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Children are unsuspecting meat eaters: An opportunity to address climate change

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ABSTRACT

Eating a plant-based diet is one of the most effective ways people can reduce their carbon footprint. However, global consumption of meat and other animal products is increasing. Studying children's beliefs about food may shed light on the relationship between eating behaviors and climate change. Here, we examined children's knowledge of the plant and animal origins of foods, as well as children's judgments of what can be eaten, using 2 dichotomous sorting tasks. The sample consisted of 4- to 7-year-old children from the United States. We found pervasive errors in their basic food knowledge. Foods derived from animals—especially, but not exclusively meats—were among those that children understood the least well. We suggest that the results may reveal a fundamental misunderstanding in children's knowledge of animal based foods, and we discuss reasons why the origins of meat may represent a particularly challenging concept for children to grasp. We end by considering the role that children may play as agents of environmental protection.

1. Introduction

Human consumption of animal products is a primary driver of climate change (Vermueulen, Campbell, & Ingram, 2012). Livestock are responsible for at least 14.5% of global greenhouse gas emissions (Gerber et al., 2013). As such, one of the most effective behaviors people can adopt to mitigate climate change is to eat a plant-based diet (Hedenus, Wirsenius, Daniel, & Johansson, 2014; IPCC, 2020; Stehfest et al., 2009). On a global level, if the consumption of animal products remains unaltered, climate change will exceed 2°C—a level that experts predict will cause human suffering and death (Kim, Neff, Santo, & Vignorito, 2015). The writer Jonathan Safran Foer (2019) put it this way: "Changing how we eat will not be enough, on its own, to save the planet, but we cannot save the planet without changing how we eat" (p. 97).

Despite the compelling scientific evidence that eating fewer animal products is a critical high-impact behavior to remediate climate change, people have been reluctant to modify their diets. In some respects, the refusal to cut back on animal foods may be attributed to a lack of recognition that meat consumption is related to global warming (de Boer, de Witt, & Aiking, 2016; Macdiarmid, Douglas, & Campbell, 2016). However, meat eating is prevalent even among individuals who are aware of the environmental costs of animal-based diets (Scott, Kallis, & Zografos, 2019; Šedová, Slovák, & Ježková, 2016).

Although meat eating is pervasive, it is also a psychologically complex behavior. Researchers suggest that many people experience unease while eating meat. Omnivores eat foods that entail animal suffering and death while at the same time endorsing the compassionate treatment of animals—a phenomenon referred to as the *meat paradox* (Loughnan, Bastian, & Haslam, 2014; see also; Foer, 2010; Joy, 2011; Singer, 1975). The tension between eating meat and the deeply held belief that animals should not be intentionally harmed has been documented in cultural contexts where meat eating is normative as well as ones where it is less ubiquitous (Khara, Riedy, & Ruby, 2021, but see also; Tian, Hilton, & Becker, 2016). A growing body of evidence points to the varied and powerful means by which meat eaters alleviate the distress of eating animals so that their diets can remain unchanged (Bastian & Loughnan, 2016; Rothgerber, 2020). For one, meat eating is rationalized as being "natural, normal, necessary, and nice" (Piazza et al., 2015, p. 116). Additionally, people attribute fewer mental capacities to animals that are eaten such as chickens and cows compared to animals that do not typically serve as food sources, including lions and dolphins (Bastian, Loughnan, Haslam, & Radke, 2012). In a striking demonstration of the real-time manner in which these protective mechanisms operate, participants were randomly assigned to eat either beef or nuts; those who ate beef expressed less moral concern for animals and judged animals to

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be less capable of suffering (Loughnan, Haslam, & Bastian, 2010).

The strategies that people use to assuage the negative feelings arising from eating animals seem to be quite effective because the global demand for meat and other animal foods shows no signs of slowing. In the United States, meat consumption is at an all-time high, with the average American eating more than 200 pounds of poultry and red meat annually (Haley, 2018). One conclusion is that the appetite for meat is stronger than the will to change behavior—even when doing so would benefit the environment, improve one's own health, and reduce the suffering of animals. Eating patterns in adulthood may be especially resistant to change for a variety of reasons. For one, adult eating behaviors are well-established habits that have been reinforced by cultural beliefs regarding the centrality of meat in the human diet. Moreover, the intractability of animal-based diets may also stem from culturally-defined symbolic values associating meat with status, wealth, and masculinity (Leroy & Praet, 2015; Rothgerber, 2013; Smil, 2002). To further complicate matters, cultural practices exert a strong influence on beliefs regarding which animals are suitable food sources. Eating horsemeat is considered taboo in the United States, for example, but horses are eaten without reservation in a number of other countries including Belgium, Iceland, Indonesia, and Japan. Finally, what one eats is widely considered to be a deeply personal decision, and one that should be protected from outside influence (Counihan, 1992). This view appears to be shared by non-governmental environmental groups that have intentionally avoided mounting campaigns to promote plant-based diets (Laestadius, Neff, Barry, & Frattaroli, 2014).

Studying children's beliefs about animal-based foods may offer a unique vantage point from which to better understand adults' resistance to eliminating—or even reducing—meat and other animal foods from their diets. For one, young children are still in the process of developing a complete understanding of the values attached to meat in their culture. Moreover, children may not have access to the same set of strategies that adults in their culture employ to quiet the unease generated by the meat paradox. Finally, children are still acquiring and refining conceptual knowledge of where food comes from, including its origins as well as the processes that transform raw products into the foods that show up on the dinner table.

Compared to research on children's food preferences and their knowledge of the nutritional value of food (see Schultz & Danford, 2016 for a review), considerably less is known about children's knowledge of the origins of food (e.g., the fact that beef comes from a cow, or that chickens produce eggs). This gap in the literature is surprising given contemporary social movements that encourage consumers to re-engage with food, ask questions about the processes underlying food production, and develop relationships with the people who farm the plants and animals that later end up on plates (Pollan, 2006). Concurrent with this trend, parents have expressed a desire for their children to know where food originates (Cairns & Johnston, 2018; Cairns, Johnston, & MacKendrick, 2013).

Overall, children's knowledge of food production processes appears to be surprisingly limited. Approximately one-third of children between the ages of 5 and 8 years do not know what bread, cheese, or pasta are made from, according to a large national survey in the United Kingdom (British Nutrition Foundation, 2013). These results are consistent with interview data indicating that American students in grades K-3 have only a vague idea of how common foods are made (Brophy, Alleman, & O'Mahony, 2003). Nearly half of students interviewed could not provide any relevant response when asked about the production of cheese; 31% were unaware of the origins of bread, and 40% of children were stymied by the production of a hamburger. The researchers noted that children knew the least about foods that undergo radical perceptual transformations during the production process (e.g., bread), especially those that are manufactured outside of children's everyday experiences (e.g., cheese, hamburgers). Although the research on this topic is sparse (see also Berti & Bombi, 1989), it suggests that school-age children have only a limited understanding of the origin of common foods.

One reason that children may lack basic food knowledge is because so many of them have very little exposure to how food is grown. With fewer and older Americans farming, the number of children in the United States who live on working farms has dwindled (U.S. Department of Agriculture, 2014). As industrialized food systems gain dominance, both children and adults are becoming increasingly distanced from the plants and animals they eat. Although food is a common topic in early childhood education, the curriculum tends to focus on *what* to eat (e.g., Hughes, 2007; Whiteley, Matwiejczyk, Hons, & Diet, 2015) rather than teaching children basic factual information about food sources. According to this line of thinking, growing up in close contact with food may be associated with greater levels of knowledge in childhood regarding food origins and production.

In addition to learning from direct observation, young children also build their conceptual structures of food through input from other people (Shutts, Kinzler, & DeJesus, 2013). Cairns and colleagues have reported on parents' felt sense of responsibility to teach children about the food they eat (Cairns et al., 2013; Cairns & Johnston, 2018). Family conversations about food happen naturally at mealtimes (Bray, Zambrano, Chur-Hansen, & Ankeny, 2016), and parents use these opportunities to convey values related to health, family and religious beliefs (Beltran et al., 2012). Interestingly, environmental impacts seem to be largely absent from parents' conversations with children about food choices.

Given the primacy of social learning in children's food knowledge, it is important to consider its potential limitations. One inherent risk of social learning is that informants do not always provide accurate information, sometimes unintentionally (i.e., because their own knowledge is faulty) and other times because they choose to provide incomplete or inaccurate information. Food is a domain in which parents openly admit to lying to their children (Heyman, Hsu, Fu, & Lee, 2013; Heyman, Luu, & Lee, 2009). For example, they may serve vegetables to unsuspecting children disguised in pasta or smoothies, or they may make patently false claims, such as that not eating carrots causes blindness.

Parents may be especially likely to misrepresent meat to children given their own complex relationship to animal foods (namely, the meat paradox). The widespread misgivings that omnivores have about eating animals may be expected to affect how parents talk to their children about meat. The meat paradox is brought into sharp focus when parents are put in the position of verbalizing tacit beliefs and values about animals that come into conflict with behavior. That is, parents who think it is important to teach children to be kind to animals also serve children animal-based foods at mealtimes. Little is known about how parents broach these types of conversations with children. In one of the only studies examining this issue, Australian researchers found that parents, especially those in urban locations, reported avoiding engaging children in conversations about where meat comes from (Bray et al., 2016). When pressed, these parents were also likely to parcel out vague responses to children's queries rather than divulge factual information in a single, big reveal. These findings are consistent with the idea that, in some Western cultures, talking about the slaughter of animals is considered to be taboo, especially with children (Heinz & Lee, 1998). Parents may also hesitate to explain meat production to children if they think that doing so would condone the maltreatment of animals or possibly result in the refusal to eat meat (Bray et al., 2016; Cairns & Johnston, 2018).

Parents' discomfort in talking about the animal origins of food may also stem from feelings of affinity toward animals shared by adults and children alike. People give special status to animals that are similar to humans (Borgi & Cirulli, 2015; Tisdell, Wilson, & Swarna Nantha, 2006). Adults express reluctance to consume animals that they judge to be intelligent, perhaps because intelligence is often viewed as a human characteristic (Ruby & Heine, 2012). Altogether, this research could point to additional reasons as to why adults avoid explaining to children the origin story of their hamburger, as well as reveal a potential knowledge base that may lead some children to become vegetarians.

When people do talk about where meat comes from, they frequently use veiled language that children could easily misinterpret. To say that hamburgers come from cows, for example, may lead children to conclude that cows produce hamburgers in the same way that a tree produces apples. In fact, interviews with children in kindergarten through third grade demonstrated that not all children comprehend that meat is the flesh of dead animals (Brophy et al., 2003). Even when children make this connection, they may not understand that animals are intentionally killed for meat production, believing instead, that meat is harvested from animals that died of natural causes. Together, these results indicate that meat may comprise a unique gap in children's food knowledge. Failing to understand the link between animals and meat may support early dietary preferences that have grave environmental impacts, particularly as they become resistant to change later in life.

In the current work, we were motivated to study children's understanding of food because of what it might reveal about pervasive eating behaviors known to be a leading cause of environmental harm. We set out to assess basic knowledge of common foods among American children between the ages of 4 and 7 years with the idea that the results may inform efforts to combat climate change by way of eating behaviors. In two independent card sorting tasks, we asked children (a) whether foods came from plants or animals, and (b) whether items were edible or not. We were particularly interested in whether children would express different degrees of knowledge about plant-based foods and foods originating from animals.

2. Method

2.1. Participants

We tested 176 children (47% female) between the ages of 4 and 7 years ($M = 5.83$) living in a metropolitan area located in the southeastern region of the United States. The sample was diverse both racially (48% identifying as non-Hispanic white) and in terms of socioeconomic status. Fifty-five percent of our participants came from families that were eligible for government assistance in the form of the Supplemental Nutritional Assistance Program or whose income levels were at or below federal guidelines for low income households. A power post hoc analysis conducted in G*Power revealed that the two-way mixed design ANOVA was sufficiently powered (0.99) to detect a medium effect size (f - 0.25) at the significance level $\alpha = 0.05$ (Faul, Erdfelder, Buchner, & Lang, 2009).

For the purposes of our analyses, we divided children into two age groups: children between the ages of 4 and 5 years were considered younger ($n = 98$), and those between the ages of 6 and 7 years were considered older ($n = 78$). Participants were recruited through an existing database, word of mouth, and from local child care centers and elementary schools. Participation was voluntary, and children received a small gift (e.g., reusable water bottle). An additional 16 children participated, but their data were excluded because they either failed to complete the study ($n = 2$) or their ages were not within our target range ($n = 14$).

2.2. Materials

2.2.1. Food origin sorting task

This task consisted of 13 laminated color pictures (10 cm × 15 cm) of various food items familiar to children, including both animal-based foods (e.g., cheese, chicken nuggets) and plant-based foods (e.g., carrots, French fries). See the Appendix for the complete list. The task also included two embellished plastic boxes (8 cm × 16 cm x 24 cm) that were used to categorize the pictures into those that came from animals and those that came from plants (see Fig. 1). The animal box was covered in animal print synthetic fur that was neutral in color. The plant box was covered in green felt with paper vines and leaves. Both boxes had holes cut in the top where children could insert the pictures.

2.2.2. Edibility sorting task

This task used 14 laminated color pictures (10 cm × 15 cm) of items representing culturally acceptable foods (e.g., a chicken, tomato) as well as items that are not generally considered to be food items in the United States (e.g., dirt, dog). For the complete list of items, refer to the Appendix. The task included two sorting locations (see Fig. 2). A plastic trash bin with a swinging lid (32 cm) served as the location for items that should not be eaten. Items that could be eaten were sorted into a plastic mouth (12 cm).

2.3. Procedure

The study was approved by the university-based Institutional Review Board. All children received written parental permission to participate in the study, and children's verbal assent was obtained at the beginning of the study session. Data was collected individually in sessions that lasted approximately 10 min. Some children were tested onsite at their school in a quiet area with minimal distractions; others came into the laboratory to participate. Parents who brought their children into the laboratory were given the option to watch the session via a one-way mirror in an adjacent room or to sit in the testing room with the child and experimenter. Parents who chose to enter the testing room were asked to sit quietly to the side and refrain from interacting with the child during the session. Laboratory sessions were video recorded whereas sessions that occurred in the school were audio recorded.

The session consisted of two card sorting tasks that were counterbalanced. In the *food origin sorting task*, children were presented with a picture and asked to identify it. If children failed to correctly identify the object, the experimenter provided the correct label. Children were then instructed to sort it into the box for animal-based food or the box for plant-based foods. Upon introducing the boxes, the researcher said, "I'm going to show you pictures of food, and I want you to tell me whether they come from plants or animals. This box is for foods that come from animals. When I show you a picture of a food that comes from an animal, you can put it here [inserting hand in the hole at the top of the box]. This

Fig. 1. Boxes used in the Food Origin Sorting Task. The box on the left was for foods that come from plants and the box on the right was for foods that come from animals.

Fig. 2. Sorting locations in the Edibility Sorting Task. Children were instructed to sort things that can be eaten in the mouth and place items that are not food items in the trash bin.

food is for foods that come from plants. When I show you a picture of a food that comes from a plant, you can put it here [inserting hand in the hole at the top of the box]." And after identifying the food in the picture, the researcher said, "Where should the [food name] go?" This procedure was repeated for all 13 cards presented in random order.

The other task was the *edibility sorting task*. The experimenter introduced the two sorting locations: a garbage can for things that are not OK to eat and a mouth for things that are OK to eat. The researcher said, "In this game, your job is to figure out whether the pictures I show you are things that are OK to eat or not OK to eat. When I show you things that people eat, you put them here [inserting hand in the model mouth]. And when I show you things that people don't eat, you put them here [inserting hand in the swinging garbage can lid]." The experimenter asked comprehension questions to ensure that children understood before starting the task. Similar to the previous sorting task, children were asked to identify each picture and then sort it into one of the two locations (i.e., "It's a [label]. Where should it go?). The procedure that was repeated for all 14 randomly ordered cards.

Table 1
Errors in Identification for Pictures Used in Each Task as a Percentage of the Sample.

Food Origin Sorting Task		Edibility Sorting Task	
Target	Percent of children who failed to identify	Target	Percent of children who failed to identify
Almond	26.7	Cat	0
Apple	0	Caterpillar	3.4
Bacon	14.8	Chicken	1.7
Carrot	1.1	Cow	0
Cheese	0.6	Dirt	1.7
Chicken Nugget	13.6	Dog	0
Egg	4.0	Fish	0
French Fries	6.3	Grass	0
Hamburger Patty	32.4	Horse	0
Hotdog	7.4	Monkey	0
Milk	2.3	Orange	0
Popcorn	1.7	Pig	0
Shrimp	25.0	Sand	0
		Tomato	3.4

3. Results

3.1. Picture identification

First, we examined children's responses when they were asked to identify the pictures prior to sorting. We applied liberal coding criteria given the young age of the children in our sample. As such, we accepted a range of labels that adequately approximated the target (e.g., steak for hamburger, sausage for hotdog). Errors included obviously incorrect labels, such as identifying an egg as a potato, or failing to provide any label at all. Error rates for each individual target used in the two sorting tasks are presented in Table 1. Because the researcher provided the correct label when the child did not know it, we did not omit any data on the basis of incorrect identification.

3.2. Sorting responses

3.2.1. Food origin sorting task

To understand children's performance in the *food origin sorting task*, we first examined error rates for each individual target item. As shown

Table 2
Error rates in the Sorting Tasks Ordered by the Percent of Children Who Sorted Each Item Incorrectly.

Food Origin Sorting Task		Edibility Sorting Task	
Target	Percent of children who sorted incorrectly	Target	Percent of children who sorted incorrectly
French Fries	46.59	Cow	76.70
Cheese	44.32	Pig	73.30
Bacon	40.91	Chicken	65.91
Hotdog	39.77	Fish	32.95
Chicken Nugget	38.07	Tomato	7.95
Hamburger	36.36	Grass	5.68
Popcorn	35.23	Orange	5.68
Shrimp	32.95	Cat	5.11
Almond	31.82	Horse	5.11
Egg	30.68	Monkey	3.98
Milk	22.16	Dog	2.84
Carrot	17.05	Caterpillar	2.27
Apple	15.91	Dirt	1.14
		Sand	1.14

in Table 2, all animal-based foods—with the sole exception of milk—were sorted incorrectly by at least 30% of children.[1] With respect to meats, the percent of children claiming that hamburgers, hot dogs, and bacon come from plants ranged from 36% to 41%. Even chicken nuggets, a food that has an animal in its name, were categorized as a plant-based food by more than a third of the children in our sample. One exception to this trend was French fries, the most frequently missed target, with nearly 47% of children identifying them as an animal-based food. Popcorn and almonds were also commonly misclassified, each by more than 30% of children.

Next, we asked whether children's classification of each target differed from what would be expected by chance (50% in the dichotomous sorting task). We analyzed the data using a series of one-sample t-tests, and conducted separate analyses for younger and older children in order to see pattern of developmental change. Children in the younger age group performed above chance levels (p's < 0.05) for 6 targets: almond, apple, carrot, egg, milk, popcorn. Their performance did not differ from chance for the remaining 7 foods: bacon, cheese, chicken nugget, French fries, hotdog, shrimp, hamburger. Older children fared much better in this analysis. They performed above chance levels for all but one target: French fries.

As a next level of analysis, we divided the targets into three categories: plant-based foods, meats, and non-meat animal foods (refer to Appendix). We used this variable as a within-subjects factor (Food Type) and added Age as a between-subject factor in a 2 × 3 mixed ANOVA. The dependent variable was the proportion of errors. The analysis yielded a significant main effect of Age, $F(1, 174) = 28.812, p < .001, \eta_p^2 = 0.142$. Categorization errors were more common among young children (M = 0.403, SE = 0.020) relative to older children (M = 0.241, SE = 0.022). The main effect was qualified by a significant interaction between Age and Food Type, $F(2, 348) = 3.723, p = .025, \eta^2_p = .021$. The interaction, shown in Fig. 3, suggests that younger children made more errors than older children when tested on meats and non-meat animal foods. No age difference was found for plant-based foods.

3.2.2. Edibility sorting task

Children's error rates for the individual target items used in the *edibility sorting task* are presented in Table 2. The four most frequently missed targets in this task were all food-source animals (i.e., cow, pig, chicken, fish). Importantly, children in our sample were much less likely to incorrectly classify organisms that are not commonly eaten in their home country (e.g., cat, horse), targets that were missorted by fewer than 1% of children. It seems that children, especially preschoolers, assume that animals are not eaten. The vast majority of young children's errors (85%) represented times when children sorted food source animals as not OK to eat. Errors of this type were highest for mammals. The majority of younger children sorted cows and pigs as not OK to eat (84% and 79%, respectively).

To see whether children's performance differed from chance (50%), we analyzed the data using a series of one-sample t-tests. Younger children consistently sorted the chicken, cow, and pig incorrectly (p's $<$ 0.05), identifying them as things that are "not OK to eat." All other items were classified accurately at a level that was statistically different from chance (p's < 0.05). The analyses for older children revealed a single difference. Specifically, older children performed at chance ($p > .05$) when deciding whether the chicken was edible. They continued to classify the cow and pig as "not OK to eat" at a level greater than what would be expected by chance, and all other targets were classified correctly (p's < 0.05).

Next, we classified the targets as food source animals (e.g., cow, pig), non-food source animals (e.g., cat, monkey) or non-animals (e.g., dirt, tomato) to create a within-subject variable with three levels (Target Type). The data were submitted to a 2 × 3 mixed ANOVA with Age (Younger, Older) as a between-subject variable. The proportion of errors was the dependent variable. Both main effects were significant. With respect to Target Type, food-source animals (M = .615, SE = .027) were misclassified significantly more often than either animals that do not serve as food sources (M = .042, SE = .012) or non-animal items (M = .038, SE = .008), $F(2, 348) = 325.73, p < .001, \eta_p^2 = .652$. Moreover, younger children (M = .259, SE = .012) made more errors relative to older children (M = .205, SE = .014), $F(1, 174) = 8.610, p = .004, \eta_p^2 = .047$. The interaction between Age and Target Type also reached significance, $F(2, 348) = 3.090, p = .047, \eta_p^2 = .017$ (see Fig. 4). It indicates that children's errors on food source animals and non-animal targets decreased with age. No similar improvement was seen for non-food source animals, likely because even younger children performed well on these targets.

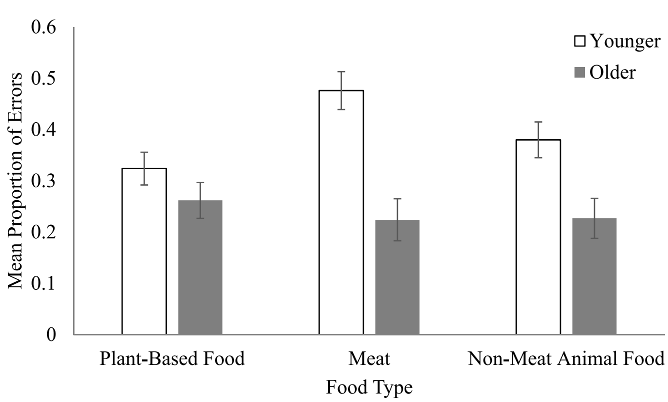

Fig. 3. Interaction between Age and Food Type in the Food Origin Sorting Task. Younger children made more errors than older children in the context of animal-based foods, but not plant-based foods. Error bars represent standard error.

4. Discussion

The present study was motivated by the environmental burden of eating meat and other animal-based foods. Although experts agree that a move toward plant-based diets is critical in combatting climate change (Hedenus et al., 2014; IPCC, 2020; Stehfest et al., 2009), the global

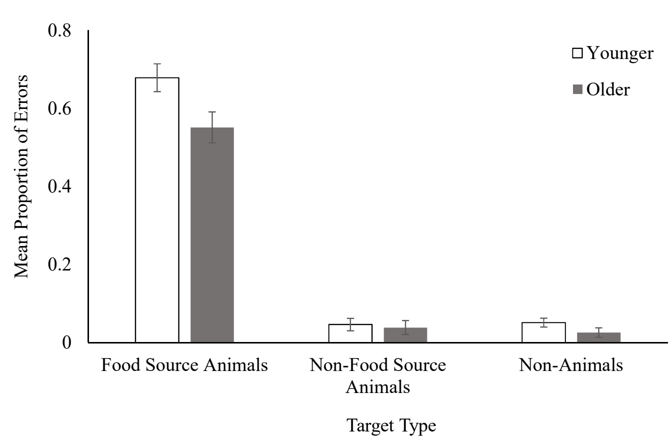

Fig. 4. Interaction between Age and Target Type in the Edibility Sorting Task. Performance improved with age for food source animals and non-animal targets. Error bars represent standard error.

[1] Many foods that traditionally came from animals are now produced from plants (e.g., non-dairy milks, veggie burgers). These alternative items, although increasing in popularity, are not ubiquitous enough to account for the high level of errors we documented with children between 4 and 7 years.

consumption of animal products continues to increase. We purport that addressing children's eating behaviors may offer a more effective approach compared to attempts aimed at modifying adults' well-entrenched diets. As a first step, we asked what young children living in the United States know about common foods derived from plants and animals with the idea that a clearer understanding of children's food knowledge might reveal early dietary propensities that have implications for planetary health. We focused our investigation on children's knowledge of the plant and animal origins of foods, as well as their understanding of what kinds of things can and cannot be eaten.

We found widespread errors in American children's basic understanding of food, suggesting that they may know less than previously recognized. Importantly, foods derived from animals were associated with the highest error rates, particularly among children in the younger age group. Four- and five-year-old children in our sample failed to accurately identify the origins of animal-based foods on a consistent basis. For example, children commonly classified bacon and hot dogs as plant-based foods. Similarly, the young children we tested were not able to reliably identify animals that are culturally appropriate to eat in the United States. Instead, they showed a strong bias to sort animals, irrespective of their cultural status as a food source, as "not OK to eat." The one exception to this trend was fish, which two-thirds of children said was edible. Importantly, young children's poor performance in the two card sorting tasks did not apply equally to all targets. Errors were much more common when children were queried on animal-based foods (*food origins sorting task*) or animals (*edibility sorting task*). The fact that children performed relatively well on items that were unrelated to animals indicates that children's pattern of performance is unlikely to be due to a fundamental flaw with the card sorting tasks. If that were the case, we would expect to see high levels of errors for all targets, not just those related to animals.

We documented considerable advances in children's food knowledge in the span between four and seven years. Unlike the younger children in our study, older children performed similarly on foods in the *food origin sorting task*, no matter whether they were derived from plants or animals. Even though older children were still error prone in this task, they performed at above-chance levels for all foods except French fries. The data suggest that although children in our study initially failed to recognize the animal origins of common foods, they acquired this knowledge around the time they entered the formal education system in the United States.

Importantly, however, not even the six- and seven-year-olds in our sample fully understood the concept of animals as food. The cow and pig were incorrectly classified as "not OK to eat" at a level greater than what would be predicted by chance. Overall, children appear to reject the idea of certain animals as food sources, which we know to be a culturally inaccurate rejection. In what follows, we first address reasons why children's knowledge of animal-based foods lags behind that of other foods. We end by considering the role that young children may play as agents of environmental change.

4.1. Understanding children's confusion about animal-based foods

One reason that children may exhibit confusion about animal-based food is because many parents in the United States are reluctant to talk with their children about the origins of meat. In their research, Cairns and Johnston (2018) identified a conflict between parents' expectation that children know where food comes from and a desire to shelter children from uncomfortable truths about meat production. This line of thinking is consistent with survey results revealing that Australian parents feel uncomfortable talking to their children about the origins of meat (Bray et al., 2016). At one level, parents may deliberately withhold information about animal slaughter in an attempt to safeguard children's innocence, viewing the realities of meat production as too gruesome for children to know at a young age. Reticence to reveal the animal origins of meat also stem from practical concerns that children may refuse to eat meat if they fully understand what it is and how it is produced (see also Hussar & Harris, 2009). Rather than manage the inconvenience of cooking several meal options or confront the emotions that may come with the revelation that the bacon on their child's plate was once a living, breathing pig, some parents instead skirt the truth altogether through vague terminology that has potentially lasting impacts on children's eating habits.

However, deliberate attempts by parents to prevent children from knowing where meat comes are unlikely to be solely responsible for children's lack of knowledge about animal-based foods. Children's misinformation can also be attributed to the ways in which meat is dissociated from its animal origins in many Western cultures that rely heavily on industrialized food systems. Meat products bear little resemblance to animals when they are offered for sale in most grocery stores in the United States. Hamburgers, bacon, and hotdogs are transformed in processes largely invisible to children, so that by the time they end up on a plate the connection between the food and the animal is abstract. Even meat products that contain bones (e.g., chicken legs), look very little like the animals from which they came. Adding to this dissociation, meat products and animals are referred to with different labels in English (e.g., pork and pig). The result is that many children do not have exposure to information that would help them make the connection between meats and their animal sources. Because relatively few children in the United States witness the slaughter of animals, and because parents are vague in their explanations of where meat originates (either purposefully or because of their own unease), it is perhaps not surprising that children's food knowledge in this particular area is underdeveloped.

Our data also indicate that meat is not entirely unique in children's misunderstandings of food. Compared to meats, children knew more about non-meat animal-based foods (e.g., cheese, eggs), but error rates for these products were still higher than those associated with most plant-based foods in the young age group we tested. This suggests that preschool-age children may not fully grasp the animal origins of foods they regularly eat. In this case, children's lack of understanding cannot be attributed to parental concerns about shielding children from uncomfortable facts. Studies in which parents articulated concerns about talking to children about meat did not uncover similar apprehensions about talking to children about non-meat animal products (Bray et al., 2016; Cairns & Johnston, 2018). On the contrary, children routinely hear, for example, that milk comes from cows, and eggs come from chickens. Nevertheless, younger children in the present study still miscategorized these foods—albeit less frequently on average than meats. We believe that young children may struggle to formulate accurate concepts of animal-based foods based on verbal information alone. Children hear that milk comes from cows, but if they do not live on farm, their experience is that milk comes from the refrigerator or the grocery store. The details of what it means for a cow to produce milk (or a pig to make bacon for that matter) is often left unspecified.

More broadly, the data contribute to an understanding of what children know about production processes. In two earlier interview-based studies probing children's understanding of production processes, researchers noted "black-box explanations" in which children were unable to account for the transformation of raw materials into finished products (Berti & Bombi, 1989; Brophy et al., 2003). Our findings reinforce the conclusion drawn by Brophy et al. (2003), that children demonstrate a "fundamental lack of awareness of many of the land-to-hand progressions that bring foods to our tables, especially processes that occur on farms or in factories" (p. 22). Not only are children unaware of the processes responsible for the production of food, the results of the present study also indicate that children lack knowledge of the raw materials of food, even in the case of items that primarily or exclusively consist of a single key ingredient, such as those examined in the present study. That is, in addition to failing to appreciate how a pig becomes bacon, many children in the United States seem to be unaware, on a more basic level, that bacon even comes from an animal.

Finally, the results of the current study shed light on the value that children attribute to non-human animals and how they might be different than those of adults. Consider speciesism, for example. Adults possess a strong bias to favor humans over animals simply on the grounds of species membership (Singer, 1975). As a result, they assign greater moral worth to the lives of humans relative to those of animals in the context of moral dilemmas (Petrinovich, O'Neill, & Jorgensen, 1993; Topolski, Weaver, Martin, & McCoy, 2013). Recent research, however, indicates that such speciesist tendencies are far weaker in children, signaling that speciesism is a socially-transmitted idea that may not surface until relatively late in development (Wilks, Caviola, Kahane, & Bloom, 2021). Four-year-old children have also been reported to appraise the lives of animals and humans similarly when asked to judge the act of killing (Pnevmatikos, 2018). Soon thereafter, however, children begin to give priority to human lives, and the gap in moral judgments between killing an animal and killing a human expands. Taken as a whole, one interpretation is that the value that children place on animals' lives starts out high, but then wanes over the course of development as they acquire socially-held beliefs that prioritize humans and downplay the moral standing of non-humans.

In this same vein, children may learn that an organism's similarity to humans determines its moral worth (Miralles, Raymond, & Lecointre, 2019; Tisdell et al., 2006). The results that emerged from the *edibility sorting task* in the current study are consistent with these patterns. Of the four food-source animals included in the task, errors were highest for the mammals (i.e., cow, pig), followed by the chicken, and then least of all, the fish. Thus, children's understanding of which animals are eaten appear to be closely aligned with their animal preferences, and more broadly, the degree to which animals are similar to humans. Our results therefore indicate that animal preferences may inform children's judgments about which animals can be a source of food, an area that is ripe for future inquiry.

Another area that warrants additional investigation concerns the ways in which culture shapes children's knowledge and attitudes of animals as food. Rothgerber (2020) outlined a number of cultural factors that likely influence the meat-related cognitive dissonance that is experienced in the context of the meat paradox. Chief among them is the degree to which cultures condone animal exploitation and harm (Joy, 2011). Other factors include contact with unprocessed meat, the living conditions and treatment of farm animals, hierarchical beliefs about humans and animals, and the value that different cultures assigned to animals (Rothgerber, 2020). Although sociocultural factors have an undeniably powerful influence in the domain of food, they were not the focus of the current research, and we leave it to others to examine these issues. Moreover, we caution readers to interpret the results of the current study judiciously, acknowledging that our findings may be not generalize to other age groups or children growing up in other cultures or even regions of the United States.

More research is needed to better understand children's concepts of animals as food, as well as how this knowledge develops over the course of childhood. One set of questions centers around how children reconcile seemingly contradictory messages about treating animals kindly with normative eating practices that necessitate animal slaughter. In an attempt to build an explanatory structure that can accommodate both of these facts, children may generate explanations of where meat comes from that do not entail animal suffering. Consistent with this notion, some children seem to think that meat is harvested from animals that have died of natural causes (Brophy et al., 2003). In this way, children's concept of animal-based foods likely resembles other forms of developmental conceptual change in that it involves the incremental refinement of, and occasional qualitative shift in explanatory models when presented with incongruous evidence (e.g., Vosniadou, 1994; Vosniadou & Brewer, 1992). With respect to meat, children may encounter additional contradictory information at the point when parents decide they are emotionally prepared to know about animal slaughter—revelations that would instigate conceptual revision. Overtly contradictory information about meat and the prolonged process of conceptual change may set up lifelong habits of eating meat with minimal moral distress. The stripping of moral culpability is ultimately responsible for the perpetuation of behavioral choices that degrade the environment (Bandura, 2016).

4.2. *Children as agents of environmental change*

The climate crisis demands large-scale behavioral change, including the transition to plant-based diets. Adults in high-emissions countries, however, have not heeded the call to reduce consumption of meat and other foods originating from animals. Most children in the United States also eat animal products, but unlike adults who have built up an arsenal of strategies to justify the consumption of animals, children appear to be naïve meat eaters. The current study suggests that children eat meat unknowingly, and perhaps in violation of a bias against animals as a food source. Childhood may therefore represent a unique window of opportunity during which lifelong plant-based diets can be more easily established compared to later in life.

Because parents are generally responsible for purchasing food and preparing meals, children do not have complete autonomy over the foods they eat. Parents who are more strongly attached to meat choose meals containing larger proportions of meat for their children (Erhardt & Olsen, 2021). Parents who wish to reduce the consumption of animal products in their families should consider making plant-based meals available. Moreover, they should refrain from withholding or distorting information about the origins of the animal-based foods. Given children's propensity to protect animals from harm, they may naturally gravitate toward plant-based foods if they have access to them. Indeed, there is evidence that children between the ages of 6–10 years may choose to eat a vegetarian diet on moral grounds even when their families consume meat (Hussar & Harris, 2009).

More broadly, our results highlight the promise of involving children and youth as agents of change in the climate crisis (see Bandura & Cherry, 2019; Hahn, 2021). Leveraging their moral authority, youth climate activists are gaining both media attention as well as the support of adults (Marris, 2019). Greta Thunberg ignited a global movement (Fridays for Future) when she protested for stronger action on climate change outside of the Swedish parliament at the age of 15. Also at the age of 15, Seattle teen Jamie Margolin established the climate protest group Zero Hour. And in 2015, a group of 21 youth plaintiffs filed a constitutional climate lawsuit against the United States government (Juliana v. United States).

Although adolescents and young adults are responsible for a number of large, coordinated efforts, the results of the current study suggest that children may also have an important role to play as agents of environmental change long before adolescence. A compelling body of evidence indicates that children view the environment as having moral standing (e.g., Howe, Kahn, & Friedman, 1996; Hussar & Horvath, 2011; Kahn & Friedman, 1995; Kahn & Lourenço, 2002). Even as early as three years, children judge environmentally-harmful behaviors to be wrong (Hahn & Garrett, 2017). Children's attitudes toward the environment have also been shown to influence those of their parents (Lawson et al., 2019). This effect is especially noteworthy because children seem to have the most influence on male parents and those who identity as politically conservative, two groups that traditionally report the lowest levels of climate concern (McCright & Dunlap, 2011).

At the family level, youth climate activism may begin at the dinner table. By refraining from eating foods that violate their beliefs about the well-being of animals, children would also be acting in a manner consistent with their moral views of the environment. In addition to reducing their own carbon footprints, children's principled eating behaviors may also influence those of their parents.

5. Conclusions

Children will inevitably inherit the climate crisis that was perpetrated by previous generations. Research in developmental psychology is revealing that children and youth should be viewed as agents of environmental change. Although they do not yet vote or hold positions of leadership, they do possess attitudes and biases that support environmentally-responsible behaviors. Childhood may therefore represent a unique opportunity during which to establish lifelong habits that help to mitigate climate change.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2021.101705.

Author statement

Erin R. Hahn: Conceptualization, Methodology, Writing, Data Curation.

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