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Daily animal exposure and children's biological concepts

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ABSTRACT

A large body of research has focused on the developmental trajectory of children's acquisition of a theoretically coherent naive biology. However, considerably less work has focused on how specific daily experiences shape the development of children's knowledge about living things. In the current research, we investigated one common experience that might contribute to biological knowledge development during early childhood—pet ownership. In Study 1, we investigated how children interact with pets by observing 24 preschool-aged children with their pet cats or dogs and asking parents about their children's daily involvement with the pets. We found that most of young children's observed and reported interactions with their pets are reciprocal social interactions. In Study 2, we tested whether children who have daily social experiences with animals are more likely to attribute biological properties to animals than children without pets. Both 3- and 5-year-olds with pets were more likely to attribute biological properties to animals than those without pets. Similarly, both older and younger children with pets showed less anthropocentric patterns of extension of novel biological information. The results suggest that having pets may facilitate the development of a more sophisticated, human-inclusive representation of animals.

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Introduction

Children's knowledge about animals and biological properties develops gradually over the course of early childhood. Preschool-aged children show some understanding of fundamental biological properties such as recognizing that plants and animals share specific properties that distinguish them from nonliving objects (Inagaki & Hatano, 1996, 2002). However, they also exhibit various scientifically inaccurate concepts about both living and nonliving objects. For example, children of this age may believe that "cars are alive because they move" (Nguyen & Rosengren, 2004), that a tulip can "feel happy" (Inagaki & Hatano, 1987), or that a child "got a cold because he disobeyed his mother" (Kister & Patterson, 1980). Despite a large body of literature investigating the developmental course of biological knowledge development, little research has examined how biological knowledge changes as a result of everyday experiences. The goal of the current research was to highlight one specific common experience that may contribute to children's biological knowledge development—pet ownership.

The role that specific experiences play in shaping children's biological knowledge development has been a particularly contentious topic in the literature. Early studies report that before the age of 5 years, young children show little in the way of biologically specific knowledge (e.g., Carey, 1985; Johnson & Solomon, 1997; Solomon, Johnson, Zaitchik, & Carey, 1996). Instead, they reason about the living world anthropocentrically, extending their biological knowledge about humans to other living things on the basis of their behavioral similarity to humans. Over time, children learn about biological functions and their relations in both formal and informal settings and begin to organize their knowledge about living things into an increasingly causally coherent and specifically biological framework rather than around their knowledge of human behavior (Carey, 1985; Solomon & Johnson, 2000). In this view, the role of experience is to move children's knowledge of living things away from anthropocentrism and toward a more sophisticated biological theory.

However, others have found evidence that children do understand biologically specific causal processes much earlier than previously demonstrated (e.g., Gelman & Wellman, 1991; Rosengren, Gelman, Kalish, & McCormick, 1991; Springer & Keil, 1989; Wellman & Gelman, 1992; Wellman, Hickling, & Schult, 1997). In contrast to a developmental progression toward biological reasoning, early experiences might in fact *create* an anthropocentric bias. Early research reporting such a bias in children relied heavily on one type of sample—children from primarily urban environments in the United States (e.g., Carey, 1985). Urban children may have more extensive experience with fictional depictions of animals than with real animals, and these experiences may cause them to reason anthropocentrically (Waxman & Medin, 2007). Research comparing 3-year-olds from urban and rural U.S. populations (who presumably have more direct experience with the natural world than urban U.S. children) supports this hypothesis. Neither younger urban nor younger rural children reason anthropocentrically (Hermann, Waxman, & Medin, 2010). However, around the age of 5 years, urban and rural children's reasoning patterns diverge, with *only* urban children beginning to show anthropocentrism (Waxman & Medin, 2007). This argument is further supported by work with rural populations from geographical and culturally distinct communities, such as Native Americans and Yukatek Maya, which consistently reveals accurate biological reasoning in very young children (Atran et al., 2001; Ross, Medin, Coley, & Atran, 2003; Waxman, Medin, & Ross, 2007). These researchers concluded that a lack of direct experience and increased exposure to unrealistic media within more urban populations may facilitate human-centered, anthropocentric reasoning (Hermann et al., 2010; Waxman & Medin, 2007).

This growing body of cross-cultural research highlights the important role of cultural input and specific experiences in the development of knowledge. However, to date no research has quantified the actual experiences that children have in the biological domain or investigated the specific impact of those experiences on children's knowledge. For instance, in the research described above, it is presumed that children from rural and urban backgrounds have reliably different experiences with animals based on their local and cultural differences; the actual differences in children's everyday experiences were not measured.

Despite a lack of empirical data on the differences in children's everyday experiences that might affect biological knowledge, substantial experiential variations both within and between cultures lend themselves well to empirical work that could illuminate the role of experience in knowledge acquisition. One such source of information about animals that can be studied in both urban and rural children is the experience of pet ownership. In both Canada and the United States, pet ownership rates are highest among households with children (Leslie, Meek, Kawash, & McKeown, 1994; Lue, Patenburg, & Crawford, 2007; Wise & Kushman, 1984). More than three quarters of American children have pets, and children are now more likely to grow up with pets than with both parents (Melson, 2001). In addition, some research suggests that socioeconomic status is not associated with pet ownership (Leslie et al., 1994), so children from a wide range of backgrounds share this experience. What impact do these daily experiences with animals have on the development of children's biological knowledge?

In one of the first studies to examine the cognitive consequences of direct animal exposure, Inagaki (1990) found that children who raised goldfish not only had more factual knowledge about fish but also were better able to use that information to make predictions, develop explanations, and reason analogically about other unfamiliar animals compared with children who lacked fish-raising experience. Children who raise pets also have more factual knowledge about a wide range of animals than children who do not, including better knowledge of internal organs, feeding habits, reproduction, and ecological relationships between animals (Prokop, Prokop, & Tunnicliffe, 2008; Prokop & Tunnicliffe, 2010).

One major limitation of previous work is that none of these studies evaluated the *content* of children's everyday experiences with animals. As a result, much is still inferred about the kinds of behaviors in which children are engaging with their pets, limiting the conclusions that can be drawn about the specific contribution of pet ownership to biological knowledge acquisition. In the research presented here, our goals were twofold. First, we sought to investigate the types of interactions children engage in with their pets. In Study 1, we observed children's interactions with their pets in their own homes in a free-play session. In addition, to capture a wider picture of children's daily interactions with their pets, we asked parents to report on their children's daily caretaking and social behaviors with their pets over the course of a month.

Our second goal was to examine how children's everyday experiences with their pets relate to both biological and psychological reasoning. Although previous findings suggest that the experience of raising pets may increase children's factual biological knowledge, further work is needed to determine whether children who have pets are more likely to exhibit biologically specific reasoning in other tasks measuring general conceptual knowledge about living things. How do children with pets think about animals more broadly? In Study 2, we tested whether children with pets have more advanced biological knowledge compared with children of the same age without similar experience. Prior studies examining the influence of pet ownership have largely used interviews in order to investigate children's knowledge about animals (Inagaki, 1990; Prokop & Tunnicliffe, 2010; Prokop et al., 2008). As in this previous work, we used an interview methodology meant to measure factual knowledge about specific biological properties (e.g., internal organs, sleep, growth, contagion, parentage) and social/psychological properties (e.g., social relationships, communication, emotions). We also used an inductive projection methodology to address children's underlying theories about similarity between humans and other animals. In this task, pioneered by Carey (1985), a researcher introduces children to an unobservable biological property (e.g., "people have spleens inside") and then asks whether they think that this property also applies to other animals, plants, or objects. The patterns of induction reflect individuals' concepts of animals and living things. These differences in reasoning patterns reflect culturally specific naming practices as well as biologically relevant formal and informal learning experiences (Anggoro, Medin, & Waxman, 2010). Thus, we may find differences in reasoning patterns between children who have experience with pets and those who do not even though they are receiving the same culturally relevant biological instruction. To the extent that children reason anthropocentrically, they should treat humans as a privileged inductive base, readily extending novel properties taught on humans to other animals but making few generalizations from animals to humans or to other animals. Children without these anthropocentric biases should treat humans and other animals comparably as inductive bases and should readily extend novel properties taught on animals to other animals and to humans.

Prior research suggests that frequent exposure to animals should decrease children's tendency to treat humans as a privileged inductive base because they should have more familiarity with and knowledge about animals. However, it is unclear what kinds of experiences children frequently have with pets that result in such knowledge shifts. One possibility is that pet-owning children frequently engage in caretaking behaviors that help them to gain firsthand knowledge about animals' biological properties such as feeding, grooming, and cleaning up after their animals. An alternate, and more likely, possibility is that children engage primarily in social interactions with their animals such as talking to and playing with them. These social experiences with animals may actually facilitate biological knowledge about animals. Inagaki and Hatano (2002) argued that these social experiences with animals facilitate children's appreciation of commonalities between animals and humans. This enables children to apply knowledge about the biological functions of humans, which children are more familiar with, to unfamiliar animals. Thus, children with more social experience with animals may treat animals and humans more similarly as inductive bases for novel biological information. However, frequent social interactions may also encourage children to take a more anthropomorphic view of animals, attributing psychological functioning widely to animals. The treatment of pets as social partners could lead children incorrectly to extend human-specific psychological properties to other animals. Insisting that an animal is "just like a person" minimizes the animal's own species membership and may lead to an incorrect interpretation of the animal's behavior (Melson, 2001). Thus, pet-owning children, despite failing to show anthropocentric reasoning on an inductive projection task, may be more likely to attribute psychological properties to animals. In the current research, we addressed these theoretical predictions by both quantifying children's interactions and measuring their biological and psychological reasoning using both inductive projection and property interview methodologies.

Study 1: Children's interactions with pets

In Study 1, we used a free-play observational paradigm to evaluate whether children treat their pets as social partners in daily interactions. This free-play session allowed us to observe the types of physical and verbal behaviors children engage in with their pets. Specifically, do children treat animals as social partners, frequently engaging them in attempts at social reciprocity? The observation took place in children's homes in order to capture the naturalistic behaviors in which children engage with their pets on a daily basis. In addition, parental reports collected information on the daily frequency with which children engage in caretaking and social interactions with their pets that may contribute to children's biological knowledge development.

Method

Participants

Participants were 24 children (15 female) the ages of 3 and 6 years (M = 4;11 [years;months], range = 3;0–6;6), each with a pet (7 cats and 17 dogs). All of the pets were considered "family" pets to which the children had consistent free access (i.e., they lived indoors with the family rather than being considered "outdoor" pets). Families were primarily recruited from a lab database of families who had previously participated in or expressed interest in participating in research. Participants lived in suburban communities within the New York/New Jersey metropolitan area on the U.S. East Coast. The sample was predominantly Caucasian (87.5%) and middle class. The majority of parents (84%) had attained a college degree or higher; only 2 parents reported not completing a high school degree. Most children in our study lived in two-parent households (95.8%) and had at least one sibling (79.2%). Of children with siblings, 36.8% had younger siblings, 36.8% had older siblings, and roughly a quarter (26.3%) had both older and younger siblings. Parents gave written consent for their and their children's participation. Parents were compensated with a $25 gift card to a local store. Children were compensated with a small toy.

Procedure

Children were recorded in their homes in a 5-min free-play session with their cat or dog. Parents were told that the researchers were interested in how children interact with their pets. During the free-play session, parents were asked to complete the study paperwork (described below) and refrain from intervening or directing their child. The child was not given any specific instructions on what to do; the researcher asked the child to "show me something that you like to do with your cat/dog." If the child was hesitant, the experimenter followed up with general prompts such as "What do you like to do with him/her?" and "Is there anything else you want to show me?" The experimenter video-recorded the interaction and refrained from interacting with the animal or child during the observation. The child's physical and verbal behaviors were later coded from the video record.

Parents were also asked to complete a survey about their child's daily interactions with the pet. They were asked to estimate how many times during the past week their child had interacted with the pet socially (e.g., playing with, talking to) and in a caretaking role (e.g., feeding, grooming, cleaning up after). In addition, parents were asked to rate, on a scale of 1 to 10, their child's degree of interest in the animal and the child's degree of involvement in daily caretaking of the animal. Finally, parents were asked to submit four weekly survey responses over the following month reporting the ongoing weekly frequency of these social and caretaking behaviors in order to ensure that their initial survey answers were representative of a typical week. Most of the four weekly follow-up surveys (73%) were returned. For all analyses below, each parent's responses were averaged across all of their returned surveys.

Coding

Trained coders used rating scales to characterize the frequency of both physical and verbal reciprocal and nonreciprocal behaviors that the child exhibited toward the animal during the recorded free-play session. Target behaviors were coded for how often during the entire observation the child exhibited them on a 7-point scale (from *never* to *very often*). The decision to use a rating scale rather than counting frequency of utterances or duration of physical interactions was made in order to enable direct statistical comparisons between verbal and physical behaviors. In addition, the use of a frequency rating scale reflects *both* the frequency and duration of physical behaviors.

The coding scheme was adapted from prior research examining children's physical and verbal interactions with robotic and living dogs in a free-play session (Kahn, Friedman, Freier, & Severson, 2003; Kahn, Friedman, Perez-Granados, & Freier, 2006; Melson et al., 2009). Specific verbal and physical behaviors were assigned to two general categories: reciprocal (social) behaviors and nonreciprocal (nonsocial) behaviors. Reciprocal behaviors were defined as any socially interactive behaviors directed toward the animal that were intended to elicit a direct response. Verbal reciprocal behaviors included asking questions (e.g., "Do you want food?" "What are you doing?"), commanding (e.g., "Come here!"), and reprimanding (e.g., "Stop!" "Don't do that!"). Physical reciprocal behaviors included hand presentation (e.g., offering to dog to sniff), toy offering or play (e.g., throwing a ball, running to make the animal chase, shaking a toy in front of cat), and motioning or pointing (e.g., *come here*, *go there*).

Nonreciprocal behaviors were defined as any behaviors directed toward the animal that were not intended or expected to elicit any kind of direct response and, thus, did not attempt to engage the animal in a dyadic social interaction. Verbal nonreciprocal behaviors included greetings (e.g., "Hi!"), general vocalizations (e.g., "You're a good dog"), and affection (e.g., "I love you"). Physical nonreciprocal behaviors included petting, displays of affection (e.g., hugging, kissing), and mistreatment (e.g., hitting, kicking, throwing).

A primary coder coded all of the interactions, and a second coder independently coded 25% of the interactions. The intraclass correlation coefficient was calculated to determine reliability (Shrout & Fleiss, 1979). Overall agreement (intraclass correlation coefficient) was very high, $ICC(3,2) = .967$. In the rare instances of disagreements, the primary coder's ratings were used.

Results and discussion

Children owning cats did not differ from those owning dogs in any observed or reported behaviors; thus, all results presented below are collapsed across pet type. Preliminary tests on gender revealed that, overall, girls ($M = 3.47$, $SEM = 0.25$) engaged in all behaviors more frequently than boys ($M = 2.37$, $SEM = 0.33$), $F(1,22) = 7.12$, $p = .014$, $\eta^2 = .244$. In addition, a nonsignificant trend was found in the interaction between gender and reciprocal behaviors, $F(1,22) = 3.26$, $p = .085$, $\eta^2 = .129$. Post hoc comparisons using Bonferroni correction at $\alpha < .05$ demonstrated that there were no differences between girls and boys in the frequency of nonreciprocal behaviors, but girls ($M = 4.83$, $SEM = 0.39$) were significantly more likely to show reciprocal behaviors than boys ($M = 3.11$, $SEM = 0.51$).

To analyze children's behavior, we entered ratings into a 2 (Reciprocity: reciprocal or nonreciprocal) $\times$ 2 (Behavior Type: physical or verbal) analysis of variance (ANOVA) (see Fig. 1). There was a main effect of reciprocity; children more frequently engaged in reciprocal behaviors ($M = 4.19$, $SD = 1.71$) than nonreciprocal behaviors ($M = 1.92$, $SD = 0.98$) toward their pets, $F(1,23) = 41.44$, $p < .001$, $\eta^2 = .643$. Similarly, a main effect of behavior type revealed that children were more likely to frequently engage in physical behaviors ($M = 3.72$, $SD = 1.31$) than verbal behaviors ($M = 2.40$, $SD = 1.42$), $F(1,23) = 15.71$, $p = .001$, $\eta^2 = .406$. The interaction was nonsignificant ($p = .19$). Thus, children engaged in both verbal and physical reciprocal (social) behaviors with their pets significantly more often than they engaged in nonreciprocal (nonsocial) verbal and physical behaviors.

Consistent with these findings, most parents reported that, on a scale of 1 to 10, their children were highly interested in their pets ($M = 7.79$, $SD = 1.84$) but that they were only somewhat involved in the animals' daily care ($M = 5.42$, $SD = 2.55$). These results are also reflected in the average number of times parents reported that their children cared for and played with their pets (see Table 1). For instance, children fed their pets only roughly 2 times per week, yet they played with and talked to their pets daily. A paired-samples t test revealed that children were significantly more likely to engage in social activities ($M = 15.81$, $SD = 8.24$) than in caretaking activities ($M = 3.07$, $SD = 3.00$) with their pets, $t(23) = 7.24$, $p < .001$, $d = 2.14$. In fact, parents reported that their children played with and talked to their pets six times more often than they engaged in caretaking behaviors such as feeding and grooming. There was no relationship between children's age and measures of interest, involvement, caretaking, and social behaviors (all $ps > .44$). In addition, independent-samples t tests found no differences between girls and boys in any parent-reported measures (all $ps > .48$).

Thus, our findings from parental reports were consistent with our findings from direct observation of children's interactions with their pets; on a daily basis, children are not engaged in caretaking behaviors but rather are treating their pets as social partners. It is possible, of course, that preschool-aged children are not permitted to engage in caretaking behaviors such as feeding. However, older children were no more likely to be involved in caretaking behaviors than younger children in our sample. Thus, although children may observe their parents completing these tasks, they are not gaining firsthand experience with caretaking behaviors and are instead more focused on social interactions with their pets.

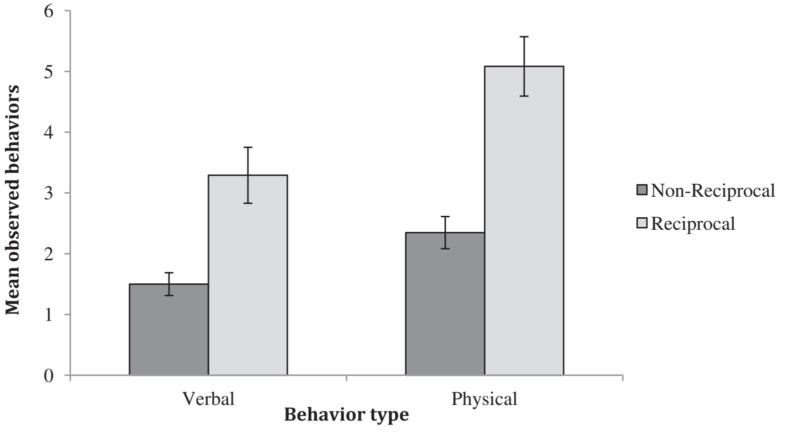

Fig. 1. Average frequency of reciprocal and nonreciprocal verbal and physical behaviors displayed by children toward their pets. Error bars represent standard errors.

Table 1
Descriptive statistics for parental reported weekly caretaking and social behaviors between children and their pets.

	Minimum	Maximum	Mean	Standard deviation
Feeding	0	8.00	2.61	2.29
Grooming	0	1.40	0.24	0.44
Cleaning up	0	3.60	0.22	0.74
Playing	0	15.40	7.00	4.39
Talking	0.60	17.80	8.81	4.68

Study 2: Children's knowledge of animals

Study 1 suggests that most of young children's interactions with their pets revolve around social and not caretaking behaviors. Children seldom engaged in caretaking behaviors, but nearly all children frequently engaged in social activities in both observation and parent report, with no differences across age groups and animal type. Children may be accumulating factual or procedural knowledge from experiences related to biological functioning by participating in some caretaking of their pets (Inagaki, 1990), but these experiences are far less frequent than social interactions. In Study 2, we investigated the association between experiences with pets and children's developing biological and psychological reasoning about animals. Because we found such consistency in children's engagement with social and caretaking behaviors, in Study 2 we focused on whether children with any pet experience differ from children without this experience. Are children with daily social experiences with animals more likely to exhibit biological reasoning, like adults, or more likely to use anthropocentric reasoning, as others have argued (Hermann et al., 2010)? To answer this question, in Study 2 we examined biological and psychological reasoning in children with and without pets as well as in an adult comparison group. We gathered data on adults in order to verify that our target sample performed similarly to adults in previous research as well as to see how children's reasoning compared with that of adults.

Method

Participants

A total of 96 children between the ages of 2;11 and 6;7 (M = 4;7) participated in Study 2. Half of the children had a pet (14 cats and 34 dogs), and the other half had never owned a pet (with the occasional exception of having owned a fish). All of the pets were considered "family" pets to which the children had regular free access (i.e., they lived indoors with the family and were not considered to be "outdoor" pets). The duration of time that the pet had been in each household varied, but most of the children (74.5%) had had the animals in their homes for their entire lives. A median split was used to separate the children into two age groups: 3-year-olds and 5-year-olds (Table 2).

The sample was predominantly Caucasian (65.3%) and middle class. The majority of parents (85.0%) had attained a college degree or higher, and all parents reported at least completing a high school degree. Children in this study were recruited from a variety of sources, including a lab database of previous research participants and local preschools. Participants lived in suburban communities within

Table 2
Sample sizes and average ages for children in age groups by pet status.

	n	Mean (years;months)	Range (years;months)
3-year-olds			
Pet	24	3;8	3;0 to 4;8
No pet	24	3;8	2;11 to 4;6
5-year-olds			
Pet	24	5;7	4;8 to 6;7
No pet	24	5;3	4;7 to 6;5

the New York/New Jersey metropolitan area. Most children in our study lived in two-parent households (96.9%) and had at least one sibling (75%). Of children with siblings, 40.3% had younger siblings, 37.5% had older siblings, and roughly a quarter (22.2%) had both older and younger siblings. A chi-square analysis revealed no relationship between pet ownership and family sibling composition ($p = .66$). The study took place either in children's homes, our research lab, or a quiet area in children's preschool. Parents gave written consent for their children's participation. Children were compensated with a small toy.

In addition, 32 undergraduate students participated in an adult comparison group for the biological induction task. Participants' ages ranged from 18 to 28 years ($M = 21.24$ years, $SD = 2.42$). Approximately half of the students currently owned a pet (4 cats and 11 dogs); the other half had never owned a pet (with the possible exception of fish). They volunteered in order to fulfill research participation requirements for their introductory psychology class.

Procedure

Biological induction task. The procedure was highly similar to that used in previous research with children in this age range (Hermann et al., 2010). Participants were introduced to a novel unobservable biological property about people or dogs and were then asked whether they think this property can be generalized to other kinds of animals, plants, or objects. The study employed a between-participants design, with participants assigned randomly to either the dog or human base condition. For the human base condition, the child was told, "People have *andro* inside them. *Andro* is round and green and looks like this!" The child and experimenter then drew *andro* inside the picture of a person. After this teaching phase, the participant was then shown individual pictures of various target entities, including animals (cat, hamster, cow, lion, bird, frog, fish, bee, and ant), plants (flower and tree), and inanimate objects (cloud, doll, crayon, and car), and for each item the child was asked, "Do you think that [category name] have *andro* inside like people do?" For the dog base condition, the procedure and target entities were identical with the exception of the novel property (*hema*). Target entities were identical for the human and dog base trials with the exception of the inclusion of dog as a target for the human base trials and the inclusion of human as a target for the dog base trials. All targets were presented in random order for each participant.

Adult participants also completed the biological induction task. The adult version was identical to the one given to children except that participants did not color the property in the line drawings. Answers were coded as either attributing the property to the target (score of 1) or not attributing the property to the target (score of 0). An average attribution score was calculated for each participant's attribution to animals (bird, lion, bee, cow, frog, ant, hamster, cat, and fish), plants (flower and tree), and inanimate objects (cloud, doll, crayon, and car).

Property interview. Next, children were asked to help the experimenter learn about animals by answering some questions. Children with pets were asked about their own cat or dog. Children without pets were asked about the experimenter's pet cat or dog. Each child was asked about the animal's possession of biological properties (e.g., internal organs, sleep, growth, food, contagion, parentage) and psychological properties (e.g., social interaction, emotions). Answers were coded as either attributing the property to the pet (score of 1) or not attributing the property to the pet (score of 0). An average attribution score was calculated for each child for biological and psychological properties. Adults did not receive the property interview because all of the biological facts were ones that lay adults were expected to identify correctly.

Parent survey. Finally, parents of children with pets were asked to complete the survey about their children's daily interactions with pets used in Study 1.

Results and discussion

Parent survey

As in Study 1, most parents reported that, on a scale of 1 to 10, their children were highly interested in their pets ($M = 7.52$, $SD = 2.20$) but that they were only somewhat involved in the animals' daily care

($M = 5.15$, $SD = 2.71$). Similarly, parents reported that their children rarely engaged in caretaking activities ($M = 3.00$, $SD = 3.07$) but frequently engaged in social activities ($M = 18.39$, $SD = 15.11$), $t(41) = 6.25$, $p < .001$, $d = 1.38$.

Independent-samples t tests comparing parental reports for children in Study 1 with those in Study 2 found no differences on any of the measures of interest, daily involvement, or frequency of caretaking or social behaviors with their animals (all $ps > .28$), suggesting that, across studies, these children have similar daily experiences with their pets.

Biological induction task

The data of 13 children were removed from the analyses because these children adopted either a *yes* or *no* bias, answering identically for all targets. This exclusion rate is comparable to previous research using this task for the same age group (e.g., Hermann et al., 2010). Chi-square analyses revealed no differences in exclusion rates for age groups ($p = .52$) or pet ownership ($p = .75$). In line with previous research, our analyses focused on two patterns of inductive reasoning that reveal anthropocentric reasoning (Carey, 1985; Hermann et al., 2010; Ross et al., 2003): (a) asymmetrical reasoning, meaning that participants are more likely to attribute properties from a human to a nonhuman animal than from a nonhuman animal to a human, and (b) the fact that participants are more likely to extend a novel biological property from a human to an animal than from a nonhuman animal to another animal.

First, we looked for evidence of an asymmetry between projections from humans to dogs versus from dogs to humans in younger and older participants with and without pets (Fig. 2). Stronger projections in the former reveal anthropocentric reasoning. Preliminary t tests found no differences between female and male participants in rates of projections to humans and dogs at any age (all $ps > .12$). As expected, adults showed no asymmetry in their projections and were equally likely to project properties from humans to dogs as from dogs to humans ($p = .26$). The following analyses focused on 3- and 5-year-olds. A log-linear analysis for a three-way contingency table comparing projection rates from humans to dogs versus from dogs to humans across age groups and pet ownership revealed a significant three-way interaction, $G^2(10) = 24.34$, $p = .007$. Follow-up 2×2 chi-squares were conducted to examine this interaction. Both 3-year-olds without pets, $\chi^2(1, N = 22) = 4.58$, $p = .032$, $r = .456$, and 5-year-olds without pets, $\chi^2(1, N = 20) = 4.90$, $p = .027$, $r = .495$, made more projections from humans to dogs than from dogs to humans. Although a similar pattern of projections from humans to dogs and from dogs to humans emerged for children with pets, these comparisons failed to reach statistical significance for either 3-year-olds ($p = .14$) or 5-year-olds ($p = .37$). Thus, both older and younger children without pets treated humans as a better inductive base for novel biological

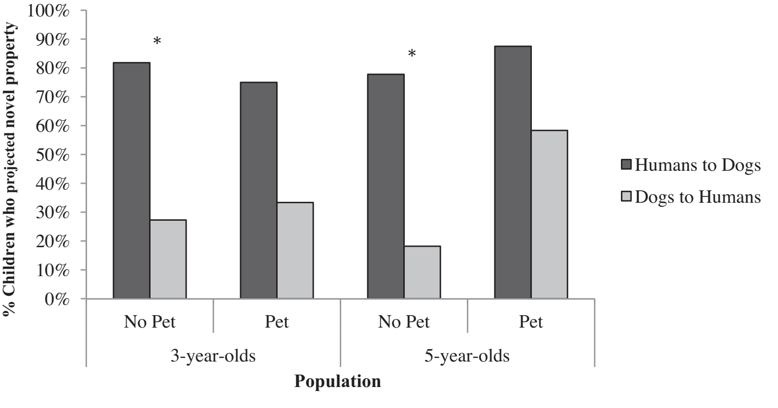

Fig. 2. Percentage of younger and older children with and without pets who projected the novel property from humans to dogs and from dogs to humans. *Significant at $p < .05$.

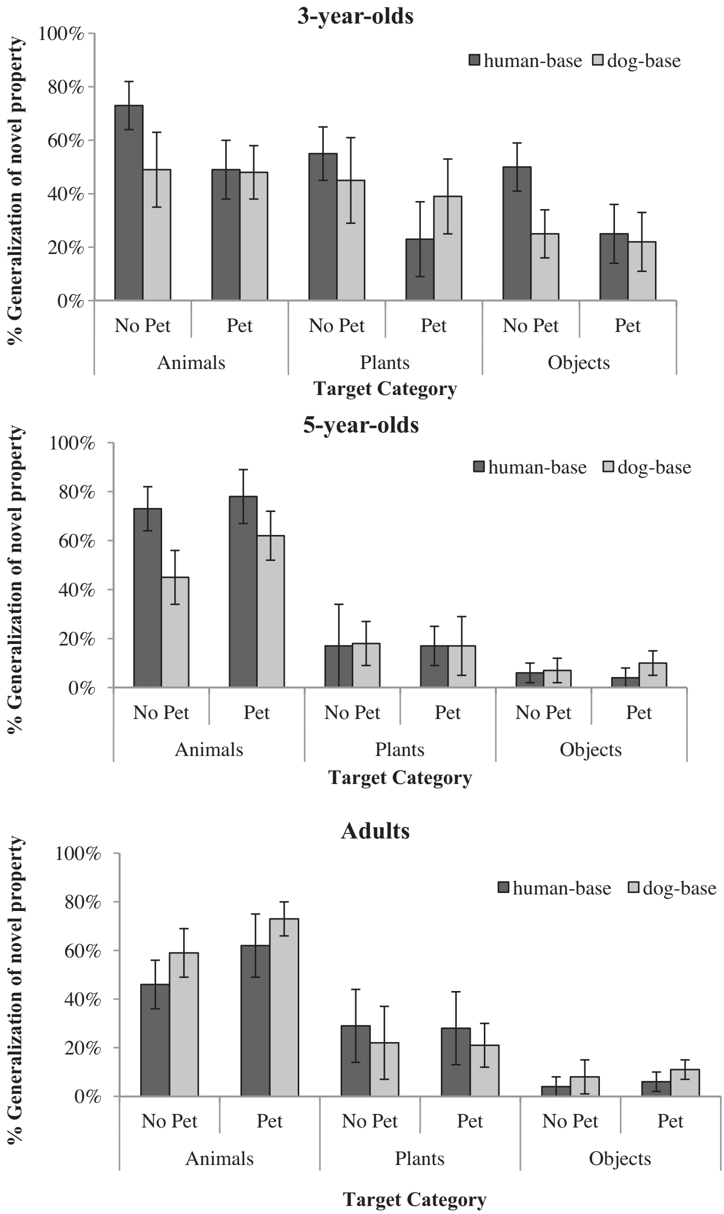

Fig. 3. Average projections to animals, plants, and objects by age group and pet ownership. Error bars represent standard errors.

properties than dogs, whereas this strongly anthropocentric pattern or reasoning was attenuated in children with pets. In addition, for older children, pet ownership was related to increased attributions from dogs to humans. The 5-year-olds with pets were significantly more likely to attribute properties from dogs to humans than the 5-year-olds without pets, $\chi^2(1, N = 23) = 3.88$, $p = .049$, $r = .411$. This comparison was not significant between 3-year-old pet owners and non-pet owners ($p = .77$).

Next, we examined projections from dogs/humans to three broader categories of living and nonliving entities—from dogs/humans to animals (cat, hamster, cow, lion, bird, frog, fish, bee, and ant), plants (flower and tree), and objects (cloud, doll, crayon, and car). Evidence of an anthropocentric bias would come from stronger projections from humans to other animals than from dogs to other animals. A repeated-measures ANOVA using age (3-year-olds, 5-year-olds, or adults), base (human or dog), and pet ownership (yes or no) as between-participants factors and using target (animal, plant, or object) as a within-participants factor was conducted to examine the effect of age and pet ownership on anthropocentrism (Fig. 3). Preliminary analyses revealed no effects of gender (all *p*s > .30), so this variable was not included in the analysis.

We found a main effect of target, $F(2,200) = 98.63$, $p < .001$, $\eta^2_p = .497$, which was qualified by a significant Age × Target interaction, $F(4,200) = 6.69$, $p < .001$, $\eta^2_p = .118$. Separate ANOVAs examined differences in projections to each of the three targets for each age group separately. For adults, there was a main effect of target, $F(2,60) = 39.67$, $p < .001$, $\eta^2_p = .569$. Adults were more likely to project the novel property to animals ($M = .60$, $SE = .05$) than to either plants ($M = .25$, $SD = .06$) or nonliving objects ($M = .07$, $SD = .02$) (both *p*s < .001). They were also more likely to project the property to plants than to nonliving objects ($p = .002$). The ANOVA on 5-year-olds also revealed a main effect of target, $F(2,72) = 73.42$, $p < .001$, $\eta^2_p = .671$. Like adults, 5-year-olds were more likely to project the novel property to animals ($M = .63$, $SE = .06$) than to either plants ($M = .17$, $SD = .06$) or nonliving objects ($M = .07$, $SD = .02$) (both *p*s < .001). They were also more likely to project the property to plants than to nonliving objects ($p = .044$). Finally, for 3-year-olds, there was also a main effect of target, $F(2,80) = 10.05$, $p < .001$, $\eta^2_p = .201$. The 3-year-olds were more likely to project the novel property to animals ($M = .55$, $SE = .06$) than to nonliving objects ($M = .31$, $SD = .05$) ($p < .001$) and were marginally more likely to project to animals than to plants ($M = .41$, $SD = .07$) ($p = .054$). Unlike adults and 5-year-olds, they were just as likely to project to plants as to nonliving objects ($p = .119$).

The three-way interaction among target, base, and age fell short of significance, $F(4,200) = 2.30$, $p = .060$, $\eta^2_p = .044$. Furthermore, there was no significant main effect of pet ownership and no significant interaction between pet ownership and any other variable (all *p*s > .18).

Property interview

We also tested whether younger and older children with pets were more willing to attribute biological and psychological properties to animals than children without pets. Preliminary analyses revealed no differences in biological or psychological knowledge between children with cats and children with dogs (all *p*s > .31), so all results were collapsed across animal type. A repeated-measures ANOVA compared children's attribution of psychological and biological properties as a function of age (3-year-olds or 5-year-olds) and pet ownership (Fig. 4). The analysis revealed a significant main effect of property type, $F(1,92) = 9.40$, $p = .003$, $\eta^2_p = .093$. Children were more likely to attribute biological properties ($M = .58$, $SD = .16$) than psychological properties ($M = .49$, $SD = .25$) to animals, $t(95) = 2.95$, $p = .004$, $d = .61$. In addition, we found a significant interaction between property type and

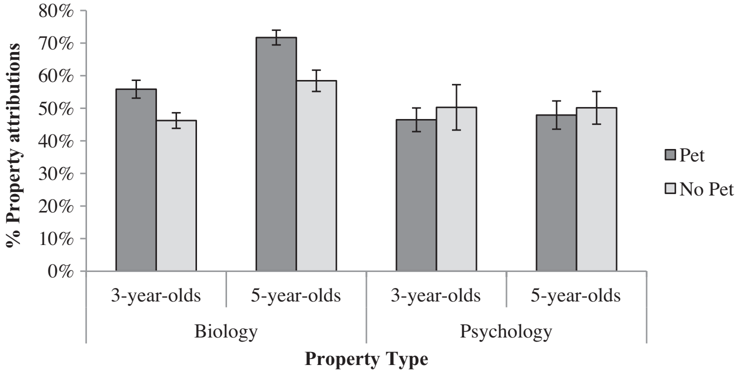

Fig. 4. Mean attributions of biological and psychological properties to animals by age and pet ownership status. Error bars represent standard errors.

age, $F(1,92) = 4.79$, $p = .031$, $\eta_p^2 = .050$. Follow-up analyses revealed that older children ($M = .65$, $SD = .15$) attributed more biological properties to animals than younger children ($M = .51$, $SD = .13$), $t(94) = 4.80$, $p < .001$, $d = .99$. There was no difference between younger children ($M = .48$, $SD = .27$) and older children ($M = .49$, $SD = .23$) in attributions of psychological properties ($p = .90$).

Most important, we found a significant interaction between property type and pet ownership, $F(1,92) = 5.61$, $p = .020$, $\eta_p^2 = .057$. Follow-up analyses revealed that both younger and older children attributed psychological properties at similar rates regardless of pet ownership (both $ps > .63$). However, children with pets were more likely to attribute biological properties to animals than children without pets within both the older age group, $t(46) = 3.33$, $p = .002$, $d = 0.98$, and the younger age group, $t(46) = 2.65$, $p = .011$, $d = 0.78$. Thus, children with pets were not more likely to view animals as possessing social properties; however, at both ages pet ownership was related to differences in performance on the biological knowledge questions. Both 3- and 5-year-olds with pets were more likely to attribute biological properties to animals than children without pets. Even though, overall, 5-year-olds were more willing to attribute biological properties to animals than 3-year-olds, 5-year-olds with pets were still more likely than their peers without similar pet-raising experience to attribute biological properties to animals.

General discussion

Previous researchers have often made assumptions about the kinds of interactions that children have with their pets (e.g., Inagaki, 1990) or the kinds of opportunities that children from different cultures have for different kinds of interactions with real and fictional animals (e.g., Hermann et al., 2010). The current research examined the content of a particularly important and prevalent daily animal experience—interactions with a family pet—and compared the performance of children with and without pets on two different types of tasks intended to measure psychological and biological reasoning.

We found that despite being highly interested and engaged in their animals, children are rarely involved in the types of experiences that have been assumed to contribute to the acquisition of biological knowledge about animals such as feeding them and cleaning up after them. Children's lack of involvement in caretaking at this young age may be due less to their own interests and more to parents not seeing their children as old enough to participate in caretaking activities. However, children are nonetheless very interested in their pets and engage in social activities with them, frequently playing with and talking to their pets. Furthermore, children treat their pets as social partners, engaging them in reciprocal social activities. Interestingly, our data suggest that this experience is not associated with increased attributions of psychological properties to animals. Rather, the experience of having a pet relates to increased biological knowledge. Based on the results of our property interview, both younger and older children with pets are more willing to extend biological properties to animals than those without pets.

In addition, our data suggest that even the youngest children who own pets treat humans and animals more similarly as inductive sources of novel biological information than children without pets. In line with previous research, our analyses focused on two patterns of inductive reasoning that reveal anthropocentrism (Carey, 1985; Hermann et al., 2010; Ross et al., 2003). First, we looked for evidence of an asymmetry between projections from humans to dogs versus from dogs to humans in younger and older participants with and without pets. Stronger projections in the former reveal anthropocentric reasoning. Children who did not have the experience of raising a pet showed this anthropocentric bias, treating humans as privileged inductive sources of novel biological information. This anthropocentric bias was attenuated in children with pets; although they showed similar patterns to children with pets, differences in projections between dogs and humans and between humans and dogs failed to reach statistical significance in both 3- and 5-year-olds with pets. This finding suggests that children with daily experiences with animals are more likely to treat humans and animals similarly in terms of the possession of unseen biological properties. However, we did not find a similar difference between children with and without pets in children's projections from dogs/humans to three broader categories of living and nonliving entities: from dogs/humans to animals, plants, and objects. Thus, we found evidence in only one of two traditional patterns of inductive reasoning, reduction of asymmetry in projections from humans to dogs versus from dogs to humans, to support that pet ownership relates to higher biological knowledge on the biological induction task. One possible explanation for the differences in findings is that the measure of similarity between dogs and humans is particularly salient to children with cats and dogs. Their extensive experience with domesticated animals may have affected their views on the biological similarity between domesticated animals and humans without similar extension to all animals. Future research can address this by looking at children with extensive experience with less typical animal species.

These results have important implications for differing theories of how experience with animals affects the development of anthropocentrism and biological knowledge. One view argues that anthropocentrism *develops* between the ages of 3 and 5 years in urban children as a result of impoverished exposure to real animals coupled with extensive exposure to anthropomorphized portrayals of animals in media and cultural discourse. Thus, extreme personification actually encourages children to come to see animals as *less* biologically similar to humans (Hermann et al., 2010). In fact, children who were read an anthropomorphic story about animals exhibited more asymmetry in their biological projections from humans and animals than children who were read a realistic animal story (Waxman, Herrmann, Woodring, & Medin, 2014). In our study, both suburban 3- and 5-year-olds without pets did show an anthropocentric bias via one measure of asymmetry. However, children of the same age who grow up with pets show attenuated asymmetries in their reasoning between dogs to humans and humans to dogs, suggesting that children with pets are less likely to reason anthropocentrically.

Our results support the argument that social experience with real animals *decreases* anthropocentrism. This is consistent with Inagaki and Hatano's (1987, 2002) hypothesis that personification as analogy plays an important role in fostering the construction of a naive biology. These researchers argue that whereas humans serve as a privileged source of information for children, personification of animals helps children to analogically extend knowledge about their own behavior and biological functioning to less familiar animals. In our research, children who have daily interactions with pets, which they largely treat as social partners, are also more likely to recognize commonalities between animals and humans at an earlier age and attribute more biological properties to animals than their peers without similar daily animal exposure. However, it is still an open question for future research to explore the direct mechanism by which social experience with animals could lead to increased biological knowledge and whether this is limited to social experiences with real domesticated animals.

Despite the current findings showing group differences between children with pets and children without pets, pet ownership in the current study was not an independent variable. Thus, within the context of the current study, we cannot determine whether lack of pet ownership causes anthropocentrism or whether pet ownership encourages biological reasoning. It is also plausible that the causal relationship may go the other way; children with higher biological knowledge may be more likely to own and/or show interest in animals. Although plausible, it seems highly unlikely that children with advanced biological knowledge would be choosing to be pet owners; close to 75% of the pets in our study had been in the families since before the births of the children. This is similar to previous research comparing urban and rural children (e.g., Atran et al., 2001; Hermann et al., 2010; Ross et al., 2003; Waxman & Medin, 2007); these children are born into an environment that affords certain opportunities for direct animal interactions and cultural discourse about animals and biology and exhibits corresponding differences in biological knowledge. In addition, our correlational results mirror recent experimental work showing that specific experiences with different portrayals of animals can increase or decrease anthropocentric reasoning (Waxman et al., 2014) as well as children's learning of novel social and biological facts about animals (Ganea, Canfield, Simons-Ghafari, & Chou, 2014), suggesting that experience with animals causes changes in knowledge.

Nevertheless, families who have pets and those who do not likely differ in a number of relevant ways. For instance, families in comparatively more urbanized areas or apartment complexes where pets are not allowed or who work longer hours are probably less likely to have pets and may also be less likely to engage in other types of animal- or biology-related activities with their children (e.g., visiting a zoo). Families who choose to have pets may differ in their attitudes toward animals and/or engagement in other types of activities related to animals and biology. In addition, it is unclear what aspect of pet raising leads to an increase in biological knowledge and a decrease in anthropocentric reasoning. For instance, we did not investigate the types of conversations that parents and children have about their animals; even though children might not be directly involved in caretaking behaviors, parents and children may have conversations about their pets that support the acquisition of biological knowledge.

The current research was conducted with children from suburban communities of a major metropolitan area in the United States. Thus, it is possible that our results would not generalize to other populations in different geographical areas or who have different culturally specific relevant input and experiences. Culture, language, and experiences are all relevant to knowledge development and reasoning (Angorro et al., 2010), and it is possible that some of these are more influential in children's reasoning than the results of social experiences with animals that we found here. For instance, populations differ in terms of the cultural background, attitudes in society toward animals, hunting, and diet, and all of these may affect the observed results. It is important for further cross-cultural experimental work to compare the effect of such experiences in the face of different social and environmental affordances.

Finally, in the current research, we focused exclusively on two very popular types of pets: cats and dogs. We chose these species specifically because they are so prevalent; in the United States, 45.3 million households own cats and 56.7 million households own dogs. Cats and dogs are three and four times more common, respectively, than the next most popular type of pet, fish (American Pet Products Association, 2014). However, children certainly have experiences with other types of animals that were not studied here. Children may also interact with other small animals such as birds, fish, rabbits, and hamsters, which may provide the opportunity to observe biological properties. However, the types of activities in which children engage with other animals may be different; for instance, an animal that lives in a cage might not respond to social stimuli as readily as a cat or a dog and, thus, may afford less opportunity for social interactions. Regardless, previous research has shown that even raising goldfish increases children's factual and conceptual knowledge about aquatic animals (Inagaki, 1990). Thus, it is important to further investigate the kinds of interactions that children have with a wider range of animal species to understand more precisely what aspect of pet raising relates to biological knowledge development.

Ongoing research in our lab is further investigating the direct impact of different types of realistic and anthropomorphized experiences with animals on children's biological knowledge about animals. We are also examining how other family characteristics and experiences, such as media use and parental attitudes toward animals, are related to children's biological knowledge. Although much research has focused on the content and development of young children's biological concepts, little research has focused on characterizing the everyday experiences that may contribute to children's knowledge development. Future work should continue to aim to combine these foci, characterizing actual experiences as well as experimentally measuring learning outcomes, to fully illuminate the ways in which direct and indirect daily experiences with both real and fictional animals can better support the development of children's early biological knowledge.

In conclusion, this research has extended prior research on the development of children's naive biology by investigating a common experience that provides direct information about animals—having a pet. We found that although children interact with their pets in a primarily social manner, this experience was related to a greater willingness to attribute biological properties to animals and also to incorporate animals and humans into a cohesive category of living things at an earlier age than observed previously. In conjunction with similar findings from experimental research (Ganea et al., 2014; Waxman et al., 2014), our findings help to support the hypothesis that treating animals as social creatures may help children to analogically understand animals as more similar to humans in other ways, including biologically (Inagaki & Hatano, 1987, 2002). Although further experimental research is needed, our research highlights the importance of understanding children's varied backgrounds and experiences as they relate to early knowledge growth.

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