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Introduction

Humans relate to animals in many different ways: for companionship, to produce and test products, satisfy our appetites, and entertain us (Herzog, 2010; Knight, Vrij, Bard, & Brandon, 2009). But which animals do we have moral obligations towards, and which traits should guide our decisions about how different animals should be treated? These questions have occupied ethicists for centuries (e.g., Kant, 2001; Singer, 2015). Recently, psychologists have sought to better understand how the average person wrestles with these issues in their daily lives (e.g., Loughnan, Bastian, & Haslam, 2014; Loughnan & Piazza, 2018).

Most ethical dilemmas involving animals entail situations where human and animal interests are in direct conflict, such as slaughtering animals for food. Such dilemmas are often resolved by people acting on a speciesist inclination to value human life over animal life (Caviola et al., 2020; Caviola, Everett, & Faber, 2019; Wilks, Caviola, Kahane, & Bloom, 2020). Other dilemmas involve conflicts where humans must weigh the lives of one animal species against another, for example, killing wolves in the interest of protecting livestock. When approaching such dilemmas, individuals may be guided by anthropocentrism (e.g., preferring the animal with greater utility for humans). Yet, research suggests people also consider the kinds of properties they believe animals possess—e.g., how intelligent or benevolent an animal is perceived—when deciding which animals to protect and value (e.g., Knight, Vrij, Cherryman, & Nunkoosing, 2004; Piazza, Landy, & Goodwin, 2014; Possidónio, Graça, Piazza, & Prada, 2019; Sevillano & Fiske, 2016).

The aim of the present research was to model a wide range of attributions people draw upon when evaluating the lives of different animals and required to choose between them. There is a great need to build a better understanding of how human valuing of animal lives changes developmentally, from early school age to adulthood. Children's perception of

animals and judgments of their worth may differ in important ways from that of adults, but little work has considered how children's appraisals of animal characteristics might impact on their judgments of animal worth.

Children's Knowledge and Evaluations of Animals

From quite a young age, children exhibit a deep fascination with animals. Children between one and three years show more interest in a living animal than a comparable toy (LoBue, Bloom Pickard, Sherman, Axford, & DeLoache, 2013). Young children are able to distinguish biological entities from inanimate objects in their need for nutrition, capacity for growth, and autonomous movements (Hatano & Inagaki, 1994; Inagaki & Hatano, 2006). By school age, children have quite a rich understanding of the unique capacities of animals—in some respects, a more accurate understanding than adults (see Kellert, 1985)—and can reasonably discriminate animal attributes from human attributes (Hatano & Inagaki, 1994).

Children as young as age six are already drawing important attributional distinctions regarding different animals. Some recent work using the Child-Belief in Animal Minds scale suggests that children ages six to thirteen form opinions of which animals have richer versus lesser "minds," with regards to basic emotions and intelligence. For instance, children rated animals such as dogs and chimpanzees as having richer minds than animals like cows and frogs (Hawkins & Williams, 2016). At the same time, young children have been found to struggle with the concept of animal sentience (see Burich & Williams, 2020)—a critical aspect of mind attribution that adults often use to guide their moral concern for animals (e.g., Gray, Gray, & Wegner, 2007; Sytsma & Machery, 2012). By age six, children form opinions about which animals are dangerous that can impact on their dislike for certain animals (e.g., snakes) (Ballouard et al., 2013; Lee & Kang, 2012). Other work has shown that both children and adults alike preferentially attend to both fear-inducing animals (LoBue & DeLoache, 2008) and animals with "cute" or aesthetically pleasing features (Borgi, Cogliati-Dezza,

Brelsford, Meints, & Cirulli, 2014). How these varied attributions relate to the kinds of moral attitudes children have towards different animals remains a largely underexplored area of developmental research.

One recent study by Wilks et al. (2020) compared the way children value animal lives—specifically, pigs and dogs—in relation to human lives. They found, using moral dilemmas where animal lives were pitted directly against human lives, that young children were less speciesist in their valuing of animals to humans. However, the focus of this study was on speciesism (i.e., the extent to which children prioritise human life relative to animal life). It does not directly address the question of how children value different animal lives. Two further studies to date have examined children's preferences for different animal lives. However, both studies are limited in terms of how they inform us about which traits children prioritise in their moral decisions.

Borgi and Cirulli (2015) presented preschool-age children with randomly paired pictures of animals and asked them to select the one they preferred ("liked most"). The authors interpreted the resulting rank order as indicating a high preference for mammals over non-mammals (i.e., a similarity bias). This method is limited in that it relies on the authors' own interpretation of which attributions guided children's preference judgments. Moreover, we must exercise caution in equating liking of animals with moral concern.

Neldner, Crimston, Wilks, Redshaw, and Nielsen (2018) moved beyond preferences and utilized a measure that more closely reflects a judgment of *moral standing*. The authors asked children ages ranging from four to ten how much they cared for an array of entities. The authors found that children tended to care more about mammals than non-mammals—for example, they cared more about dolphins than lizards—though there was variability across age groups. Overall, the results give weight to the claim that children's moral concerns, like their preferences, reflect a similarity bias—a bias that has also been observed in adults (e.g.,

Miralles, Raymond, & Lecointre, 2019). However, Neldner et al.'s own interpretation of the animal rankings was that children had given priority to "high sentience" over "low sentience" animals. Currently, the data remain agnostic with regards to which interpretation best accounts for the pattern.

One straightforward method to help disentangle competing accounts would be to have children themselves make multi-dimensional ratings of animal targets, rather than relying on the experimenters' own interpretation. Such a method would allow us to test whether other inferred characteristics—beyond sentience and biological relatedness to humans—might contribute to children's moral concern for animals. Indeed, in the present study, we sought to apply such a method to arrive at a more systematic, bottom-up assessment of the factors impacting on children's valuation judgments.

While little is known about the dimensions that factor into children's value judgments of animals, a growing body of research has examined the features that impact on adults' moral concerns (Loughnan & Piazza, 2018). Key dimensions include the degree of "mind" an animal is believed to possess (e.g., Knight et al., 2004; Leach, Sutton, Dhont, & Douglas, 2020), how harmful or dangerous an animal is perceived (e.g., Piazza et al., 2014; Sevillano & Fiske, 2016), an animal's aesthetic qualities (e.g., how "cute" the animal appears; Piazza, McLatchie, & Olesen, 2018), an animal's status as a food source for humans (e.g., Bastian, Loughnan, Haslam, & Radke, 2012; Bratanova, Loughnan, & Bastian, 2011; Ruby & Heine, 2012), and the degree of similarity perceived between the animal and humans (e.g., Bastian, Costello, Loughnan, & Hodson, 2012; Tisdell, Wilson, & Nantha, 2006). These dimensions seem to reflect biases among adults related to a tendency to value traits in animals that define what it means to be human (e.g., being smart and sociable; Haslam, Kashima, Loughnan, Shi, & Suitner, 2008); a biophiliac tendency to appreciate animals that induce positive emotions (e.g., joy, tenderness) or fail to elicit negative emotions, such as fear or disgust (Ulrich, 1993;

Wilson, 1984), and an appetitive orientation towards seeing animals as objects for human consumption (Loughnan et al., 2014; Loughnan & Piazza, 2018). Here, we sought to explore whether these tendencies might be present as early as six years of age.

Overview of the Present Study

We investigated a wide range of factors that might contribute to children's developing moral concern for animals. Drawing on previous work—most of which has focused on adult participants—we utilized a multitude of appraisal dimensions that children completed with regards to a broad set of animal targets, including vertebrate and non-vertebrate. The appraised animals were then ordered by children in terms of the target's *relative* moral standing (i.e., their moral standing vis-à-vis the other animals in the set). To investigate the developmental trajectory of children's concern for animals, we sampled children from two different age groups—younger and older school-age children—and compared their judgments with those of adults.

Our selection of attributional dimensions was guided by past research that relates, either directly or indirectly, to the evaluation of animal lives. Although these studies have been predominantly focused on adult judgments, we thought that this literature would be a suitable launching point for our developmental investigation. Our survey of the literature identified four subtopics that touch upon the perception and valuation of animal lives, including studies of (a) mind attribution and moral standing; (b) appraisals of animals used for meat consumption; (c) wildlife conservation decisions; and (d) the treatment of companion animals. Our review led us to identify seven unique dimensions that have the potential to empirically serve as orthogonal predictors of moral standing. These dimensions included an animal's perceived level of (i-ii) "mind" including the aspects of *intelligence* and *sentience*, with "sentience" operationalized in terms of the capacity to experience pain—an aspect of sentience that features prominently in debates about animal treatment (e.g., the

sentience of fish; see Lund, Mejdell, Röcklingsberg, Anthony, & Håstein, 2007), (iii) *benevolence* or an animal's perceived lack of harmfulness, (iv) *edibility* or an animal's status as a source of food for humans, (v) *aesthetic quality* or an animal's perceived physical attractiveness, (vi) special or charismatic *physical abilities*, such as the ability to fly or run fast, and (vii) degree of *similarity to humans*.

Although these seven dimensions have been studied in isolated strands of research, and primarily with adults, we are not aware of any research that has sought to systematically model the moral import of such a wide range of dimensions within samples of children. Obtaining ratings of these attributes among a diverse set of animals, along with moral-standing judgements, allowed us to model which attributions directly fed into children's moral evaluations, and to compare their judgments with those of adults.

Method

Preregistration and Open Science

We preregistered our research objectives, recruitment strategy, methods, and analysis plan on AsPredicted [see https://aspredicted.org/blind.php?x=ek6wr3]. An anonymized version of our data set and copies of our research materials are available on Open Science Framework [see https://osf.io/vn32g/?view_only=65d780793e474a49a4bd7a0f15ef53cb]. This research was conducted within the guidelines of the Faculty of Science and Technology Research Ethics Committee at Lancaster University.

Participants

Our pre-registered recruitment strategy was to recruit a minimum of 200 children (n = 100 per age group) and 150 adults to have a 90% power to detect moderate size effects (f = .25) when comparing across a three-level (age group) between-subjects design using G*power (Faul, Erdfelder, Buchner, & Lang, 2009). Past studies have observed moderate to large relationships between, for instance, perceptions of mind, benevolence, and moral

standing (Piazza et al., 2014). We did our best to recruit roughly equal numbers of younger and older children. Table 1 presents gender distributions of our sample by age group.

Adults. Adult participants were recruited from Prolific Academic. We used Prolific Academic because it caters to workers living in the UK (Peer, Brandimarte, Samat, & Acquisti, 2017), which made it a reasonable comparison group for our children samples. One-hundred and sixty-one adults started the survey and 152 completed it (M_{age} = 34.70 years, *SD* = 12.19). Participants received £3 for completing the survey, which lasted approximately 20 minutes. The majority of the sample was British (76.3%); the remaining participants had a variety of nationalities. Ninety-two individuals (60.5%) were pet owners.

Children. We recruited 243 children from four primary schools in Lancashire, England. Schools were approached by the experimenter and invited to participate. Schools that agreed to participate were given study information sheets and consent forms to be sent home to parents. The rate of return varied between schools. Most schools returned approximately 30% of the consent forms, but one school returned about half. Children with parents who signed the consent forms were asked for their verbal assent before starting the study. Two children were removed, because they only partially completed the second task even with repeated prompts from the researcher, leaving a total of 126 boys and 115 girls. Ages range from 6.17 to 10.33 years (*M* = 8.33). Children were split at the mean age into younger (*M* = 7.83, *SD* = 1.15) and older (*M* = 9.03, *SD* = 0.48) (Table 1). One hundred and seventy-three children (71.8%) had a pet at home.

Table 1

Distribution of gender and demographic location by age group.

	Younger Children (6 to 8 years)	**Older Children (8 to 10 years)**	**Adults**
Male	69	57	55
Female	70	45	96
Total	139	102	151 (1 missing)
City	56	35	64
Small town or village	69	55	72
Countryside	13	11	16
Total	138 (1 missing)	101 (1 missing)	152

Materials and Measures

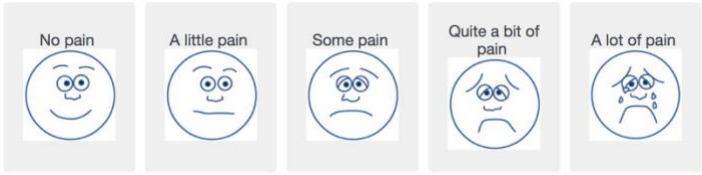
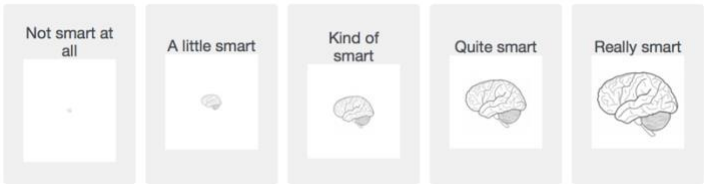
Animal images. Our set of animal targets was inspired by past stimuli used by Piazza et al. (2014, Study 1) and Borgi and Cirulli (2015). These two stimulus sets represented a range of animal types that appeared, at face validity, but also empirically, to differ in their degree of intelligence, sentience (capacity for pain), harmfulness, and similarity to humans. However, we had several ratings to collect for each target. Thus, to make the survey less onerous for children (we aimed for no more than 20 minutes per child), we sought to reduce the number of animals in the set. We also sought to limit the number of mammals in the set out of concern for potential ceiling effects, such as judgments of pain and intelligence clustering at the upper bound of the scale. Our general aim was to provide sufficient coverage

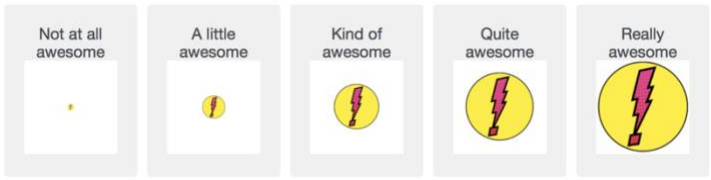
(low, medium, high) of each trait dimension across the entire stimulus set, while balancing these aforementioned concerns—a fuller description of our approach can be found in Supplementary Materials.

The final set included eight well-known mammals (dog, dolphin, elephant, monkey, pig, sheep, wolf, human), two birds (parrot, chicken), two herptiles (frog, lizard), two insects (bee, butterfly), a cephalopod (octopus), shark, arachnid (spider), jellyfish, and worm (19 total). We allowed our intuitions about each trait dimension to guide our selection (see Table S1 in Supplementary Materials for our expectations with regards to each animal target). Once the animal targets were set, we consulted the online, open-source image directory, Pixabay, to obtain a suitable image for each. In selecting the images, we applied a set of six criteria (see Supplements for details).

Table 2

Questions and scales used to measure each attributional dimension.

Variable	Question	Images used for Scales
Pain	If someone hit or kicked ANIMAL really hard, or stepped on ANIMAL, how much pain would it feel?	
Intelligence	How smart or clever do you think ANIMAL is?	
Harmfulness	How dangerous or harmful do you think ANIMAL is?	

Similarity	How much do you think ANIMAL is like you?	
Aesthetics	How ugly do you think ANIMAL is?	
Ability	Animals all have different abilities, horses can run fast, birds can fly, and some lizards can climb up walls. Let's think about ANIMAL's abilities. How awesome would you say those abilities are?	
Eat	Some animals we eat, like turkeys. Let's think about whether people eat ANIMAL. Do people eat ANIMALS?	Yes No
Edibility	How yummy (good) or yucky (bad) do you think ANIMAL would taste?	

Animal attributions. To make the materials more accessible to children, icons were used to correspond to each rung of a 5-point Likert scale to assist with comprehension (see Table 2). For ratings of pain capacity, emotion faces depicting gradations of pain were adapted from the Wong-Baker FACES scale (Wong & Baker, 1988). Faces depicting levels

of disgust (at one end) to satisfaction (at the other end) were adapted from the (DoctorYumProject, 2018) to assess edibility. Ratings of harmfulness were communicated via faces ranging from happy to angry with green, amber, and red scaling. The other questions used pictures which increased in size to indicate the intensity of the answer. An image of a brain was used as the corresponding icon for the intelligence judgment; a cartoon image of two children was used for the similarity judgment; and a yellow circle with a pink lightning bolt (suggesting energy) was used for the ability judgment. A neutral, dark-brown circle was used for the aesthetic judgment to avoid biasing children's judgment in this domain towards a particular appearance or facial configuration.

Before answering the edibility question, children were asked whether people anywhere in the world eat the animal, to distinguish between their knowledge of the animal as a food source and their personal assessment of the edibility of the animal (which was the dimension of interest).

Background activities involving animals and meat. A series of questions were used to assess participants' background activities involving animals. The questions, adapted from Kellert (1985) and Daly and Morton (2006), related to activities in which participants might encounter animals or representations of animals in everyday life (see Supplements for details). Participants were also asked whether they had pets (yes/no) and, if so, they indicated which ones from a list of the following animals: dog(s), cat(s), bird(s), fish, small rodent (hamster, gerbil, mouse, etc.), reptile (turtle, lizard, etc.), amphibian (frog, newt, etc.), livestock (horse, sheep, goat, etc.), other type of pet. Finally, to give us some insights into children's experiences with meat, we asked all participants (children and adults) how often they ate pork, chicken, beef, and lamb. Participants marked whether or not they ate these meat products, and, if so, they indicated how often (never, sometimes, often).

Procedure

Attribution task. Adult participants completed the entire study on the computer. For children, the rating task was completed on a tablet and the experimenter read the questions out loud to the child. They then selected the answer on their own by tapping the corresponding picture/point along the scale. If a child showed fear when rating the spider, the researcher used a white card to cover the image on the screen and, during the moral ranking task, the spider card was placed face down.

During the testing phase, participants were presented each animal target in a randomized order, with the human target always last, and they rated each target on a 5-point Likert scale for each dimension (Table 2). To reduce the length of the study for children, we created two subsets of ten targets, and randomly assigned children to one of the two subsets. The subsets consisted of nine animals and the human target. Half of the children completed each set (Set 1 [120], Set 2 [121]). Each page of the survey depicted a single question, with the image of the animal above the question prompt and Likert scale. The order of the questions was fixed, as presented in Table 2, and the procedure was repeated for all targets.

Moral ranking task. The moral ranking task required participants to value each animal life relative to the entire set of targets in the context of a life or death situation. In other words, the task forced participants to prioritize some animals' lives over others. The task was loosely inspired by the medicine allocation task used by Goodwin and Landy (2014) for different human targets.

Participants were presented with all 19 targets and given the following scenario:

> *Let's imagine for a minute that all the animals are sick. They all have a disease that is going to kill them unless we do something about it. Thankfully, we have some medicine that can help the animals get better. However, we can't help all the animals*

at the same time. We can only help one at a time. We are going to have to make some difficult decisions. Which animal should we help first?

Participants then placed all 19 targets in order from helping first to last. Adults completed this on the computer using a ranking procedure that required them to move each image of the animal, initially presented in a randomized order, into an order from the animal they wished to save first to the animal they wished to save last. Once they were satisfied with the order of targets, they submitted their response.

Children completed the task in person with the assistance of the experimenter. Children were presented laminated versions of the 19 targets. The cards were presented in a random display in front of the child (see Figure 1). Because participants were run back to back, a method was developed to shuffle the images from the preceding child. The cards were placed in a randomized fashion, so that there was no obvious pattern. This procedure sought to eliminate any instinctual reading of the cards from left to right.

The child was prompted by the experimenter to choose the target they would like to help first. The child either pointed, picked up the card, or voiced their selection. As cards were chosen, the researcher moved each selection to the top of the table. The cards were kept in sequence with each subsequent choice tucked partially under the last. This allowed children to review their answers at the end and make any unprompted changes they wished. At the end, the children were asked if they were happy with the order they selected. The experimenter avoided asking children if they would like to make changes, as children might infer by such a prompt that they should make changes.

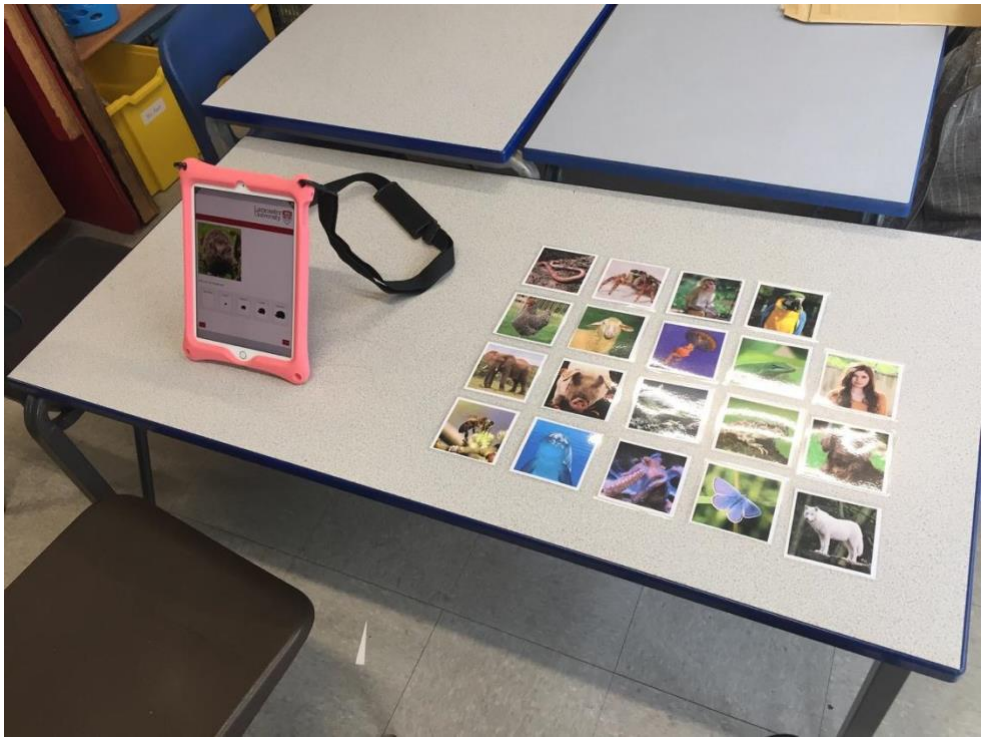


Figure 1. The experimental set up at a school. Cards were not displayed at the same time as the iPad during testing.

After completing the moral ranking task, participants completed the background animal activities questionnaire and demographic questions with regards to their gender, date of birth, and for adults nationality and ethnicity. Adults were debriefed, thanked and paid £3 for their participation. Children were debriefed, thanked and as gratitude to the participating schools, chocolates were placed in the break rooms for teachers to enjoy.

Results

Analysis Plan

Our main goal was to develop data-driven models of the attributional dimensions children and adults use to inform their moral valuations of animals. We used Structural Equation Modeling (SEM) to build structural models for each age group (e.g., Ullman & Bentler, 2003). These models could then be examined for commonalities and differences

across the three groups. Using SEM deviated from our preregistered analysis plan to use factor analysis and multiple regression, but it is in keeping with the intent of this plan.

To this end, we first established a set of criteria that could guide our model development (we elaborate the criteria below). As a first step in this process, we examined the raw correlations between the attribution dimensions and the moral concern rankings for each age group. We allowed these correlations to inform our decisions in the subsequent model-development phase. Throughout our analyses, we used the median ranking score for each animal target as our index of moral concern (for animal median-ranking scores by age group, see Figure 5). Because of the nature of the task (moving one animal up necessitated moving another down) the moral rankings for most of the animals across all ages were quite skewed, either positively or negatively. Thus, it could be argued that the median was a truer indicator of central tendency. Below we present the correlations first, followed by the model development, for each age group. The models were constructed using the lavaan package in R (R Core Team, 2020; Rosseel, 2012).

As a secondary analysis, in line with our preregistered exploratory aims and analysis, we contrasted the moral ranking structures and attribution patterns of each age group with Mann–Whitney *U* tests. We also conducted exploratory analyses of children's understanding of which animals are eaten, attribution patterns and moral rankings as a function of gender, and attribution patterns based on background activities involving animals. These latter analyses were conducted primarily for descriptive purposes, as we had no preregistered hypotheses regarding how gender or background experiences would impact on attributions made of different animals or the valuation of animal lives (see Supplementary Materials).

Step 1: Correlations between Attributions and Moral Rankings

Table 3 presents correlations between the mean animal attribute ratings and the median moral judgment ranking for each of our three age groups.

Table 3

Correlations of the animal attribute ratings and moral rankings by age group.

	Group	Pain	Intelligence	Ability	Similarity	Harmfulness	Aesthetic	Edibility
Intelligence	Children 6-8	-0.307						
	Children 8-10	-0.218						
	Adults	**0.432**						
Ability	Children 6-8	-0.093	**0.862**					
	Children 8-10	0.001	**0.868**					
	Adults	0.356	**0.879**					
Similarity	Children 6-8	0.015	**0.506**	**0.595**				
	Children 8-10	0.032	**0.653**	**0.587**				
	Adults	**0.692**	**0.825**	**0.616**				
Harmfulness	Children 6-8	**-0.482**	0.478	0.319	-0.319			
	Children 8-10	-0.385	0.420	0.267	-0.159			
	Adults	-0.205	**0.518**	**0.445**	0.193			
Aesthetic	Children 6-8	0.134	**0.560**	**0.618**	**0.797**	-0.260		
	Children 8-10	-0.062	**0.661**	**0.482**	**0.793**	-0.203		
	Adults	**0.532**	**0.486**	**0.473**	**0.646**	-0.121		
Edibility	Children 6-8	-0.381	-0.060	-0.209	0.207	-0.029	-0.029	
	Children 8-10	**-0.487**	0.025	-0.148	0.223	-0.106	0.232	
	Adults	0.436	0.115	-0.180	0.401	-0.021	0.042	
Moral rank	Children 6-8	-0.025	0.345	0.344	**0.763**	-0.419	**0.796**	0.019
	Children 8-10	-0.341	**0.523**	0.269	**0.757**	-0.041	**0.674**	**0.544**
	Adults	**0.690**	**0.717**	**0.477**	**0.944**	0.133	**0.597**	0.389

Note. Spearman's correlations are based on mean scores calculated for the seven variables for each of the 18 animal targets; that is, each target comprised a separate case (N = 18) for the seven measures. Bolded values are significant at $p < .05$.

Younger children. Younger children afforded *more* moral standing to animals when they were perceived as beautiful, benevolent, and seen as similar to humans. Pain capacity and edibility had nearly zero relationship with moral concern. Intelligence and ability were positively related to moral standing, but not statistically significant.

Older children. Older children afforded targets *more* moral standing when they were perceived as beautiful, intelligent, edible, and similar to humans. Attributions of benevolence, ability, and pain capacity did not significantly correlate with moral rankings.

Adults. Adults afforded *more* moral standing to animals that were perceived to be beautiful, similar to humans, intelligent, have the capacity to suffer, and have special abilities. Perceptions of benevolence and edibility had weaker associations with moral concern and did not reach levels of statistical significance.

Notably different from children, and something that informed our structural models, only adults perceived animal capacity for pain and intelligence to be positively associated. That is, for adults, the smarter the animal was perceived to be, the more it was deemed capable of suffering. Furthermore, only adults associated pain capacity with similarity to humans, whereas all three groups associated intelligence with human similarity. The relationship between intelligence and similarity was particularly strong for adults.

Attribution reduction. Ability was highly correlated with intelligence for all age groups (> .86). This created a potential issue of multicollinearity when trying to use both ability and intelligence in the structural equation models. Because intelligence had a larger and more consistent relationship with the moral ranking variable, across the three age groups, compared to ability, it was retained and ability was dropped from further analysis.

Step 2: Modeling the Development of Moral Concern

Our approach to model development was both theoretically and empirically driven. We considered insights from previous research on animal attribution, but drew also on the raw correlations we observed between our variables. Though the dimensions that we included in our study were guided by past findings, most of this literature has focused on adults, and thus we cannot assume *a priori* that they apply to younger participants.

A third criterion that we applied was, where possible, to treat similarity to humans as a 'higher order' (superordinate) variable that might be informed by 'lower-level' perceptual judgments. Our reasoning here was that similarity to humans is quite an abstract concept, not a feature that can be directly perceived in an animal, such as an animal's appearance, their physical abilities, etc. Thus, we sought where possible to model similarity as a dimension built upon other lower-level dimensions. For adults, intelligence had the strongest correlation with similarity judgments, whereas for children aesthetics had the strongest correlation with similarity judgments (see Table 3). Thus, intelligence may not be as relevant to children's concept of similarity as it is for adults—a finding which we sought to model more systematically via SEM.

Model fit statistics can be seen in Table 4. A detailed description of our modeling procedures for each group can be found in Supplementary Materials, and the best fit models are depicted in Figure 2 (adults), 3 (younger children) and 4 (older children).

Table 4

Model fit statistics of the Structural Equation Models by age group.

Model Description	χ^2 *(df)*	Comparative Fit Index	Root Mean Square Error of Approximation	Standardized Root Mean Square Residual	Moral R^2
Younger children					
Model 1 (Intel, Harm, and Aesthetic into Moral)	0 (0)	1.000	0.000	0.000	0.744
Model 2 (Sim assimilates Intel Harm and Aes)	7.87 (3)	0.886	0.300	0.065	0.635
Final Model (Aes direct to Moral; see Figure 3)	2.68 (2)	0.984	0.138	0.039	0.747
Older children					
Model 1 (Intel, Ed, and Aesthetic into Moral)	0 (0)	1.000	0.000	0.000	0.684
Final Model (Sim assimilates Intel and Aes; see Figure 4)	1.23 (2)	1.000	0.000	0.020	0.797
Adults					
Model 1 (Pain, Intel, Aesthetic, Ed Harm into Moral)	0 (5)	1.000	0.000	0.000	0.801
Model 2 (Harm dropped)	0 (4)	1.000	0.000	0.000	0.800
Model 3 (Sim assimilates Intel Pain and Aes)	6.38 (4)	0.957	0.182	0.042	0.826
Final Model (Aes direct to Moral; see Figure 2)	1.76 (4)	1.000	0.000	0.028	0.869

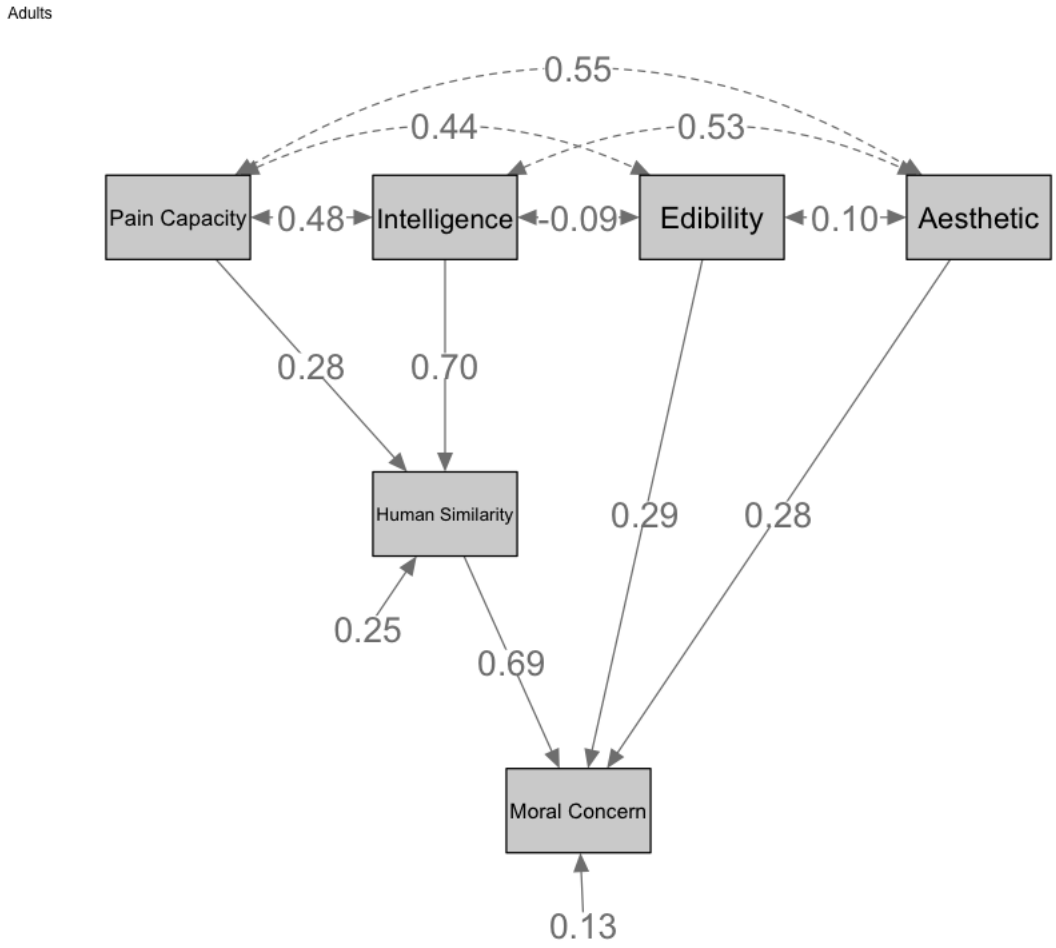


Figure 2. The best fit model of the attributional dimensions predicting adults' valuing of animal lives.

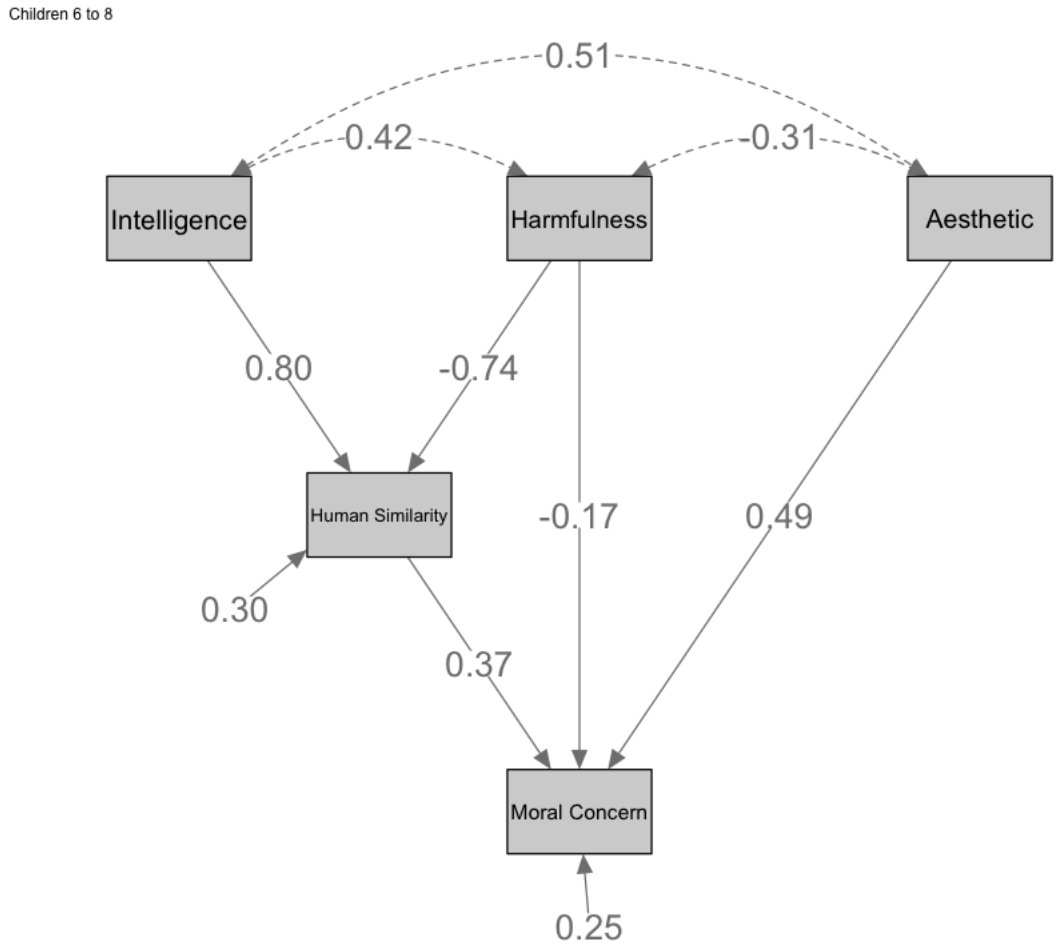


Figure 3. The best fit model of the attributional dimensions predicting younger children's valuing of animal lives.

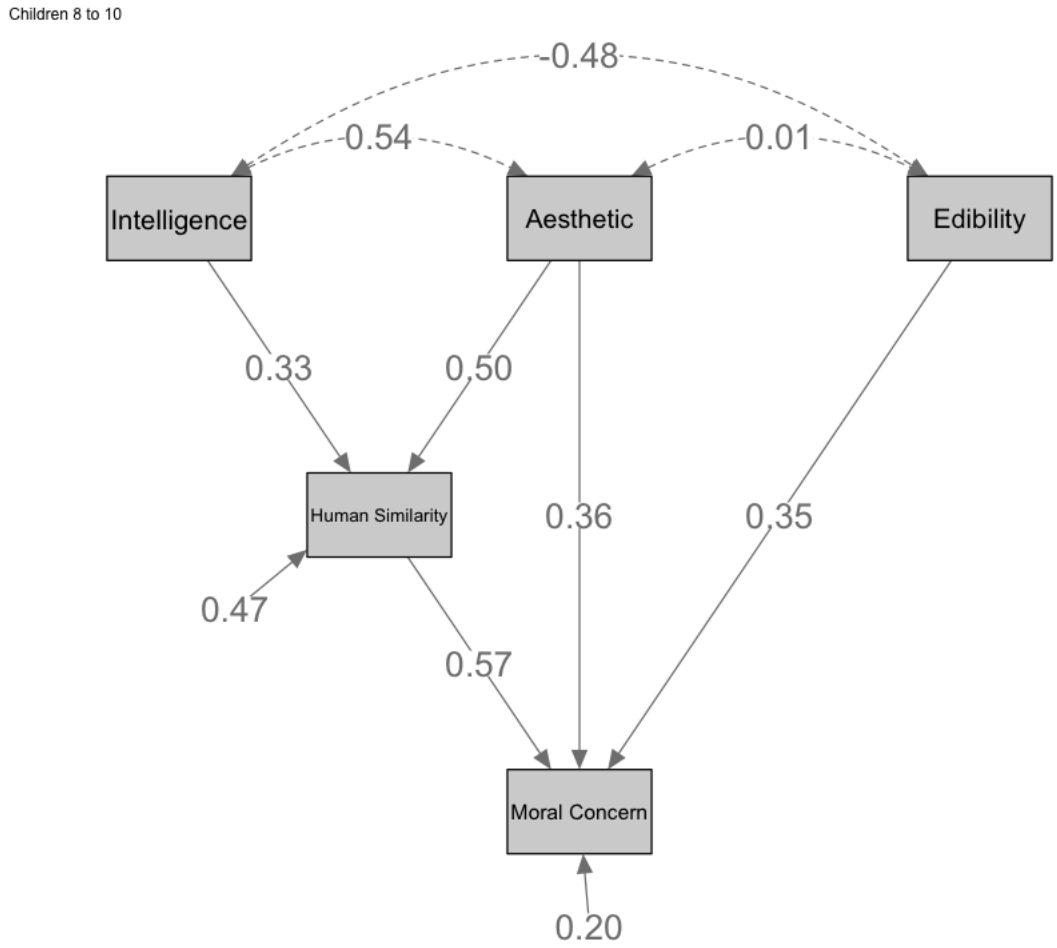


Figure 4. The best fit model of the attributional dimensions predicting older children's valuing of animal lives.

Summary of Modeling Results

Table 5 presents a summary of our SEM results by age group. In sum, younger children exhibited an attribution model that relied heavily on aesthetic judgments and an animal's similarity to humans. Young children's concept of human similarity entailed being intelligent and benevolent. Older children also valued animals high in aesthetics and human similarity. However, older children also factored in an animal's edibility and gave little weight to harmfulness, compared to younger children. Somewhat different from younger

children, older children conceptualized an animal's similarity to humans in terms of intelligence and aesthetics. Lastly, adults' moral concern for animals, like older children, was guided by human similarity, aesthetics, and edibility. However, for adults, human similarity was conceived mainly in mentalistic terms, i.e., the possession of intelligence and sentience. Neither younger nor older children factored sentience into their moral judgments or concept of human-animal similarity.

Table 5

Summary of results: Attributions predicting moral concern for animal lives by age group.

	Younger Children	**Older Children**	**Adults**
Predictive attributions:	Aesthetics Similarity -Benevolence -Intelligence Benevolence	Similarity -Aesthetics -Intelligence Aesthetics Edibility	Similarity -Intelligence -Pain Edibility Aesthetics

Animal Size and Capacity for Pain

Patterns in the children's ratings of the pain capacity of animals suggested that children may have used the size of the animal as a heuristic for guiding their judgments of capacity for pain. To explore this further, the first author ranked the animals by body size from 1 to 19, bees being the smallest and receiving that smallest number and elephants being the largest. This allowed us to correlate the size of the animal with the pain capacity ratings. The size and pain correlation for all children was r_s= -0.78, $p < 0.001$, with larger animals being rated as *less* capable of experiencing pain, while adults' pain judgments exhibited a small, positive, though non-significant, correlation with size, r_s= 0.32, $p = 0.18$.

Children's Meat Consumption, Understanding of Animal Products and Which Animals Are Eaten

Ninety-seven percent of our child participants ate at least one meat group at least sometimes (78% ate beef, 84% ate chicken, 78% ate pork, 36% ate lamb). Because almost all of the children in our sample consumed at least some meat, we did not explore the data in terms of children who do and do not eat meat.

Table 6 depicts children's understanding of which animals are eaten, relative to adults' understanding—the table is limited to animals that received at least 50% agreement by adults. As can be seen, relative to adults and older children, younger children had the lowest understanding of which animals are consumed by people. Chickens were the only animal that younger children understood were eaten at rates comparable to adults. Older children's responses more closely aligned with those of adults, though this was mainly the case for traditional farmed animals (chickens, pigs and sheep) and octopus. Even older children struggled with the notion that other animals, such as sharks, frogs and dogs, are eaten by people somewhere in the world.

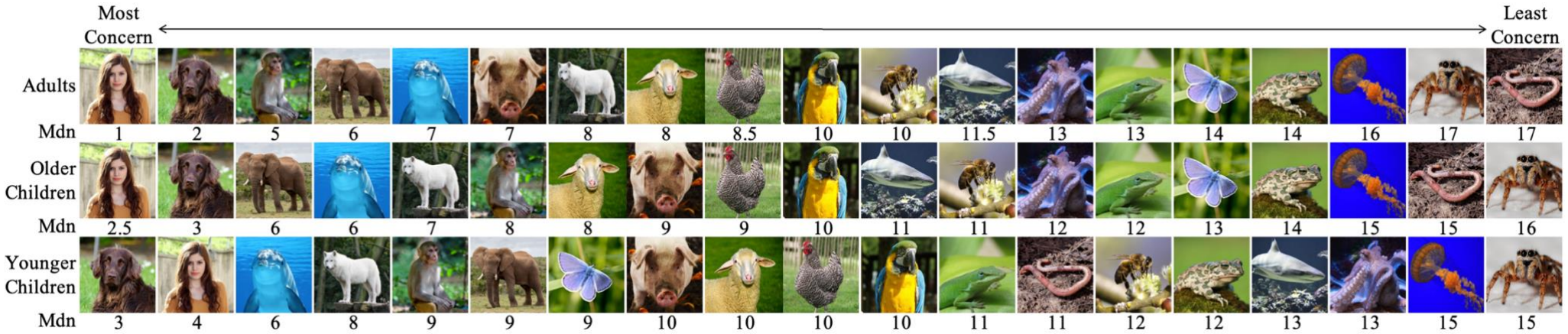
Spearman's correlations revealed that adults rated animals they identified as being eaten as more edible ("yummy") than animals perceived not to be eaten, $r_s = 0.73$, $p = 0.001$. This was also true for older children, though the association between edibility and food identification was weaker, $r_s = 0.56$, $p = 0.015$. Younger children exhibited a strong association between their edibility judgments and their identification of food animals, $r_s = 0.79$, $p < 0.001$. This may be because many younger children failed to identify animals eaten outside of their culture as food and their edibility judgments were mainly restricted to the animals they eat, whereas older children were more aware of animals that are eaten outside of their culture, though they do not personally consider such animals tasty.

Table 6

Knowledge of animals being eaten and edibility scores by age group. Targets include those animals that at least 50% of adults said are eaten by people.

	Adults			**Older Children**			**Younger Children**		
	Eaten	Edibility		Eaten	Edibility		Eaten	Edibility	
		Mean	*SD*		*Mean*	*SD*		*Mean*	*SD*
Chickens	100%	4.52	0.86	91%	4.13	1.21	91%	3.97	1.38
Dogs	61%	1.78	1.05	36%	1.71	0.90	14%	1.35	0.67
Frogs	86%	2.18	1.17	49%	1.53	0.83	41%	1.84	1.10
Octopuses	98%	2.78	1.37	85%	2.75	1.35	63%	2.58	1.49
Pigs	100%	4.38	1.03	96%	3.82	1.28	80%	3.48	1.61
Sharks	82%	2.44	1.18	58%	2.35	1.06	48%	2.00	1.05
Sheep	97%	3.78	1.31	85%	3.06	1.41	73%	2.96	1.57

Figure 5. Animal target median rankings by age group.



Developmental Comparisons of Moral Rankings by Animal Target

The median rank that each animal target received by age group is presented in Figure 5. Overall, the order between the age groups looks remarkably similar with mammals at the top and invertebrates at the bottom and birds, fish, reptiles, and amphibians in between, though with some notable exceptions (e.g., bees were ranked in the mid-range for most groups). A few developmental differences stand out. Younger children placed the dog first on the list whereas adults and older children have humans ranked first. Additionally, younger children valued worms and butterflies much higher than older children or adults. Another important distinction is the shape of the ranking distributions. The rankings of adults and, to some extent, older children were fairly spread apart suggesting clear demarcations in the valuing of some animals over others. However, the rankings of younger children were bunched more closely together suggesting greater overlap in how younger children valued the animals.

A scatterplot of the animal targets depicting the strength of the relationship between the relevant dimensions from our structural models and the moral ranking task can be viewed in Figure 6, presented as a function of age group. Several developmental trends can be observed. First, in terms of discontinuity, harmfulness factored negatively into younger children's moral judgments of animals but the impact of harmfulness reduced, with older children, and nearly reversed, with adults. Edibility emerged as a relevant correlate of moral concern in older children and continued into adulthood. In terms of continuity, aesthetics and similarity to humans emerged as strong predictors of moral concern in younger children and remained strong predictors into adulthood.

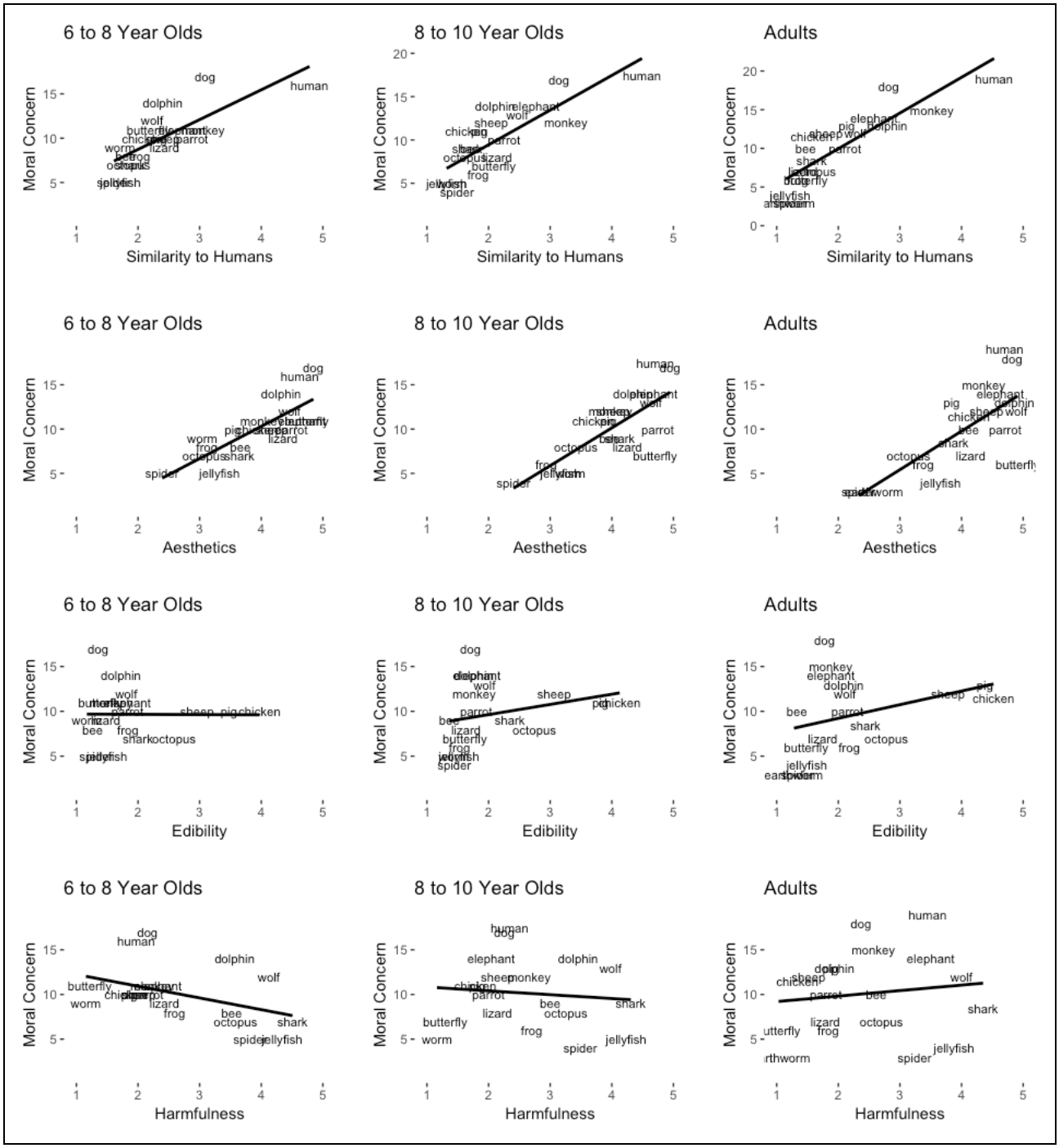


Figure 6. Scatter plots of the animal targets based on the relationship between moral concern and the relevant dimensions from the final structural models, by age group. Regression lines added.

Supplemental Information on Gender and Background Activities Involving Animals

See Supplemental Materials for details. In general, gender had little effect on animal attributions and rankings. Participating in benign activities with animals tended to promote positive attributions of animals' abilities, intelligence, and aesthetics, for older children and adults, but had little impact on younger children's attribution tendencies. Owning a pet also impacted positively on ability judgments, but only for adults.

Discussion

The present study investigated the factors that enter into children's moral concern for animal lives, and developmentally modeled this concern from school age into adulthood. Though children tended to organize the animals in a similar structure to adults when creating their moral hierarchy, they used somewhat different criteria to reach those conclusions. First, though participants of all ages elevated aesthetically pleasing animals and those that have similarities with humans, this emphasis on the aesthetic qualities of animals was especially pronounced among young children (ages 6-8). Furthermore, the manner in which children (younger and older) construed human-animal similarity differed from adults. Adults tended to view human-animal similarity strictly in mentalistic terms, that is, as a matter of possessing intelligence and sentience. By contrast, children of all ages failed to relate sentience (measured as the capacity to experience pain) as a human feature. Moreover, sentience factored little into children's moral valuations of animals, and, if anything, the relationship between sentience and moral standing was negative among children. When we explored children's attribution of pain capacity more deeply, we observed that it was guided by a simple body-size heuristic: children intuited that larger animals experience less pain than smaller animals. This might reflect an intuition among children that smaller animals are more physically vulnerable than larger animals. The way we phrased the sentience measure (how much the animal would be hurt if someone hit, kicked, or stepped on it) may have contributed

to this intuition. By contrast, adults associated body size to some extent with *higher* levels of sentience, and they tended to view sentience as a concomitant of intelligence: smarter animals were perceived as having a greater capacity to experience pain. This positive relationship between intelligence and sentience has been consistently found among adult participants (e.g., Bastian et al., 2012; Piazza et al., 2014). The absence of this relationship among children is intriguing, and it seems to be consistent with a recent study which found that children under age 7 tend to struggle with the concept of animal sentience (Burich & Williams, 2020). Yet, further research is needed to clarify whether alternative assessments of sentience might yield different results (see Limitations below).

Participants of all ages showed greater concern for beautiful animals. This is consistent with past perspectives on biophilia and biophobia (Ulrich, 1993; Wilson, 1984), which considers how humans connect to and avoid aspects of the natural world that facilitate human flourishing. Research in this area has shown that both children and adults place great emphasis on certain physical attributes of animals indicative of safety, such as perceiving a baby-like appearance (Borgi et al., 2014), or that induce positive emotions, such as perceiving warm colors in penguins (Stokes, 2007). Children as young as five experience a range of emotions towards animals, with aesthetically positive animals (e.g., penguins) eliciting joy and interest, and threatening and aesthetically negative animals (e.g., snakes, insects) tending to elicit fear and disgust (Olivos-Jara, Seguar-Fernández, Rubio-Pérez, & Felipe-García, 2020). Like adults, children as young as 3-years of age have been shown to preferentially attend to dogs and cats that have been enhanced to exhibit "cute" features (Borgi et al., 2014). In turn, the perception of baby-like or "cute" features in animals has been associated with positive outcomes related to caretaking of companion animals (Thorn et al., 2015), rejection of farm animal slaughter (Piazza et al., 2018), and protective feelings towards a broad range of animals (Possidónio et al., 2019).

Here we observed a developmental trend whereby younger children highly prioritized aesthetics when forming moral decisions about which animals should be valued and protected. This emphasis on aesthetics was stable with age, yet older children and adults shifted their focus to include more appetitive and mentalistic features, i.e., edibility and intelligence. This seems to be a developmental shift in emphasis as opposed to qualitative shift—older children still value animal aesthetics, however, their moral evaluations begin to take on board additional concerns, such as the utility humans derive from domesticated animals. They also tended to construe beauty as a feature that certain animals share in common with humans. Thus, their appreciation of aesthetics in animals begins to take on an increasingly human-centric quality.

Related to the notion of biophobia, younger children also tended to value animals that they perceived to be benevolent, whereas older children and adults did not put as much weight on this feature. It is generally within early to middle childhood (e.g., 5-10 years) that children's phobias for particular animals (e.g., snakes, spiders) emerge and heighten (Askew & Field, 2007), though attentional biases in detecting threatening animals are present even earlier (LoBue & DeLoache, 2008). Consistent with this developmental timing, Lee and Kang (2012) found that children at the age of 6 exhibit an orientation towards features in animals indicative of threat (e.g., the presence of claws or sharp teeth), and they associate these features with valenced judgments of animals as "bad". Thus, our younger children may be exhibiting a heightened sensitivity to potentially threatening aspects of animals and allowing these attributions to influence their moral considerations about which animals are deserving of their concern.

That participants of all ages valued animals that shared qualities with humans aligns in some ways with the studies by Borgi and Cirulli (2015) and Miralles et al. (2019), which found that animals phylogenetically similar to humans (mammals) were liked over animals

more biologically distal (birds, reptiles, insects) among toddlers and adults (respectively). It also aligns with developmental perspectives suggesting that a preference for similarity in human-human affiliations emerges quite early in development (Fawcett & Markson, 2010) and can bias attitudes regarding how individuals are treated (Hamlin et al., 2013). However, we found that the moral judgments of younger children placed *relatively* less emphasis on animals' similarity with humans, compared to older children and adults. This reduced emphasis on similarity may be reflective of a lesser degree of speciesism among our younger children. Wilks et al. (2020) found that children ages 6-10 valued animal life *in its own right,* relative to human life, more so than adults did. Wilks et al. speculated that the speciesist tendency to value human life over non-human animal life, appears to have a fairly late developmental origin.

Our findings add to this perspective by showing that younger children seem to value animals less through a human-centric lens compared to older children and adults. In fact, younger children tended to value dogs over humans, somewhat, in our medical intervention task, while this was not the case for older children and adults. Furthermore, we found that children's concept of what it means to be humanlike, differs from that of adults, which focuses more exclusively on the mentalistic properties of animals. By contrast, children seem to consider a wider range of properties, such as benevolence and physical appearance, as qualities that animals and humans share, and their moral judgments of animals seem to encompass these broader, non-mentalistic properties to a much greater extent. This increasing emphasis on an animal's mind with age may be an extension of children's maturing ability to reason about the minds of others (see e.g., McAlister & Peterson, 2007; Wellman, Cross, & Watson, 2001), but it also likely reflects their increasing tendency to value qualities they associate with the dominion or supremacy of humans, which, for many

adults, involves traits related to humans' superior ingenuity and cognitive capacities (e.g., Haslam, Bain, Douge, Lee, & Bastian, 2005; Haslam et al., 2008).

Finally, different from the younger children, older children (ages 8-10) appreciated that some animals provide a utility to humans as food—a factor that entered into adults' evaluations. This pattern among our older children may reflect older children's growing awareness and appreciation of the use of animals as food. Compared to our younger children, who struggled with identifying which animals are eaten, our older children exhibited a richer understanding of which animals are used for human consumption. Years 5-10 appears to be the period that many children come to associate animal products with their animal origins, to have conversations with their parents about meat (Bray, Zambrano, Chur-Hansen, & Ankeny, 2016), and make decisions for themselves to avoid meat (Hussar & Harris, 2010). Thus, the emerging moral use of edibility information among the older children may be partly attributed to their greater awareness of the origins of meat. Yet, this result might also be indicative of a budding speciesism among older children. Consistent with a speciesist perspective, older children appear to consider not only the ways in which animals are *like* humans, but how they *benefit* humans when making judgments about their moral worth. Thus, our findings seem to reflect both a greater awareness of the animal origins of meat among older children and their greater valuing of the role meat plays in their life and wider society.

Strengths, Limitations and Future Directions

Two strengths of our study are that we utilized a naturalistic animal valuation task and had our participants form multiple ratings of each animal target, which could then be correlated with valuation judgments. Using this method we were able to move beyond experimenter interpretations of participants' moral decisions. In this manner, our findings both align with and help elucidate past findings (e.g., Neldner et al., 2018). Our findings help

clarify that children's evaluations of animal lives do indeed take into account the perceived richness of animal minds—though children's attribution of mind appears to focus on animals' abilities rather than their sentience. Moreover, children's moral evaluations were not limited to mind attributions. They were also affected by appraisals of animal benevolence, physical attractiveness, and (for older children) edibility. Thus, our methodology helped to clarify the multi-dimensional nature of children's valuations.

A methodological limitation of our study concerns the number of animal targets employed and the use of single items to assess each attribution dimension. This was done to keep the study to a reasonable length for children. Our preliminary search for suitable targets began with fifty-five animals (see Supplementary Materials), but for practical purposes, we limited the set of animals to nineteen (ten per child) and the set of attributions to seven (70 total ratings). This inevitably led to a reduction in the diversity of animal species that could be sampled and modeled. The decision to use one item per attribution dimension may have presented a particular limitation for our assessment of sentience and intelligence. While our measure of sentience in terms of the experience of pain in response to bodily insults has face validity and is in keeping with philosophical definitions of sentience (e.g., Walters, 2018), alternative or wider assessments of sentience that expand the set of bodily insults (e.g., cutting part of the body; Villar, Rodríguez, Rodríguez, & Pérez, 2018) or the quality of experiences (e.g., to include emotions beyond pain), might return different results than observed here. Having children focus on the emotional capacities of animals, for instance, might redirect children to focus more on the mentalistic qualities of sentience, as opposed to concentrating on the animal's body size as a moderator of pain experiences. Furthermore, expanding the assessment of animal intelligence to include a variety of cognitive, behavioral, and social abilities (e.g., see Leach et al., 2020) would provide a more fine-grained

assessment of children's ability to reason about the minds of animals and the role such attributions play in their valuing of different animals.

Another limitation was that we allowed past research to guide our methodological decisions about which attribution dimensions to include as appraisals, rather than developing a purely bottom-up procedure to guide our decisions. Future research should consider potentially expanding the set of attributions considered, for example, by first gathering participant-generated characteristic judgments prior to modeling their relevance for moral evaluations. Familiarity with an animal is an attribution dimension we did not include, but might be considered. At least one study with adults (Possidónio et al., 2019) found a weak, albeit significant, tendency for familiar animals, across 120 targets, to be judged acceptable to kill for human consumption. Thus, future studies should consider how familiarity with an animal might impact on children's concern for animal lives.

Finally, our findings are limited by the focus on Western populations, which poses constraints on how widely we can generalize the results (Simons, Shoda, & Lindsay, 2017). Cultures of course vary in terms of which animals are categorized as food and non-food, and which animals are ascribed an elevated status (e.g., the sacred status of cows and elephants for Hindus; Manokara, Lee, Kamble, & Krumhuber, 2020). These cultural differences would inevitably impact on how children value different animal lives, via the edibility ratings they make and possibly additional attributions not captured in the present investigation (e.g., sacredness). Future research should continue to explore the factors guiding children's judgments of animal lives in different cultures, as attitudes towards animals, their use and capacities, can vary between countries as much as within (e.g., Phillips & McCulloch, 2005).

Conclusion

Our findings highlight a number of ways in which children's concern for animal life differs from that of adults. When deciding which animals deserve protection, young children

ages 6-8 appear to prioritize several non-mentalistic properties, including the aesthetic qualities of animals and the potential threat they pose to personal safety. By contrast, older children ages 8-10 begin to place greater emphasis on the mental capabilities of animals and the potential utility of animals as food for humans. This emphasis on the mental life of animals and their utility appears to strengthen further in adulthood. At the same time, there was great continuity in the way children and adults prioritized animal life, as adults' moral evaluations were still affected by their aesthetic appraisals, and even younger children factored animal intelligence into their decisions to some degree—though children's understanding of sentience was notably different from that of adults. Finally, all ages displayed a human-centric concern for animals, as animals sharing qualities with humans were highly valued. Yet, this speciesist bias was least pronounced among younger children, and children's notion of human similarity differed from adults in its non-mentalistic focus. Overall, our findings suggest that the manner in which adults approach the valuation of animal life has its origins in early childhood, yet there is a gradual shift towards greater appreciation of animal minds, a mentalistic notion of sentience, and the utility that animals offer humans.

Declaration of Conflicting Interests

The authors declare no funding from public, commercial, or not-for-profit sectors therefore no financial or personal conflicts of interest with respect to the authorship or the publication of this article.

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