Grown or made? Children's determination of the origins of natural versus processed foods

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A B S T R A C T

Children utilize different reasoning strategies based upon their knowledge of a category member's origins. However, this has yet to be examined in the domain of foods, which can have origins that are both natural and human-made. Across two studies, younger and older children (N = 98) were asked if familiar and unfamiliar natural and processed foods, non-food natural kinds and artifacts were grown in a garden or made in a factory. Older children were more accurate than younger ones at identifying the origins of all items. In addition, both age groups were better at identifying the origins of non-foods than foods, and at identifying familiar compared to unfamiliar processed foods, though no difference was found between familiar and unfamiliar natural foods. Thus, knowledge of food origins is not developing similarly as with non-food items and familiarity is a factor in identifying processed, but not natural, foods.

1. Introduction

A common theoretical view of conceptual development argues that children develop an early understanding of their world by creating naïve theories specific to certain areas, such as physics and biology (Diesendruck, 2003; Gopnik & Wellman, 1994; Inagaki & Hatano, 2006; Medin & Atran, 1999; Murphy & Medin, 1985; Wellman & Gelman, 1992; Wellman, Hickling, & Schultz, 1997). In support of this view is the young age and relative ease with which children are able to accurately categorize both known and novel entities given the myriad of ways in which a category member could be identified as such. Therefore, it seems likely that there are cognitive mechanisms that constrain children's choices when developing conceptual models based on an emerging understanding of their world and how it interacts with each other (see Murphy & Medin, 1985; Murphy, 2002). These early competencies are due to special reasoning systems that are specific to a few core knowledge areas, which encompass domains that are broad, but coalesce around certain central characteristics (Ahn, 1998; Ahn, Gelman, Amsterlaw, Hohenstein, & Kalish, 2000; Ahn, Kim, Lassaline, & Dennis, 2000; Murphy, 2002; Wellman & Gelman, 1992; Wellman et al., 1997). For the purposes of this research, we focus on two of these core knowledge areas: 1) natural kinds, which are naturally occurring categories, e.g., animals, minerals and plants and 2) artifacts, which are human-made with an intended function or use that determines category membership, e.g., tools, toys and machines.

The extraordinary ability of children to flexibly apply different categorization strategies based on whether the item is natural or human-made centers around their knowledge of categories' origins. Origins inform us of the member's intrinsic potential and is the fulcrum upon which most properties coalesce. For example, natural kinds are not made, but discovered, not subjective, but objective

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(see Dupré, 1981; Hatano & Inagaki, 1994; Kalish, 2002; Keil, 1992). Thus, natural kinds are constrained by the very nature of their internal properties. However, not all items have natural origins, some are created by humans, which fulfill some purpose of human needs or desires. Therefore, we categorize it based on the creator label or intended function rather than its naturally occurring internal properties. Similar to natural kinds, our concepts of artifacts revolve around the knowledge that its origins are human-made.

Young children appear to be aware of and make different assumptions based on a category member's origins. Children as young as 4 years apply biological properties and explanations to natural kinds, while for artifacts children apply intentional properties and explanations (Backscheider, Shatz, & Gelman, 1993; Carey, 1985; Gelman, Spelke, & Meck, 1983; Hatano & Inagaki, 1994, 1996; Jipson & Callanan, 2003; Springer & Keil, 1991; Simons & Keil, 1995; Waxman & Braun, 2005). For example, 4-year-olds select explanations based on inheritance or genetics for natural kinds (e.g., a 'mom' flower is responsible for the color of its seeds) and human-made or mechanical ones for artifacts (e.g., a worker made the color of a soda can; Springer & Keil, 1991). In addition, 4- and 5-year-olds are able to apply cognitive properties, such as emotions, thinking, and feelings, to animals but not to machines, and biological properties, such as brains to humans but not to computers or dolls (Scaife & Van Duuren, 1995; Subrahmanyam, Gelman, & Lafosse, 2002). Children explain the movement of animals and toys differently, believing that animals move because of intention, muscle contractions and bones, while toys move because of external forces or mechanical gears and batteries (Gelman & Gottfried, 1996; Gelman & Kremer, 1991; Gottfried & Gelman, 2005; Massey & Gelman, 1988; Simons & Keil, 1995). Indeed, even the questions children spontaneously ask about novel animals and artifacts differ, with more questions about function for artifacts and about biological processes for animals (Greif, Kemler Nelson, Keil, & Gutierrez, 2006).

However, one area that has not been fully investigated is children's knowledge of the origins of foods. Humans need food to survive and have multiple daily interactions with it, yet there is a dearth of research on children's conceptual development in this domain. Beyond its survival value, food is unique in several respects as compared to non-foods. For example, there are fewer opportunities for trial and error learning with foods, given the risk associated with consuming poisonous, rotten, unhealthy or non-food items (ones that look like food but are not). However, food selection is problematic since we are a generalist species (e.g., omnivores) and there is no one characteristic that identifies non-poisonous, heathy foods (see Rozin, 1990, 1999; Cashdan, 1994). Moreover, there are only a few innate constraints to help avoid poisonous foods, such as preference for sweet foods, heightened sensitivity to bitter foods, taste aversion, limited exploration with unknown plants and a rapid decline in willingness to try new foods around the age children become mobile (Birch, 1999; Cashdan, 1994; Garcia & Koelling, 1966; Garcia, McGowan, Ervin, & Koelling, 1968; Liem & Mennella, 2003; Mennella & Ventura, 2011; Wertz & Wynn, 2014b). These constraints are not enough to account for the longevity of the human species, though. Thus, from infancy, there is a heavy reliance on information from external sources about which foods are edible and healthy. Prior exposure to foods through family and community settings are strongly correlated with young children's food preferences (e.g., Birch & Fisher, 1997; DeJesus et al., 2018; Frazier, Gelman, Kaciroti, Russell, & Lumeng, 2012; Harper & Sanders, 1975; Shutts, Kinzler, McKee, & Spelke, 2009; Shutts, Condry, Santos, & Spelke, 2009; Wardle & Cooke, 2008). Children are also likely to use information about foods from members of the family and community, such as mothers, teachers and peers, when making decisions about the healthfulness or tastiness of a food (Nguyen, 2012; Nguyen, Gordon, Chevalier, & Girgis, 2016).

While not specific to foods' origins, previous research has examined young children's knowledge of plants (from which natural foods originate) as part of their naïve theory of biology. Older 4-year-olds and 5-year-olds apply the property of growth to plants, while to a lesser extent other animate properties such as breathing, sickness or death (Beveridge & Davies, 1983; Inagaki, 1996; Keil, 1983; Stavy & Wax, 1989), though Nguyen and Gelman (2002) found that by age 6 years, children consistently apply the concept of death to animals and plants, but not artifacts. Inagaki (1996) found that 5-year-olds could apply properties of illness, nourishment, aging and death to plants (e.g., needs energy from food or will die). In addition, older 4-year-olds and 5-year-olds favor plants repairing itself after injury, e.g., regrowth, as opposed to being mended by a person (Backscheider et al., 1993). Importantly, 4-year-olds understand seed origins, differentiating between flower and fruit seeds, and applying natural causes for their growth (e.g., a seed can only grow from the same fruit) and not human-made ones (e.g., seeds do not come from a factory; Hickling & Gelman, 1996). When asked how growth in plants occur, a majority of older 4- year-olds responded with natural causes, i.e., rain or water (Christidou & Hatzinikita, 2006). Children extend these appropriate explanations to the order in which plants grow, e.g., seed, plant, flower, fruit (Hickling & Gelman, 1996).

While children appear to have solid foundational knowledge of properties associated with the origins of plants, foods add a level of complexity that are not evinced in most other domains. Namely, different foods have different origins: natural foods are a natural kind and processed foods are human-made. These origins provide a wealth of information about the properties associated with the different food types. In the case of natural foods, we categorize them by their internal properties and these properties are applied to all members of a basic level category (e.g., apples). Seeds hold the intrinsic properties of the food it yields, thus category membership is objective and inflexible (e.g., apple seeds cannot grow oranges[1]). In contrast, processed foods are created by humans for the purpose of consumption. These foods are created by mixing multiple ingredients and/or the application of a chemical reaction of some kind (e.g., heat or freezing). As compared to natural foods, these have an increased likelihood to have additives and to be deceptive in appearance (e.g., candy shaped to look like fruit, Dickson-Spillman, Siegrist, & Keller, 2011; Monteiro, 2009; United States Department of Agriculture, 2010).

Given the uniqueness of foods, with its necessity for survival, negative consequences for ingesting poisonous or rotten foods, and young children's heavy reliance on social learning for information about it, previous research has questioned whether children have a

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[1] It should be noted that these basic assumptions may change given the increase in genetic engineering of natural foods.

separate reasoning system for it (Rozin, 1996, Shutts, Kinzler et al., 2009; Shutts, Condry et al., 2009; Siegal, 1995; Wertz & Wynn, 2014a, 2014b). There is support for children's concepts of natural foods being an extension of non-food natural kinds. Girgis and Nguyen (2018) found that older 5-year-olds used a food's substance to identify the name and healthfulness of a deceptive food (e.g., candy shaped apple) similar to the categorization strategies that children use for both natural kinds and artifacts, though the developmental timeline is delayed by approximately a year. Wertz and Wynn (2014a) found that infants as young as 18-months associated fruits as a product of a plant. Shutts, Kinzler et al. (2009) found infants did not initially make inferences about utensils and containers for food differently than ones for non-foods. Yet, there is also research that supports children treat natural foods differently from non-food plants and artifacts. For example, children prioritize different sets of properties when identifying novel foods compared to novel artifacts. Young children are more likely to use color as the basis to identify novel items as food, but use shape to identify a novel item as a toy (Lavin & Hall, 2001; Macario, 1991; Santos, Hauser, & Spelke, 2002). In addition, Wertz and Wynn (2014b) found infants were more cautious around fruit plants that were thought to be real compared to ones that were not. While our research cannot fully answer whether we use a separate reasoning system for foods, it will provide answers as to whether young children are as knowledgeable about the origins of natural and processed foods as they are the origins of category members in non-food domains, as evidenced in previous research.

1.1. Current research

The primary goal was to examine age related differences in children's knowledge of the origins of natural and processed foods. As there is no research to date specific to children's knowledge of the origins of different food types, we operationalized the origins for natural versus processed foods as distinct and discrete categories. It is necessary to first determine whether children can both recognize and identify natural foods as having separate, natural origins compared to processed foods, which are not naturally created. Therefore, we operationalized natural foods as foods that are found in nature, specifically foods that can be found in a garden that need sunlight and water to grow. Processed foods are foods that are human-made, found in a factory that need a mixing bowl and oven to be made. However, no explicit reference was made to human activity or intervention, since humans could be involved in both gardening and in factory settings. Across two studies, 3- to 5-year-olds viewed pictures of food and non-food items and asked if it was grown in a garden or made in a factory.

1.2. Hypotheses

1. In regards to the primary goal of Study 1, we predicted that children would be more accurate at identifying the origins of natural foods as compared to processed foods, since their theory of the natural world is well developed by age 5 years (see Erickson, Keil, & Lockhart, 2010; Gelman & Davidson, 2013; Inagaki, 1996, 2006; Leddon, Waxman, & Medin, 2009).
2. We conducted a second study to examine the role of familiarity on children's knowledge of natural and processed foods. Based on differences in children's categorization strategies of foods in Study 1, we predicted that familiarity may be a factor in children's knowledge of the origins of processed foods, but not for natural foods.
3. Lastly, across both studies, we predicted that older children will be more accurate identifying the origins of all items as compared to younger children (see Gelman, 2003 and Keil, 1992 for an overview of young children's developing concepts in other domains).

2. Study 1

2.1. Methods

2.1.1. Participants

There was a total of 46 participants, who were divided into 23 younger children (M = 3.48 years, *range* = 3.04–4.19, 9 females) and 23 older children (M = 4.83 years, *range* = 4.20–5.39, 11 females). An independent *t*-test revealed a significant difference between the mean age of the two age groups, $t(44)$ = 10.72, $p < .001$. Children were recruited from preschools located in a predominately middle-class, European American city in the Southern United States. Informed consent was obtained from the guardians and assent from participants.

2.1.2. Materials

Since this research was the first we are aware of to investigate this question, we could not be certain that children's knowledge of the different types of natural and processed foods developed similarly. Therefore, in Study 1 we included multiple types of each. Intrinsic to the origins of natural foods, we included fruits and vegetables. In contrast, we divided processed foods into two broad groups: sweets and savories. We also included two types of exploratory variables: meat products and canned/frozen foods. We considered meat products its own group, separate from non-meat savories, due to the differences inherent between meat and plant-based processed foods. While both animals and plants are living entities, animals have brains, faces, voluntary movement, blood, and bones, which differ from the majority of plants. We also included canned and frozen foods to more fully explore whether children were considering human intervention in their origins of foods. The pictures of the canned and frozen foods were designed to be similar to how children may encounter them. Towards this end, the canned food was visible in liquid in the can and frozen foods were visibly frozen (e.g., ice crystals) and in a bag. This allowed us to examine whether children are only considering food type (i.e., natural) or the role of human intervention in food preparation (i.e., processed).

The test stimuli included a total of 27 colored pictures: 23 of food, two of nonfood plants and two of artifacts. There were eight natural food items: four fruits (apple, banana, orange, strawberry) and four vegetables (broccoli, corn, green beans, potato); 15 processed food items: four sweet (cake, chocolate candy bar, cookie, popsicle), four savory (bread, french fries, noodles, pizza), three meat products (chicken nuggets, deli sliced turkey meat, hot dog), and four pictures of canned/frozen natural foods (canned apples, canned green beans, frozen corn, frozen strawberries). The were two non-food plants (rose, tree) and two artifacts (teddy bear, tennis shoes). Each image was approximately 3 in x 3 in on a white background. Children viewed these images via Power Point slides on a laptop.

In addition to these images, there were pictures of a garden, sun, water, factory, mixing bowl and oven for children to visualize our description of the origins and to keep them distinct from each other during the testing process. We selected a garden with the sun and water because older children (4- and 5-year-olds) used these as explanations as to why plants grow (Christidou & Hatzinikita, 2006). We selected the factory since older children endorsed that seeds were not made in a factory (Hickling & Gelman, 1996). Lastly, we selected the mixing bowl and oven to accompany the factory, since these are two common and accessible forms of how humans make processed foods: through mixing ingredients and changing their chemical composition through cooking. These pictures helped to ensure children understood we were referring to only those mechanisms that make a food grow as opposed to one that was made.

The garden picture was approximately 4 in x 6 in. while the sun and water pictures were approximately 2 in x 3 in. The garden picture was centered over the pictures of the sun and water. The factory, mixing bowl and oven were the same sizes and layout, with the factory centered over the mixing bowl and oven. Each set of three pictures were printed on separate sheets of 8.5" x 11" paper. All images were found using search engines such as Google Images and edited using Microsoft Paint. See Appendix A for sample stimuli, though please note that labels were provided verbally to participants and not written underneath the pictures.

2.1.3. Procedure

Children were tested individually for approximately 15 min by a researcher either in a quiet area of their preschool classroom, an empty preschool classroom, or in a laboratory on a university campus.

To begin, pointing to the corresponding pictures, the researcher explained that some foods are grown in a garden, which need a lot of sun and water to grow and some foods are made in a factory, which are made with a mixing bowl and an oven. After asking children to point to the picture of the garden and factory to ensure they correctly understood the labels, the researcher covered the pictures of the sun/water and oven/mixing bowl, so only the picture of the garden and factory were visible. The researcher then explained that they had some pictures of foods and objects but were unsure where these items came from and needed help identifying if they were grown in a garden or made in factory. On a laptop, children saw the 27 pictures. For each, the researcher verbally labeled the picture and asked whether it was grown in a garden or made in a factory (e.g., "See this, this is an apple. Is an apple grown in a garden or made in factory?").

As a result of including the exploratory foods, there were an uneven number of natural and processed foods. To help reduce response bias, we arranged the stimuli in a predetermined random order, so that there was no repetitive pattern when presenting natural and processed foods (for example, not in blocks of 2 processed and 1 natural). In addition, we presented the stimuli in one of two orders across participants, to help reduce the likelihood of testing effects of the stimuli arrangement. Presentation of the garden and factory picture sets were counterbalanced as were the phrases 'grown in a garden' and 'made in a factory'.

2.2. Results and discussion

Correct responses for natural foods (fruits and vegetables) and nonfood plants (rose and tree) were that they grow in the garden. Correct responses for processed foods (sweets, savories) and our exploratory variables (canned or frozen natural foods, meat products) and artifacts (teddy bear, tennis shoes) were that they are made in a factory.

Correct responses were coded 1 and incorrect responses were coded 0.

2.2.1. Natural versus processed foods

To answer whether children differ in their knowledge of the origins of natural and processed foods, we created two summary variables by summing responses for 1) the natural foods trials (fruits and vegetables) and 2) the processed foods trials (sweet and savory). We then divided by the number of trials to get the proportion of correct responses, which are reported as percentages.

A 2 × 2 (Age [younger children, older children] x Food Type [natural, processed]) mixed ANOVA revealed a main effect of Age, such that older children provided more correct responses to the origins of natural and processed foods ($M = 86$ %) than younger children ($M = 67$ %), $F(1, 44) = 16.71$, $p < .001$, $\eta_p^2 = .26$. No other effects were found. Participants' responses were compared to chance. A one-sample t-test (test value = 50 %) revealed younger children provided correct responses to the origins of natural ($M = 68.4$ %) and processed foods ($M = 66.3$ %) at above chance levels, p's < .01 as did older children for both natural ($M = 84.1$ %) and processed foods ($M = 88.5$ %), p's < .001.

One interpretation of these findings is that older and younger children are knowledgeable of the origins of natural and processed foods. However, an alternative interpretation is that children are not flexibly applying different origins to two separate category members housed underneath a single superordinate category. Rather, children may be treating the natural foods as non-food plants and processed foods as artifacts, which would yield the same correct pattern of responding.

Therefore, we included an additional two analyses. If children's developing concepts of foods are separate from non-food domains, then we predict their knowledge of the origins of foods will differ from non-food plants and artifacts.
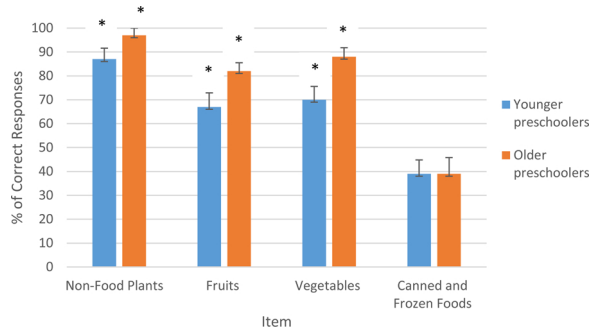
Fig. 1. Participants' correct responses to the origins of fruits, vegetables, canned/frozen natural foods and non-food natural kinds by age. Error bars represent standard error of the mean. Asterisks (*) denote participant responses at above chance levels (50 %).

2.2.2. Natural foods, canned/frozen foods and non-food plants

In order to examine 1) whether young children are simply thinking of, and therefore categorizing, natural foods as non-food plants and 2) whether children make use of cues that indicate human intervention, we created the following summary variables: 1) fruits, 2) vegetables, 3) frozen/canned fruits and vegetables and 4) nonfood plants. We separated natural foods into fruits and vegetables to further examine any differences in beliefs about origins children may have between them as compared to non-food plants.

A 2 × 4 (Age [younger children, older children] x Item [fruits, vegetables, canned/frozen, non-food plants]) mixed ANOVA revealed a main effect of Age, such that older children provided more correct responses for the origins of all items as compared to younger children, $F(1, 44) = 9.26$, $p = .004$, $\eta_p^2 = .17$ and a main effect of Item, $F(3, 132) = 37.37$, $p < .001$, $\eta_p^2 = .45$. No interaction was found. To follow up on the main effect of Item, we conducted a series of six paired sample t-tests. Bonferroni-adjusted significance level of .008 (.05/6) was calculated for these tests to account for the increased possibility of a Type-I error. The results revealed children as a whole provided more correct responses for the origins of non-food plants than for vegetables, $t(65) = 3.56$, $p = .001$, fruits, $t(65) = 3.43$, $p = .001$, and canned/frozen natural foods, $t(65) = 9.11$, $p < .001$. In addition, children provided more correct responses for the origins of fruits and vegetables than for canned/frozen natural foods, $ts(65) = 5.90, 6.39$, $ps < .001$, respectively. There were no differences in children' correct responses for the origins of fruits and vegetables, $p = .31$. See Fig. 1 for responses to origins of plants, natural foods (fruits and vegetables) and canned/frozen foods by age.

2.2.3. Savory, sweet and meat processed foods and artifacts

In order to examine 1) whether young children are simply thinking of, and therefore categorizing, processed foods as human made artifacts, we created the following summary variables: 1) savory, 2) sweet, 3) meat products and 4) artifacts. The reason for separating processed foods into the three categories was that each of these categories vary in taste, appearance and in composition and we are uncertain as to whether children's knowledge of the origins of these different types of processed foods develop similarly or differently as compared to artifacts.

A 2 × 4 (Age [younger children, older children] x Item [savory, sweet, meat, artifacts]) mixed ANOVA revealed a main effect of Age, such that older children provided more correct responses for the origins of all items than younger children, $F(1, 44) = 10.08$, $p = .003$, and a main effect of Item, $F(3, 132) = 4.95$, $p = .003$, $\eta_p^2 = .18$. No interaction was found. To follow up on the main effect of Item, we conducted a series of six paired sample t-tests. Bonferroni-adjusted significance level of .008 (.05/6) was calculated for these tests to account for the increased possibility of a Type-I error. The results revealed children as a whole provided more correct responses for the origins of artifacts than for savory foods, $t(65) = 2.77$, $p = .007$, sweet foods, $t(65) = 2.22$, $p = .03$, and meat products, $t(65) = 3.69$, $p < .001$. There were no other differences found, $ps > .03$. See Fig. 2 for percent of correct responses to
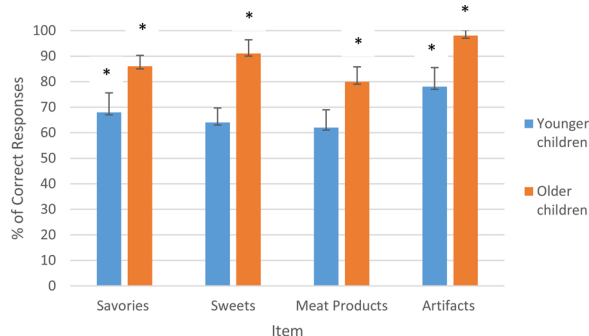

Fig. 2. Participants' correct responses to the origins of savory, sweet and meat processed foods and non-food artifacts by age. Error bars represent standard error of the mean. Asterisks (*) denote participant responses at above chance levels (50 %).

savory and sweet foods, meat products and artifacts.

The results did support our predicted age differences with older children better able to identify the origins of the food and non-food items than the younger children, but did not support our prediction that children would identify the origins of natural foods more accurately compared to processed foods. However, these results do reveal that children's knowledge of origins develops similarly among the different types of natural and processed foods, i.e., similar for fruits and vegetables and conversely, for sweets, savories and meat products.

While one reason for this pattern of results is that children consider natural and processed foods as nested under the single category of foods, another reason may be that children are treating natural foods as part of the plant category and processed foods as human-made artifacts. Therefore, we ran additional analyses on our exploratory variables and non-food controls to determine which of these may be more likely. As we expected, children's knowledge of the origins of natural and processed foods were not developing similarly to their knowledge of the origins of non-food plants and artifacts. Children provided more correct responses for the origins of plants, followed by fruits and vegetables and lastly, for canned and frozen natural foods (plants > fruits & vegetables > canned/ frozen natural foods). In addition, children provided more correct responses for the origins of artifacts than sweets, savories and meat products (artifacts > sweets, savories, meat products).

We were intrigued by the pattern of results in regard to children's knowledge of the origins of our exploratory variables: meat products and canned/frozen foods. Children did not differ in their knowledge of the origins of meat products as opposed to processed foods that did not include meat. While the labels of two of the three meat products referenced meat (chicken nuggets and deli sliced meat), it could be children are not connecting these foods to the actual animals used in its ingredients, but rather recognize it as being not natural. Alternatively, it could be when determining the origins of processed foods, children are considering all ingredients, including meat, equally rather than individually. We cannot make any definitive conclusions from this one study, but an important next step will be to include a wider variety of meat produces that vary on how much human intervention was needed to make it. For example, responses to fried or grilled chicken parts (breast, leg, thigh) may differ from deli sliced turkey meat.

We were surprised that children did not appear to systematically use cues of human intervention to identify the origins of natural foods that had been processed into canned and frozen ones. Therefore, we examined the individual response pattern to the four canned and frozen foods. We found 21 % of each age group correctly identified the origins of these foods (made in factory) for three or more of them, approximately 50 % of each age group correctly identified 1 or fewer of the foods, while approximately 30 % of each age group correctly identified half of the foods. From this pattern of results, it appears that children were not using either the subtle or more obvious visual cues (liquid/ice crystals and cans/bags) to identify the foods as processed. Given that children do use human intervention as a basis for the reasoning in some domains (for example, see Guthiel, Bloom, Valderrama, & Freedman, 2004), it could be that children are prioritizing natural foods over human intervention when deciding whether a food is grown in a garden or made in factory. However, given that half of the children were not using any systematic strategy in identifying their origins, neither of these reasons are completely supported by the evidence. The lack of a consistent response supports that children find it more difficult to categorize its origins as compared other types of food. This could be due to frozen/canned natural foods are the closest in appearance to its natural form. Future research is needed to more fully understand why children were not systematically attending to one property: human intervention or natural foods.

As indicated by the first analysis, children did not make distinctions in determining the origins between and among the types of natural and processed foods as we predicted they would. It, therefore, seems that children's concepts of all food types are developing similarly, regardless of whether it is natural or made by humans. Yet, considering the previous research on children's essentialist reasoning strategies in the biological world, it may be that the familiarity of these food types obscured any differences in their knowledge of their origins. We conducted a second study to examine whether familiarity is a necessary factor in children's developing concepts; in particular, with processed foods given the many different ways in which foods can be created through complex, chemical interactions.

3. Study 2

3.1. Methods

3.1.1. Participants

Participants included 26 younger children (M = 3.6, *range* = 3.31–3.97, 8 females) and 26 older children (M = 4.50, *range* = 4.00–5.11, 15 females). An additional group of 20 children (M = 3.9, *range* = 3.01–4.60, 7 females) participated in a task to help select the unfamiliar stimuli for the study. Children were recruited from preschools located in a predominately middle-class, European American city in the Northeastern United States. None of these children had participated in Study 1.

3.1.2. Materials

As this was the first study to investigate the origins of unfamiliar foods, we decided to exclude our exploratory variables from Study 1 (canned/frozen foods and meat products), and instead focus exclusively on fruits, vegetables, sweets and savories. Our concern was that including both familiar and unfamiliar canned/frozen foods and meat products would have lengthened the task to the point where children may have difficulty finishing it because of the increased demands on memory and attention.

The test stimuli included a total of 28 pictures. We used the same pictures of the non-food plants and human-made items from Study 1 (rose, tree teddy bear, tennis shoes), but this time as controls to ensure children understood the procedure. Pictures of the familiar foods were identical to the ones used in Study 1 with two exceptions: noodles and candy bar. In Study 1, the noodles were in

a bowl and the candy bar was sliced in half. In Study 2, the noodles were depicted without the bowl and the candy bar was whole. All of the other pictures were of whole foods and without any artifacts, e.g., bowl, utensils. The food pictures were 6 familiar natural foods: 3 fruits (apple, banana, strawberry) and 3 vegetables (broccoli, corn, green beans); 6 familiar processed foods: 3 sweet (cake, candy bar, cookie) and 3 savory (hot dog, French fries, noodles); 6 unfamiliar natural foods: 3 fruits (gooseberry, papaya, persimmon) and 3 vegetables (daikon, eggplant, tomatillo); 6 unfamiliar processed foods: 3 sweet (baklava, besan ladu, khanom buang) and 3 savory (falafel, orzo, sushi). The pictures' size and presentation were identical to Study 1 as were the pictures and presentation of the garden, sun, water and factory, mixing bowl, oven. See Appendix B for a sample stimuli of the unfamiliar foods.

A separate group of children provided recognizability and familiarity ratings to select the unfamiliar foods. The intention was for the food to be unfamiliar, but recognizable as a food. Therefore, for each picture, children were asked, "What's its name?" and "Is this a food?". Children saw 48 pictures, which included non-food controls to ensure children's attention to the task. Twelve unfamiliar foods were selected from these pictures based on the following criteria: less than 10 % of participants named the food correctly but at least 75 % of participants recognized it as a potential food. In addition, less than 30 % of participants labeled the unfamiliar food with a familiar one, e.g., labeled the persimmon a tomato.

3.1.3. Procedure

The procedure was identical to Study 1.

3.2. Results and discussion

The data were coded as they were in Study 1. Since the alternative explanation for the results in Study 1 were ruled out with the additional analyses, we analyzed responses to the non-food controls with a one-sample t-test (test value = 50 %). It revealed that younger children responded correctly to the non-food controls ($M = 76.9$ %) at above chance levels, $t(25) = 6.49$, $p < .001$, as did older children ($M = 80.7$ %), $t(25) = 7.27$, $p < .001$. Based on these results, they were not included in further analyses.

We examined the impact of food type and familiarity on children's ability to identify food origins, therefore we created 4 summary variables by collapsing across all trials with: 1. familiar natural food, 2. familiar processed food, 3. unfamiliar natural food, and 4. unfamiliar processed food.

A $2 \times 2 \times 2$ (Age [younger children, older children] x Familiarity [familiar foods, unfamiliar foods] x Food Type [natural foods, processed foods]) mixed ANOVA revealed a main effect of Age, such that older children ($M = 75$ %) had more correct responses to the origins of all foods compared to younger children ($M = 61.4$ %), $F(1, 50) = 10.02$, $p = .003$, $\eta_p^2 = .16$. There was also a main effect of Familiarity, $F(1, 50) = 15.07$, $p < .001$, $\eta_p^2 = .23$, which was qualified by a Familiarity x Food Type interaction, $F(1, 50) = 11.00$, $p = .003$, $\eta_p^2 = .18$. Follow up paired sample t-tests revealed participants provided more correct responses for the origins of familiar processed compared to unfamiliar processed foods, $t(51) = 5.17$, $p < .001$, and more correct responses for the origins of unfamiliar natural compared to unfamiliar processed foods, $t(51) = 2.52$, $p = .015$. There were no differences in correct responses between familiar natural and familiar processed foods or familiar and unfamiliar natural foods, $p's > .14$. See Fig. 3 for responses by familiarity and food type.

Similar to Study 1 and as predicted, older children are more likely to identify the origins of familiar and unfamiliar natural and processed foods than younger children. In addition, the results supported the prediction that familiarity would be a factor in children's knowledge of origins of processed foods, but not natural foods, as both age groups were better at identifying the origins of familiar processed foods as compared to unfamiliar ones. Additional support for this is provided by the more accurate responses for the origins of unfamiliar natural foods as compared to unfamiliar processed foods. Moreover, there were no differences in responses between the familiar and unfamiliar natural foods like there was for familiar and unfamiliar processed foods.
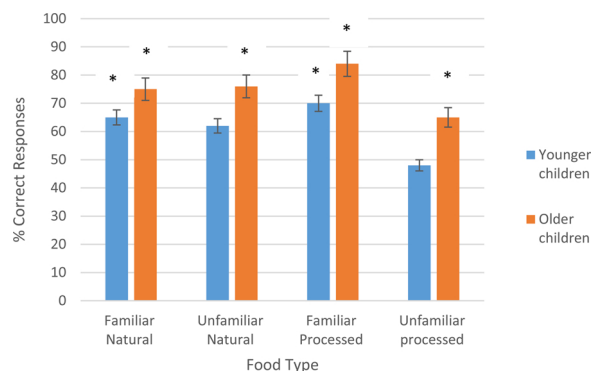

Fig. 3. Correct responses to the origins of familiar and unfamiliar natural and processed foods by age. Error bars represent standard error of the mean. Asterisks (*) denote participant responses at above chance levels (50 %).

4. General discussion

The dearth of research in children's conceptual development of food is surprising given its centrality in human lives. An essential component to our knowledge of categories is the knowledge of its origins, which is critical to children's developing concepts within a specific domain. This is the first research we are aware of to investigate whether the development of children's knowledge of the origins of foods, specifically, if children understand that natural foods are grown in a garden and processed foods are made in a factory. While this research is exploratory in nature, we believe that it provides a foundation for future research that can deepen our theoretical and applied scientific knowledge of children's developing concepts and interactions with food.

In Study 1, older children were more accurate than younger children, revealing a developmental trend in these domains, including non-food plants and artifacts. Specifically, older children were able to identify the origins accurately for fruits, vegetables, savories, sweets and meat products, but were at chance for canned/frozen foods. Younger children were able to identify the origins accurately for fruits, vegetables, and savories, but were at chance for sweets, meat products and canned/frozen foods. Within each age group, children did not differentiate among basic level category members of natural or processed foods revealing a similar developmental pattern across food types.

Moreover, secondary analyses revealed that children are flexibly applying different origins to members of a single category. This is the first research we are aware of to find evidence that children may not be treating natural foods as plants, and processed foods as human-made artifacts. However, it will be necessary for future research to more fully investigate this with a wider and more varied number of foods.

Interestingly, both age groups were not able to use the cues of human intervention to identify natural foods that had been canned and frozen. This was surprising given the obvious cues that the natural foods were processed, namely the cans and bags in which they were presented. Moreover, the results were not indicative of a pattern wherein half the children identified the correct origins and half the children did not. This pattern of results seems to support that children were uncertain of these foods, identifying its origins by the food type (natural) or by its packaging (processed), though it varied among the different stimuli. One reason for this is that children may not be considering food origins as discrete and separate: natural and human-made. It may be that children consider foods as a hybrid concept (Bloom, 2007; Chomsky, 1995; Malt, 1994). From a core theory perspective, natural kinds have an essence that defines its category membership just as human-made artifacts have an intended function that defines its category membership. However, a hybrid concept is one in which items are considered both natural and artifactual: people can identify it by its internal make-up (e.g., natural) but also consider its intended function, applying it to the larger social context of how it is used. There are several reasons that foods may be considered a hybrid: 1) our daily interaction with it, which includes procuring it (including food selection decisions), creating it and consuming it, 2) the numerous methods in which foods can be created, which vary in the level of human effort and the degree of difference from its natural form (e.g., stewed apples, apple sauce, apple pie) and 3) inherent in its label, food is consumed by humans and therefore has some history of human intervention even for those foods that are natural, e.g., planting and harvesting. It is critical to examine this possibility as future research builds on the results from these two studies.

We conducted a second study to examine the effect of familiarity on children's knowledge of the origins of foods. We found the same age differences as we did in the first study, with older children providing more correct responses than younger children for both familiar and unfamiliar natural and processed foods. From the pattern of responses, it appears that familiarity (or lack of) impacted responses for processed foods rather than natural foods. Children were more likely to provide the correct origins for familiar natural and processed foods as compared to unfamiliar processed foods. Additionally, children were more likely to correctly identify the origins of unfamiliar natural foods as compared to unfamiliar processed foods. Lastly, there were no differences in responses to familiar and unfamiliar natural foods.

What do these differences in responses to unfamiliar processed foods compared to the other food types mean to children's developing concepts of food? These results support that there are properties of natural foods that children are utilizing to identify it that are not used to identify foods that are processed. It may be that knowledge of processed foods takes time and experience to acquire given the many different ways they can be created. It could also be that children's knowledge of the biological world provides some advantage in identifying the origins of natural foods as opposed to processed foods. As mentioned in the Introduction, the natural, objective properties associated with specific natural foods, whether it is familiar or unfamiliar, will reliably be the same, since it is natural. This is not true for human-made foods, where human intention and intervention are the reasons these foods exist, and therefore, less reliable. In addition, there appears to be a higher threshold for determining the origins of a processed food without prior experience or familiarity with it. The evidence from the second study appears to support that children are making these distinctions as well. It is noteworthy that children were able to identify the origins of unfamiliar natural foods given most children have limited experience with how their food is made or grown, as a majority of our foods are procured from grocery stores. Poti and Popkin (2011) found children still ate the majority of their meals at home, but the source of meals changed with close to 60 % of children getting their food (i.e., energy intake) from a store. While we did not collect data on where children get their foods from for these studies, we did an informal sampling of parents of twelve participants in Study 1. We found that all except one went grocery shopping with their children, half helped prepare meals at home with their children and two-thirds had their children help in a fruit or vegetable garden approximately 30 min or less a week. Future research should more thoroughly and systematically explore how children's exposure and experience influence their knowledge of both food types. Critically, future research should investigate whether children are able to apply the appropriate causal explanations to natural and processed foods and if this is similar (or different) to their causal knowledge plants and artifacts.

4.1. Limitations and future directions

While the intention for Study 1 was to explore children's knowledge of origins of a broad array of food types, one possible

limitation may have been response bias due to the uneven number of natural and processed foods. Having established a baseline of children's knowledge of origins for these foods, the next step should be to systematically test different types of food, such as meat products and foods that are derived from meats, like milk and eggs, and to compare this developmental trend to non-food natural kinds and artifacts. A second possible limitation is the selection of the mixing bowl and oven for the processed foods. We selected these because we believed it fit with how most of the processed foods we used were made. However, the mixing bowl and oven could not be applied to all of the foods, like the canned/frozen fruits and vegetables. Though only the garden and factory were visible after the familiarization task, it could be the initial reference to the mixing bowl and oven unintentionally affected children's responses. Future research should include alternative pictures and/or methods for children to identify different food origins.

We took into consideration the color of foods in stimuli selection, however, we did not systematically match the colors between the food types. As found in previous research on children's categorization of foods in general, children may have used color to determine its origins, applying bright colors with natural foods and neutral colors for processed. Considering that color is an intrinsic property of the food determined by its seed (e.g., green versus red apples), it is to be expected that children attend to color as one of the properties that may identify a food's origins. This is a particularly interesting question for future research: which properties do children take into consideration when categorizing familiar or novel foods and are they weighing them differently based on food type.

One aspect we did not investigate is if children take into account the healthfulness of foods when determining whether it was grown in a garden or made in factory. While our processed foods varied in healthfulness, for example unhealthy cake and baklava and healthy sushi and noodles, we did not vary this systematically. Moreover, all of our natural foods were healthy (though few natural foods are unhealthy) and plant based. Future research should continue to investigate if children use a food's origins to determine its healthfulness.

Future research should continue to examine children's reasoning strategies in regard to animal versus plant based foods. There is little research into children's cognitions of animal-based foods, though Hahn and Gillogly (2019) found that children were less likely to identify animal-based foods (e.g., milk, hamburgers) as originating from animals as compared to plant based foods. A systematic investigation of whether natural and processed foods are considered on a continuum rather than considered as discrete categories is needed. Meat products provide a good test of this considering they originate from living natural kinds and range in how processed (or human-made) it is.

In addition, we hope that this research can inform the development of strategies to increase healthy food consumption, given the obesity rate has doubled for children and quadrupled for adolescents in the past 30 years (Centers for Disease Control & Prevention, 2014). One simple, inexpensive method to increase healthier food choices for young children may be to have parents and teachers instruct them in how foods are grown or made. Importantly, future research into children's development of concepts of food should include genetically modified foods and food hybrids, e.g., a tayberry which is a combination of a raspberry and blackberry.

The ultimate goal of this research is to expand our understanding of the current theoretical view of children's conceptual development of foods. A critical aspect of this is to build a model, understanding if, and if so how, children are building their categories of the different food types. Our research has provided evidence that children are differentiating between the food types by their origins, but what properties are they using to do this? Is there a hierarchical structure to their concepts of foods or is it a matter of having a certain cluster of properties that is the threshold to identifying food types? For instance, children's initial concepts of foods might be based on whether an object meets the criterion of being fit for human consumption. If this criterion is met, then children consider the properties associated with natural and processed foods, followed by the specific properties associated with basic level category members. Alternatively, children may consider clusters of properties, such as fit for consumption, origins, appearance, color, texture, with each of these under equal consideration as to whether an object is a food or not. We hope that future research continues to build a fully developed theoretical model of how children and adults consider foods both as its own category and as compared to non-food categories.

5. Conclusions

It appears that even young children are aware that natural foods are grown in the garden with sun and water; conversely, they are aware that processed foods are not grown in a garden but made in a factory with a mixing bowl and oven. This is the first research we aware of to investigate how children are conceptualizing category members with different origins that belong to the same category. The findings suggest that children do not use a uniform strategy when identifying the origins of foods, but differentiate between category members (natural and processed foods) and among categories. In addition, natural and processed foods are not simply an extension of plants and artifacts but may be thought of as separate, stand-alone categories. These results provide additional building blocks for the foundation of our understanding of children's conceptual development of food, especially in light of the dearth of research in this area and the distinctiveness of this domain.

Declaration of Competing Interest

None.

Acknowledgements

Appendix A

Sample Stimuli for Study 1

Natural Food

Apple   *Broccoli*

Processed Food

French fries   *Cake*

Canned and Frozen Food

Canned green beans   *Frozen corn*

Meat Products

Deli sliced turkey

Non-food plants

Rose

Artifact

Teddy bear

Appendix B

Sample Stimuli for Study 2

Unfamiliar Natural Foods

Papaya   *Eggplant*

Unfamiliar Processed Foods

Khanom buang   *Baklava*

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