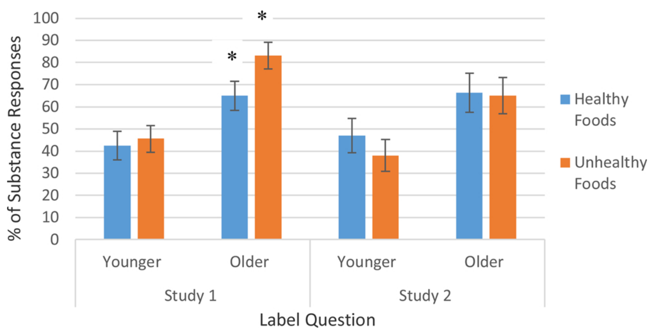

Fig. 1. Percent of substance responses for the label question by age for Study 1 and 2. Error bars represent standard error of the mean. Asterisks (*) refer to above chance performance.

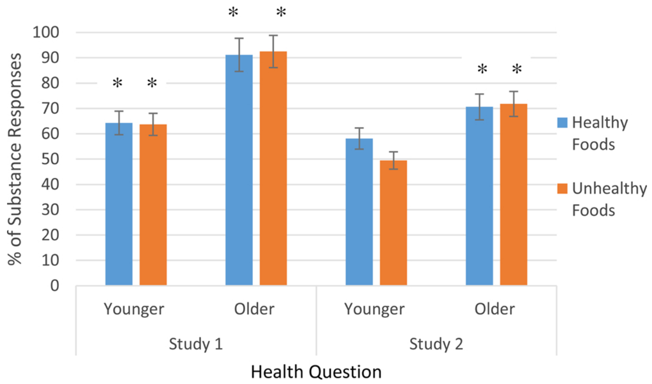

Fig. 2. Percent of substance responses for the health question by age for Study 1 and Study 2. Error bars represent standard error of the mean. Asterisks (*) refer to above chance performance.

7.3. Label and health questions

As we did in Study 1, we examined the combined responses to the label and health questions based on the food's substance. Participant responses were compared to chance. A one-sample *t*-test (test value = 50%) revealed the younger age group used a food's substance at above chance levels for healthy foods, $t(25) = 3.13$, $p = .004$, and for unhealthy foods, $t(25) = 2.26$, $p = .03$, and the older age group's substance responses were at above chance levels for both healthy, $t(19) = 4.95$, $p < .001$, and unhealthy foods, $t(19) = 5.53$, $p < .001$. See Fig. 3 for substance responses to both the Label and Health question (combined) by age for Study 1 and 2.

7.4. Explanation responses

A one way ANOVA revealed older participants were more likely to reference substance in their explanations than younger participants, $F(1, 44) = 5.30$, $p = .02$. Older participants were less likely to make irrelevant explanations for their answers to health question compared to younger participants, $F(1, 44) = 6.41$, $p = .01$. There were no differences between the age groups in their explanations that referenced shape, $p = .91$. Participant responses were compared to chance as well. A one-sample *t*-test (test value = 33%) revealed the younger age group was at above chance levels when referencing the food's substance for their explanations, $t(25) = 2.57$, $p = .01$ and at chance when explaining their responses to the health questions by the food's shape and for irrelevant explanations, *p's* > .22. Older children's substance explanations were at above chance levels, $t(19) = 5.97$, $p < .001$, their irrelevant explanations were at below chance levels, $t(19) = -12.60$, $p < .001$ and their shape explanations were at chance, $p = .24$. See Fig. 4 for Explanation Type responses by age for Study 1 and Study 2.

Lastly, we examined whether participants who selected the substance of the food for its healthfulness were also more likely to reference the substance of the food to explain their responses to the health question (e.g., 'it's unhealthy' was most likely explained by referencing properties of the candy). A Pearson's correlation revealed a moderate positive correlation for substance responses to the health question and substance based explanations for younger participants, $r = .48$, $p = .01$. Older participants' positive correlation between their substance responses to the health question and their substance explanations was trending towards significance, $r = .43$, $p = .05$.

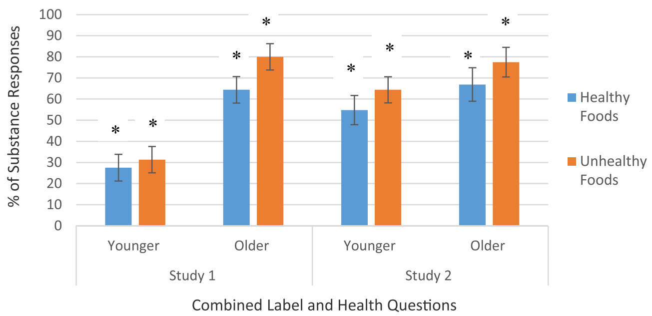

Fig. 3. Percent of substance responses for both the label and health questions (combined analysis) for Study 1 and Study 2 by age. Error bars represent the standard error of the mean. Asterisks (*) refer to above or below chance performance.

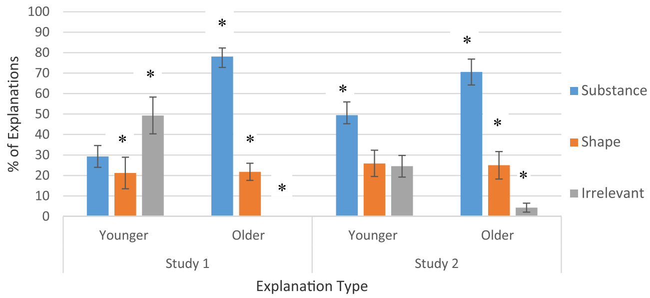

Fig. 4. Percent of explanation types for the health question by age for Study 1 and Study 2. Error bars represent standard error of the mean. Asterisks (*) refer to above or below chance performance.

7.5. Comparison between Study 1 and 2 for the younger age group

The goal of this second study was to investigate whether changes in our procedure (i.e., trial wording and visual transformation of substance into shape) would increase the likelihood of the younger age group selecting the food's substance for its label and healthfulness as compared to Study 1. For the label question, we ran an independent *t*-test, which revealed no differences in the younger age group's substance responses between Study 1 and 2, for both healthy and unhealthy foods, *p's* > .41. For the health question, an independent *t*-test revealed no differences in the younger age group's substances responses between Study 1 and 2, for both healthy and unhealthy foods, *p's* > .11.

For responses to the combined analysis (substance responses to *both* the label and health questions), an independent *t*-test revealed that the younger age group in Study 2 used a food's substance to label it and its healthfulness for healthy and unhealthy foods more often than the younger age group in Study 1, *t's*(44) = 4.85, 3.60, $p < .001$, = .001, respectively.

Lastly, we examined differences among the younger age group's explanations for their responses to the health question in Study 1 and Study 2. A one way ANOVA revealed a trend towards significance for more substance explanations in Study 2 as compared to Study 1, $F(1, 45) = 4.06$, $p = .05$, less irrelevant explanations for Study 2 as compared to Study 1, $F(1, 45) = 5.07$, $p = .02$ and no differences between the age group's references to shape, $p = .56$.

8. Discussion

The results of Study 2 indicated the same pattern of age-related responses as in Study 1. Examining the test questions separately, the older children were more likely to label the food and its healthfulness by its substance than the younger children. These same age differences were found when we examined the combined test questions, such that older children were more likely to apply a single strategy, using the food's substance to identify *both* the food's label and healthfulness than younger children. Additionally, we found the same age differences in explanation responses with older children more likely to use the food's substance to explain their health responses than younger children.

The older age group's substance responses for the label question were at chance, which was unexpected given their use of the substance to identify the food's label in Study 1. We examined the distribution of responses and found 11 of the 20 participants selected the food's substance 100% of the time to label the food, while 6 used the food's shape for 75% of the trials. This reflects the possibility that children were using two different strategies rather than a random selection. We also found that these same 11 participants selected the food's substance for the health question as well, revealing a systematic strategy to categorizing foods.

Even with an explicit visual transformation of a chef filling the shape of the food with either the candy or broccoli, the younger age group did not use the food's substance to identify its label or its healthfulness. In addition, the substance responses did not increase between Study 1 and Study 2 when examining the test questions separately. However, it appears that the methodological changes did influence the consistency of the younger participants' responses, with more substance responses in the combined analysis, i.e., using a single strategy to identify a food and its healthfulness.

We would like to take a moment to discuss an interesting pattern of results when considering the separate versus combined analyses. Although the substance responses in the combined analysis significantly increased in Study 2 as compared to Study 1, the results of the comparison of the separate analysis between Study 1 and 2 showed a non-significant decrease. We found that younger participants' substance responses in Study 1 to the health question were random across trials (13 participants selected substance on 50% of the trials) as compared to responses in Study 2, which were more consistent (seven participants selected substance on 75% or more of the trials, while nine participants selected shape on 70% or more of the trials). This could account for the pattern of results. Further support is provided by the significant increase in the explanations referencing the food's substance for younger children's responses to the health question.

9. General discussion

While past research has revealed that preschoolers can identify both a food's label and healthfulness when its shape and substance match (Holub & Musher-Eizenman, 2010; Lafraire, Rioux, Roque, Giboreau, & Picard, 2016; Nguyen, 2007; Nguyen & Murphy, 2003; Rioux, Picard, & Lafraire, 2016; Tatlow-Golden, Hennessy, Dean, & Hollywood, 2013), little is known about the strategies that children use when making these decisions for foods with mismatching shapes and substances. One strategy young children may employ is associating a food's external properties with its label and healthfulness (a food that looks like a healthy apple is labeled 'apple' and 'healthy'). An alternative strategy is using a food's internal properties for its label and healthfulness (an apple shaped candy is labeled 'candy' and 'unhealthy'). It could also be that children use different strategies when deciding a food's label versus its healthfulness (e.g., using substance for one but not the other).

In Study 1, we used an appearance-reality task where the food's shape did not match the food's substance in label and/or healthfulness (e.g., healthy apple shape with unhealthy candy substance). We found a stable pattern of age differences with older children using the substance of the food more often than the younger children to identify its label and health both when examined separately and combined. Moreover, the types of explanations children gave for their responses to the health question supported these reasoning strategies. Older children referred to the foods' substance in their explanations, while the younger ones did not.

We would also like to highlight two compelling findings regarding strategies in Study 1. The first is younger children's tendency to use the food's substance to identify its healthfulness, but not its label. To further understand the overall pattern, we ran a post hoc paired sample *t*-test, which revealed that younger children used the food's substance to identify its healthfulness significantly more than they did for the food's label, $t(19) = 2.92$, $p = .009$. We are cautious in interpreting this finding, since younger children's substance based explanations for their health explanation were at chance. However, future research should examine in detail if children do indeed apply different strategies and if this may be a result of what appears obvious (label) versus what appears less obvious (health). In addition, we found that children were more likely to label unhealthy foods by its substance as compared to healthy food, though this appears to be mostly due to differences in responses by the older age group. There are limitations to the conclusions that we can draw based on this one study, but an important area for future research will be to investigate whether children's concepts differ for different types of foods. We expound on this future direction below.

In Study 2, we simplified the food's description and made the transformation of the food's substance into its shape explicit. The same stable age differences existed with the older age group more likely to use a food's substance to identify its label and healthfulness when examined both separately and combined as compared to the younger age group. Older children also provided more substance based explanations for their responses to the health question than younger children. Interestingly, these changes did not increase the younger children's substance selection for the food's label and healthfulness when analyzed separately. These changes did seem to influence younger children's responses in the combined analysis, as they tended to identify *both* the food's label and healthfulness by its substance (and did so more than in Study 1). This was supported by children's use of substance-based explanations, which they provided more of in Study 2 than in Study 1.

With the exception of the responses to the label question in Study 2 (of which a smaller subset were consistently selecting the food's shape to label it), older children (namely, older 5-year-olds and younger 6-year-olds) were systematically using a food's substance to identify it and its healthfulness and did so more than younger children (namely, 3- and 4-year-olds). The increase in the younger children's use of a single strategy, using the food's substance to identify *both* its label and healthfulness (in Study 2) would suggest that the shape equals food rule is not rigid. It appears that a change in strategies from external properties to internal properties to identify foods occurs during the later preschool, early kindergarten years.

Unlike most of the category members in other domains, foods are a necessary part of daily survival with limited trial and error in the selection of healthy foods. Since there is not a full proof method that young children utilize to identify healthy foods, there is a heavy reliance on caregivers to provide foods for safe consumption. Research in the food domain is growing due to these unique characteristics among the other core knowledge areas, such as natural kinds and artifacts (see Liberman, Woodward, Sullivan, & Kinzler, 2016; Shutts et al., 2009; Wertz & Wynn, 2014a, 2014b). The primary goal of this research was to determine whether children's categorization strategies are similar for food as they are for other domains, such as natural kinds and artifacts. According to the core knowledge perspective, older 4-year-olds use internal properties (non-obvious) to categorize natural kinds and function (non-obvious) to categorize artifacts. Our results support that children are employing the same categorization strategies for food as they are for natural kinds and artifacts and on a similar developmental timeline. Specifically, at age 5 years children are identifying category members based on internal properties rather than on physical appearance (see Gelman, 2003 for review, though see Sloutsky, 2003 and Sloutsky & Spino, 2004 for counter arguments to the core knowledge perspective), though future research should directly compare categorization strategies of foods with these other domains.

Our secondary goal in conducting these studies was to inform interventions on reducing children's unintentional poisonings and obesity. While we did not use stimuli that are representative of the more typical items by which children are unintentionally poisoned, we expect the strategy of identifying deceptive items would be similar. Interestingly, the results from these two studies appear to fit with the NPDS (2016) reporting of unintentional poisonings; most poisonings occur under the age of 6 years, 46%, and drop to 7% from age 6 through to the adult years. We suggest based on the current investigation that one reason for this may be that young preschoolers are using the physical appearance of the object to identify the item, for example, laundry cleaning pods designed in both color and shape to look like candy are thought to be candy. The drop in unintentional poisonings occur approximately when children use a food's internal properties to identify it. The results from this research support the idea of explicitly showing young preschoolers how certain non-foods, e.g., poisonous substances, are made as a way to increase children's ability to identify it as a non-food. In addition, these kinds of explicit transformation descriptions could help inform young preschoolers about foods that look one way (healthy), but are really something else (unhealthy) to increase healthy food choices. We acknowledge that the present findings are not specific to reducing poisonings or to decreasing unhealthy food choices, but we do believe that findings on children's categorization strategies may be helpful in understanding one small part of children's decisions in these areas.

10. Limitations and future directions

Thus far, based on the findings from the separate and combined analysis in both studies, we have suggested that older children use substance when determining food's label and healthfulness. However, an alternative explanation may be that we influenced older children's substance responses by both showing and labeling the substance of the food immediately before asking the test questions. There are several reasons that children's responses are unlikely due to do this effect.

If it was the case that children were influenced into focusing on the food's substance, one would expect to find this same pattern in the younger children as well. However, instead of being more susceptible to those cues, in the separate analyses, the younger age group did not use the food's internal properties to label it. We further controlled for variables that may have highlighted either the food's shape or substance by using black and white drawings of foods and half of the trials only mismatched on label and not healthfulness. Moreover, in terms of what children saw when the test questions were asked, the shape of the food was the larger and more salient drawing with only the substance visible via the open flap. It is for these reasons that we believe that this alternative explanation cannot fully explain these results. However, labels are powerful markers of category membership and future research should examine children's categorization strategies of foods without the use of labels.

Although our stimuli were intended to represent single foods with competing appearances and substances, a cause for concern is if children thought that each stimulus represented two separate foods. For example, the flap in the food shape was similar to a cupboard door that opened up to a second, separate food or that the internal properties were only a small part of the food's shape. We created the stimuli to counter this issue, specifically the flap in the center of the food shape. In addition, preschoolers believe that substances have a core element that is consistent throughout the entirety of the substance, even when transformed (Au, 1994; Dickinson, 1987; Smith et al., 1985). We augmented this understanding through our instructions, descriptions, drawings, and test questions, which all emphasized that the substances were the insides of the shape. In the story, we told children about the strange foods, which were *filled* with broccoli or *filled* with candy. When lifting the flap and showing the substance to participants, we told children 'let's look inside and see what it is made up of inside' and then reiterated twice in Study 1 and once in Study 2 that the substance food (candy) was 'made up of', and 'inside of' the shape ('it is made up of candy', 'look see all of the unhealthy candy inside of it'). In addition, the older (both studies) and younger children's (in Study 2) explanations as to why they answered as they did to the health question support that they believed the substance food was the insides of the food. These explanations refer to the food's healthfulness, to the ingredients and properties of the substance food (e.g., "it's filled with sugar", "its broccoli and that's healthy", "it'll make you strong", "it's good for you"). We believe for these reasons that it is unlikely that the children thought the stimuli represented two separate foods rather than one.

Unfortunately, we cannot attribute this to the change in wording or the visual transformation alone, since we varied both in Study 2. To increase our confidence in the generalizability of these findings to children's actual behavior, there are a few worthwhile areas for future research. For example, understanding whether it is simple visual priming or a more complex understanding of food transformations. This can be tested by utilizing depictions of food transformations, such as the chef starting with the filling and closing the shape back to its original form. It would also be helpful to examine if there are differences in responses based on first versus third person scenarios. In addition, it could be that using only one food in a substance to shape transformation may help younger children to focus on a deceptive food's internal properties. While we do not always have the opportunity to see how our food is made, it may be that this more realistic food transformation could increase children's substance based responses to deceptive foods.

11. Conclusion

To date, there is little research that has investigated *how* children label a food and its healthfulness. There are important implications of the results of our study, namely, that young children still need to be closely monitored in what they eat and informed of why certain foods that appear to one way may in reality be something else. Teaching children to be sensitive to the substance of the food may help children avoid ingestion of unhealthy foods and non-food products. Knowing now that children have a developing appreciation for substances, educators and parents can capitalize on this knowledge by involving children in food preparation and cooking as well as offering food demonstrations and explanations that highlight the importance of a food's internal make up.

Notably, these results reveal which properties children select as the basis for their categorization of food: both its label and its healthfulness. From this initial study, it appears that children's conceptual development, in terms of understanding that a food's internal properties defines its category membership, is similar to other domains, such as natural kinds and artifacts. These findings provide a strong foundation for future research in how children think about foods.

Declaration of interest

None.

Acknowledgements

The authors are grateful to Shanhong Luo and Cameron Gordon for their valuable insights and discussion regarding this research. We would also like to thank Scott Ferris, Jenna Huff, Taylor Gwyn, Ashley Morton, and Bethany Wentworth for their dedicated research assistance. This research would not be possible without the schools, directors/principals, teachers and children. We are thankful for their participation. The first author would like to dedicate this paper to her parents, Dr. Maurice and Barbara Girgis, for their unwavering support.

Appendixes. Supplementary data

Supplementary material related to this article can be found in the online version at doi:10.1016/j.cogdev.2018.08.003.

References

Ahn, W. (1998). Why are different features central for natural kinds and artifacts? The role of causal status in determining feature centrality. *Cognition, 69*(2), 135–178. https://doi.org/10.1016/S0010-0277(98)00063-8.

Au, T. K. (1994). Developing an intuitive understanding of sustance kind. *Cognitive Psychology, 27*(1), 71–111. https://doi.org/10.1006/cogp1994.1012.

Bailenson, J. N., Shum, M. S., Atran, S., Medin, D. L., & Coley, J. D. (2002). A bird's eye view: Biological categorization and, 2018 Biological categorization and reasoning within and across cultures. *Cognition, 84*(1), 1–53. https://doi.org/10.1016/S0010-0277(02)00011-2.

Birch, L. L. (1999). Development of food preferences. *Annual Review of Nutrition, 19*, 41–62. https://doi.org/10.1146/annurev.nutr.19.1.41.

Birch, L. L., & Fisher, J. O. (1997). Food intake regulation in children. *Annals of the New York Academy of Science, 819*(1), 194–220. https://doi.org/10.1111/j.1749-6632.1997.tb51809.x.

Bollinger, B., Leslie, P., & Sorensen, A. (2018). Calorie posting in chain restaurants. *American Ecnocmical Journal: Economic Policy, 3*(1), 91–128. https://doi.org/10.3386/w15648.

Carolinas Poison Center (2018). *Look-a-likes.* Retrieved from http://www.ncpoisoncenter.org/body.cfm?id=276.

Centers for Disease Control and Prevention (2018). *Overweigh & obesity: Childhood obesity facts.* Retrieved from https://www.cdc.gov/obesity/data/childhood.html.

Connolly, G. N., Richter, P., Aleguas, A., Pechacek, T. F., Stanfill, S. B., & Alpert, H. R. (2010). Unintentional child poisonings through ingestion of conventional and novel tobacco products. *Pediatrics, 125*(5), 896–899. https://doi.org/10.1542/peds.2009-2835.

Datar, A., Sturm, R., & Magnabosco, J. (2004). Childhood overweight and academic performance: National study of kindergartners. *Obesity, 12*, 58–68. https://doi.org/10.1038/oby.2004.9.

de Onis, M., Blössner, M., & Borghi, E. (2010). Global prevalence and trends of overweight and obesity among preschool children. *American Journal of Clinical Nutrition, 92*(5), 1257–1264.

Deák, G. O. (2006). Do children really confuse appearance and reality? *Trends in Cognitive Sciences, 10*(12), 546–550. https://doi.org/10.1016/j.tics.2006.09.012.

DeJesus, J. M., Gelman, S. A., Viechnicki, G. B., Appugliese, D. P., Miller, A. L., Rosenblum, K. L., et al. (2018). An investigation of maternal food intake and maternal food talk as predictors of child food intake. *Appetite, 127*, 356–363. https://doi.org/10.1016/j.appet.2018.04.018.

Dickinson, D. K. (1987). The development of a concept of material kind. *Science Education, 71*(4), 615–628. https://doi.org/10.1002/sce.3730710412.

Diesendruck, G. (2001). Essentialism in Brazilian children's extensions of animal names. *Developmental Psychology, 37*(1), 49–60. https://doi.org/10.1037/0012-1649.37.1.49.

Diesendruck, G., & Peretz, S. (2013). Domain differences in the weights of perceptual and conceptual information in children's categorization. *Developmental Psychology, 49*(12), 2383–2395. https://doi.org/10.1037/a0032049.

Flavell, J. H., Green, F. L., Flavell, E. R., Watson, M. W., & Campione, J. C. (1986). Development of knoweldge about the appearance-reality distinction. *Monographs of the Society for Research in Child Development, 51*(1), 1–87. https://doi.org/10.2307/1165866.

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. https://doi.org/10.1111/j.1467-7687.2011.01106.x.

Garcia, J., & Koelling, R. A. (1966). Relation of cue to consequence in avoidance learning. *Psychodynamic Science, 4*(1), 123–124 10.3758_BF03342209.pdf.

Garcia, J., McGowan, B. K., Ervin, F. R., & Koelling, R. A. (1968). Cues: Their relative effectiveness as a function of the reinforcer. *Science, 160*(3829), 794–795. https://doi.org/10.1126/science.160.3829.794.

Gelman, S. A. (2003). *The essential child: Origins of essentialism in everyday thought.* New York: Oxford University Press.

Gelman, S. A., & Davidson, N. S. (2013). *Cognitive Psychology, 66*(3), 327–353. https://doi.org/10.1016/j.cogpsych.2013.02.001.

Gelman, S. A., & Koenig, M. A. (2003). Theory-based categorization in early childhood. In D. H. Rakison, & L. M. Oakes (Eds.). *Early category and concept development: Making sense of the blooming, buzzing confusion* (pp. 330–359). New York: Oxford University Press.

Gelman, S. A., & Markman, E. M. (1986). Categories and induction in young children. *Cognition, 23*, 183–209. https://doi.org/10.1016/0010-0277(86)90034-X.

Gelman, S. A., & Wellman, H. M. (1991). Insides and essences: Early understandings of the non-obvious. *Cognition, 38*(3), 213–244. https://doi.org/10.1016/0010-0277(91)90007-Q.

German, T. P., & Johnson, S. C. (2002). Function and the origins of the design stance. *Journal of Cognition and Development, 3*(3), 279–300. https://doi.org/10.1207/S15327647JCD0303_2.

Gopnik, A., & Sobel, D. M. (2000). Detecting blinkets: How young children use information about novel causal powers in categorization and induction. *Child Development, 71*(5), 1205–1222. https://doi.org/10.1111/1467-8624.00224.

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*(2), 206–214. https://doi.org/10.1016/0022-0965(75)90098-3.

Hirschfeld, L. A. (1995). Do children have a theory of race? *Cognition, 54*(2), 209–252. https://doi.org/10.1016/0010-0277(95)91425-R.

Holub, S. C., & Musher-Eizenman, D. R. (2010). Examining preschoolers' nutrition knowledge using a creation and food group classification task: Age and gender differences. *Early Child Development and Care, 180*(6), 787–798. https://doi.org/10.1080/03004430802396027.

Jaswal, V. K. (2006). Preschoolers favor the creator's label when reasoning about an artifact's function. *Cogntion, 99*(3), B83–B92. https://doi.org/10.1016/j.cognition.2005.07.006.

Kalish, C. W., & Gelman, S. A. (1992). On wooden pillows: Multiple classification and children's category-based inductions. *Child Development, 63*, 1536–1557. https://doi.org/10.1111/j.1467-8624.1992.tb01713.x.

Keil, F. (1992). *Concepts, kinds and cognitive development.* Cambridge, MA: MIT Press.

Kemler Nelson, D. G., Frankenfield, A., Morris, C., & Blair, E. (2000). Young children's use of functional information to categorize artifacts: Three factors that matter. *Cognition, 77*(2), 133–168. https://doi.org/10.1016/S0010-0277(00)00097-4.

Krause, C., & Saarnio, D. (1993). Deciding what is safe to eat: Young children's understanding of appearance, reality, and edibleness. *Journal of Applied Developmental Psychology, 14*(2), 231–244. https://doi.org/10.1016/0193-3973(93)90034-S.

Lafraire, J., Rioux, C., Roque, J., Giboreau, A., & Picard, D. (2016). Rapid categorization of food and nonfood items by 3-to 4-year-old children. *Food Quality and Preference, 49*, 87–91. https://doi.org/10.1016/j.foodqual.2015.12.003.

Lavin, T. A., & Hall, D. G. (2001). Domain effects in lexical development: Learning words for foods and toys. *Cognitive Development, 16*(4), 929–950. https://doi.org/10.

1016/S0885-2014(02)00070-9.

Liberman, Z., Woodward, A. L., 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 USA, 113*(34), 9480–9485. https://doi.org/10.1073/pnas.1605456113.

Lobstein, T., & Davies, S. (2008). Defining and labeling 'healthy' and 'unhealthy' food. *Public Health Nutrition, 12*(3), 331–340. https://doi.org/10.1017/S1368980008002541.

Marcario, J. F. (1991). Young children's use of color in classification: Foods and canonically colored objects. *Cognitive Development, 6*(1), 17–46. https://doi.org/10.1016/0885-2014(91)90004-W.

Medin, D., & Ortony, A. (1989). Psychological essentialism. In S. Vosniadou, & A. Ortony (Eds.). *Similarity and analogical reasoning* (pp. 179–195). West Nyack, NY: Cambridge University Press.

Moll, H., & Tomasello, M. (2012). Three-year-olds understand appearance and reality – just not about the same object at the same time. *Developmental Psychology, 48*(4), 1124–1132. https://doi.org/10.1037/a0025915.

Murphy, G. L., & Medin, D. L. (1985). The role of theories in conceptual coherence. *Psychological Review, 92*(3), 289–316. https://doi.org/10.1037/0033-295X.92.3.289.

National Poison Data System (2016). *Poison center data snapshot – 2016 [Data file]*Retrieved from https://aapcc.s3.amazonaws.com/pdfs/annual_reports/2016_Annual_Report_Snapshot_pdf, 2018 FINAL_.pdf.

Newman, G. E., & Keil, F. C. (2008). Where is the essence? Developmental shifts in children's beliefs about internal features. *Child Development, 79*(5), 1344–1356. https://doi.org/10.1111/j.1467-8624.2008.01192.x.

Nguyen, S. P. (2008). Children's evaluative categories and inductive inferences within the domain of food. *Infant and Child Development, 17*, 285–299. https://doi.org/10.1002/icd.553.

Nguyen, S. P. (2012). The role of external sources of information in children's evaluative food categories. *Infant and Child Development, 21*(2), 216–235. https://doi.org/10.1002/icd.745.

Nguyen, S. P. (2007). An apple a day keeps the doctor away: Children's evaluative category representation of food. *Appetite, 48*, 114–118. https://doi.org/10.1016/j.appet.2006.06.001.

Nguyen, S. P., & McCullough, M. B. (2009). Making sense of what is healthy for you: Children's and adult's evaluative categories of food. In S. J. Ellsworth, & R. C. Schuster (Eds.). *Appetite and nutritional assessment* (pp. 1–13). .

Nguyen, S. P., & Murphy, G. L. (2003). An apple is more than just a fruit: Cross-classification in children's concepts. *Child Development, 74*, 1783–1806. https://doi.org/10.1046/j.1467-8624.2003.00638.x.

Nguyen, S. P., Gordon, C. L., Chevalier, T. N., & Girgis, H. (2016). Trust and doubt, an examination of children's decision to believe what they are told about food. *Journal of Experimental Child Psychology, 144*, 66–83. https://doi.org/10.1016/j.jecp.2015.10.015.

Puhl, R. M., & Latner, J. D. (2007). Stigma, obesity, and the health of the nation's children. *Psychological Bulletin, 133*(4), 557–580. https://doi.org/10.1037/0033-2909.133.4.557.

Rioux, C., Picard, D., & Lafraire, J. (2016). Food rejection and the development of food categorization in young children. *Cognitive Development, 40*, 163–177.

Rioux, C., Lafraire, J., & Picard, D. (2017). Food rejection and the development of food induction in young children. *Journal of Cognitive Psychology*. https://doi.org/10.1080/20445911.2017.1367688.

Roberto, C. A., Larsen, P. D., Agnew, H., Baik, J., & Brownell, K. D. (2010). Evaluating the impact of menu labeling on food choices and intake. *American Journal of Public Health, 100*(2), 312–318. https://doi.org/10.2105/AJPH.2009.160226.

Rozin, P. (1990). Development in the food domain. *Developmental Psychology, 26*, 555–562. https://doi.org/10.1037/0012-1649.26.4.555.

Santos, L. R., Hauser, M. D., & Spelke, E. S. (2002). Domain-specific knowledge in human children and nonhuman primates: Artifacts and foods. In M. Bekoff, C. Allen, & G. M. Burghardt (Eds.). *The cognitive animal: Empirical and theoretical perspectives on animal cognition* (pp. 205–216). Cambridge, MA: MIT Press.

Schultz, C. M., & Danford, C. M. (2016). Children's knowledge of eating: An integrative review of the literature. *Appetite, 107*, 534–548.

Schwebel, D. C., Evans, W. D., Hoeffler, S. E., Marlenga, B. L., Nguyen, S. P., Jovanov, E., et al. (2017). Unintentional child poisoning risk: A review of causal factors and prevention studies. *Children's Health Care, 46*(2), 109–130. https://doi.org/10.1080/02739615.2015.1124775.

Shutts, K., Kinzler, K. D., & DeJesus, J. M. (2013). Understanding infants' and children's social learning about foods: Previous reserach and new prospects. *Developmental Psychology, 49*(3), 419–425. https://doi.org/10.1037/a0027551.

Shutts, K., Kinzler, K. D., McKee, C. B., & Spelke, E. S. (2009). Social information guides infants' selection of foods. *Journal of Cognitive Development, 10*(1-2), 1–17. https://doi.org/10.1080/15248370902966636.

Siegal, M. (1995). Becoming mindful of food and conversation. *Current Directions in Psychological Science, 4*(6), 177–181. https://doi.org/10.1111/1467-8721.ep10772621.

Siegal, M., & Share, D. L. (1990). Contamination sensitivity in young children. *Developmental Psychology, 26*(3), 455–458. https://doi.org/10.1037/0012-1649.26.3.455.

Sloutsky, V. M. (2003). The role of similarity in the development of categorization. *Trends in Cognitive Sciences, 7*(6), 246–251. https://doi.org/10.1016/S1364-6613(03)00109-8.

Sloutsky, V. M., & Spino, M. A. (2004). Naive theory and transfer of learning: When less is more and more is less. *Psychonomic Bulletin & Review, 11*(3), 528–535. https://doi.org/10.1037/0096-3445.133.2.166.

Smith, C., Carey, S., & Wiser, M. (1985). On differentiation: A case study of the development of the concepts of size, weight, and density. *Cognition, 21*, 177–237. https://doi.org/10.1016/0010-0277(85)90025-3.

Taylor, M. G. (1996). The development of children's belies about social and biological aspects of gender differences. *Child Developmet, 67*(4), s1. https://doi.org/10.1111/j.1467-8624.1996.tb01814.x.

Tatlow-Golden, M., Hennessy, E., Dean, M., & Hollywood, L. (2013). Big, strong and healthy. Young children's identification of food and drink that contribute to healthy growth. *Appetite, 71*(1), 163–170. https://doi.org/10.1016/j.appet.2013.08.007.

Thibaut, J. P., Nguyen, S. P., & Murphy, G. L. (2016). Body and soul: Do children distinguish between foods when generalizing psychological and biological properties? *Early Education and Development, 27*, 1250–1262. https://doi.org/10.1080/10409289.2016.1146551.

Valdez, A. L., Casavant, M. J., Spiller, H. A., Chounthirath, T., Xiang, H., & Smith, G. A. (2014). Pediatric exposure to laundry detergent pods. *Pediatrics, 134*(6), 1127–1135. https://doi.org/10.1542/peds.2014-0057.

VanderBorght, M., & Jaswal, V. K. (2009). Who knows best? Preschoolers sometimes prefer child informants over adult informants, 2018 child informants over adult informants. *Infant and Child Development, 18*, 61–71 10/1002/icd.591.

Ventura, A. K., & Mennella, J. A. (2011). Innate and learned preferences for sweet taste during childhood. *Current Opinion in Clinical Nutrition and Metabolic Care, 14*(4), 379–384. https://doi.org/10.1097/MCO.0b013e328346df65.

Wang, G. S., Roosevelt, G., & Heard, K. (2013). Pediatric marijuana exposures in a medical marijuana state. *Journal of American Medical Association Pediatrics, 167*(7) 630-630633. 10.1001jamapediatrics.2013.140.

Wellman, H. M., & Gelman, S. A. (1992). Cognitive development: Foundational theories of core domains. *Annual Review of Psychology, 43*, 337–375. https://doi.org/10.1146/annurev.ps.43.020192.002005.

Wertz, A. E., & Wynn, K. (2014a). Selective social learning of plant edibility in 6- and 18-month-old infants. *Psychological Science, 25*(4), 874–882. https://doi.org/10.1177/0956797613516145.

Wertz, A. E., & Wynn, K. (2014b). Thyme to touch: Infants possess strategies that protect them from dangers posed by plants. *Cognition, 130*(1), 44–49. https://doi.org/10.1016/j/cognition.2023.09.002.

Zlatevska, N., Neumann, N., & Dubelaar, C. (2018). Mandatory caroie disclosure: A comprehensive aanlysis of its effect on consumers and retailers. *Journal of Retailing, 94*(1), 89–101. https://doi.org/10.1016/jretai.2017.09.007.