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The friendly fossa: The effect of anthropomorphic language on learning about unfamiliar animals through both storybooks and live animal experiences

Megan Conrad *,[1], Stuart Marcovitch, Janet J. Boseovski

Department of Psychology, University of North Carolina at Greensboro, Greensboro, NC 27402, USA

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ABSTRACT

Children's storybooks about animals often use elements of fantasy; even educational storybooks intended to teach children about factual and biological properties include talking animals depicted as more like humans than animals. Previous research has found that anthropomorphic images, specifically in storybooks, hinder factual learning and thus should not be used in the context of educational experiences. However, little research has explored the impact of anthropomorphic language alone as well as its use in other contexts such as zoos where parents often naturally use anthropomorphic language. The current studies explored the impact of anthropomorphic language on learning about an unfamiliar animal (fossa) across two contexts: storybooks (Study 1; N = 48; age range = 4;0–6;3 [years; months]) and a zoo (Study 2a; N = 29; age range = 4;5–7;10). An adult comparison group (Study 2b, N = 82) was also included. Across both studies, there was no evidence that anthropomorphic language decreased factual learning. However, children given anthropomorphic information about a fossa were more likely to generalize anthropomorphic traits, such as emotions, intentions, and preferences, to other fossas, and this was consistent with the adult comparison group. We discuss considerations for parents and educators regarding the appropriateness of fantastical language about animals in experiences specifically designed to support biological learning.

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* Corresponding author.
E-mail address: geerdtsm@wpunj.edu (M. Conrad).
[1] Current address: Department of Psychology, William Paterson University, Wayne, NJ 07470, USA.

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Introduction

A large body of research in developmental psychology has focused on the emergence and gradual development of children's basic knowledge about the biological world. Children may receive relevant information that helps them to develop this knowledge from direct experiences with animals such as visiting zoos (Geerdts, Van de Walle, & LoBue, 2015b; Rigney & Callanan, 2011) and interacting with pets (Geerdts, Van de Walle, & LoBue, 2015a). More frequently, information is often gained through mediated experiences, including conversations with parents (Crowley et al., 2001; Gelman, 2009; Gelman, Taylor, & Nguyen, 2004; Rigney & Callanan, 2011) and reading storybooks (Ganea, Canfield, Simons-Ghafari, & Chou, 2014; Ganea, Ma, & DeLoache, 2011; Geerdts, Van de Walle, & LoBue, 2016a; Legare, Lane, & Evans, 2013; Waxman, Herrmann, Woodring, & Medin, 2014). However, both children's media (Geerdts, Van de Walle, & LoBue, 2016b; Goldstein & Alperson, 2020; Marriott, 2002; McCrindle & Odendaal, 1994) and conversations with adults (Ash, 2003; Geerdts et al., 2015b, Rigney & Callanan, 2011) tend to heavily anthropomorphize animals. Animals are often presented in an unrealistic manner, depicted as capable of a range of psychological and behavioral properties that are specific to human functioning. What impact does exposure to anthropomorphic portrayals of animals in these typical informal learning experiences have on children's developing knowledge about real animals? The limited experimental research in this area, which we review below, has produced conflicting findings, making it difficult to know whether realistic or fantastical portrayals of animals are best for fostering preschool-aged children's knowledge about unfamiliar animals.

In the current studies, we focused on two common informal learning contexts especially relevant to learning about animals: storybook reading and zoos. We review the literature on learning about animals from realistic and anthropomorphic storybooks as well as relevant literature on learning about live animals in informal learning environments. We then present findings from two experimental studies in which we explored children's learning about unfamiliar animals across two contexts: fantasy and realistic storybooks (Study 1) and docent descriptions in a zoo setting (Study 2). Continued research efforts in this area can help to clarify for parents, educators, and designers of informal learning environments whether fantastical elements are appropriate for supporting learning about unfamiliar animals and whether their effectiveness is different across different contexts.

Learning about animals from storybooks

Storybook reading is an important learning tool that is a daily occurrence for many children. Nearly all (91%) children in the United States younger than 5 years have been exposed to storybooks, with the average age of first exposure at 5 months (Rideout, 2011). Furthermore, digital media time does not seem to be displacing children's time spent with books; the average amount of daily reading time, 29 min, remained consistent from 2011 to 2017 (Rideout, 2017). Thus, storybook reading is a common experience with potential ramifications for early learning.

Previous content analyses of children's literature have found that storybooks may be a significant source for exposure to a wide variety of animals. Pentimonti, Zucker, Justice, and Kaderavek (2010) examined the content areas of read-aloud informational texts in preschool classrooms and found that the most common content area (23.2%) was living creatures, which included animals, dinosaurs, and insects. Marriott (2002) examined more than 1000 picture books for young children and found that nearly half (48.5%) featured animals as significant characters. Across these books, more than 60 different animal species were featured. However, this analysis also found that only a quarter of the animals were featured in natural settings. Instead, animals typically exhibited human-specific attributes such as talking, living in houses, and going to school. A more recent analysis of 42 storybooks for 3- to 6-year-old children revealed that 57.7% contained anthropomorphic animals (Goldstein & Alperson, 2020). Even books that are focused on a biologically relevant topic (e.g., contagion, camouflage, biological inheritance) often contain anthropomorphism (Geerdts et al., 2016b). One study of a preschool lending library found that the most frequently checked out books were more likely to contain anthro-

pomorphism than the less popular books (McCrindle & Odendaal, 1994), again highlighting the prevalence of exposure to anthropomorphism within storybooks.

Given the ubiquitous nature of fantastical animals in children's storybooks, a key research question is the impact on children's learning about real animals. A number of previous studies have found that fantasy elements *decrease* factual learning and transfer (e.g., Richert, Shawber, Hoffman, & Taylor, 2009; Richert & Smith, 2011; Simcock & DeLoache, 2006; Walker, Gopnik, & Ganea, 2015) and that young children extend information from media more efficiently when the referent and the object are more similar (Ganea, Bloom Pickard, & DeLoache, 2008). This accumulated body of research suggests that anthropomorphism should *hinder* children's factual learning and transfer to real animals due to the larger differences between anthropomorphic animals and real animals relative to realistic portrayals of animals. In line with that prediction, a number of studies have found that anthropomorphic storybooks decrease factual learning and increase anthropocentric reasoning (see Geerdts, 2016, for an extended review of the following literature). Waxman et al. (2014) found that 5-year-old children who were read an anthropomorphic storybook (*The Berenstain Bears*) were more likely to display a human-centered pattern of biological reasoning, a biologically incorrect pattern seen more commonly in younger children, than children of the same age who were read a realistic animal storybook (*First Animal Encyclopedia*). Ganea et al. (2014) found that preschool-aged children who were read an anthropomorphic storybook about an unfamiliar animal (cavy) were less likely to extend factual properties from the storybook to real cavies than children who were read a realistic storybook. In addition, children extended the characters' anthropomorphic properties, such as talking and having friends, to *real* cavies. Although some of these anthropomorphic beliefs are benign and naturally decrease with age and direct animal experience (e.g., believing that animals can talk or live in houses or wear human clothing), other anthropomorphic beliefs may persist into adulthood and can potentially be dangerous. For instance, a conceptualization of wild animals as human-like can lead to an expectation of friendly behaviors. The "Bambi" portrayal of deer and similar depictions of forest animals as cute, sweet, and lovable has caused major problems for park rangers, with an increasing number of visitors being attacked after attempting to approach or hand-feed wild animals (Strauss, 2006). Thus, it is important to take the potential ramifications of anthropomorphism seriously.

However, the negative effects on learning observed in those studies may be limited to more extreme depictions of anthropomorphism. All the previously cited studies contained *heavily* anthropomorphized depictions of animals; the animals in these stories more closely resembled humans than animals. Other studies with *lesser* degrees of anthropomorphism (i.e., using anthropomorphic language alone and realistic images of photographs of real animals) did not find similar decreases in factual learning and in some cases even observed increases in learning. Ganea et al. (2011) taught 3- and 4-year-old children color camouflage facts using either factual language storybooks ("The bird doesn't see the frog because it's the same color as the things around it") or anthropomorphic language storybooks ("The bird doesn't see Sammy because Sammy's color is the same as the things around him. Sammy tricked the bird!"). Children performed equally well at transferring information from the factual and anthropomorphic books, and very few children in either condition provided camouflage explanations using intentional terms. Similarly, Geerdts et al. (2016a) explored color camouflage learning from anthropomorphic and realistic storybooks with 3- to 5-year-old children. Performances on recall and generalization tasks were similar between anthropomorphic and realistic storybook conditions. Even though children used anthropomorphic language in their recall of anthropomorphic stories, they were not more likely to attribute anthropomorphic properties to real animals and they did not generate anthropomorphic explanations for camouflage. Children in the anthropomorphic conditions actually provided more sophisticated biological explanations than children in the realistic conditions. However, both of these studies used highly familiar animals (frogs, birds, and butterflies) and were only measuring learning about camouflage. Ganea et al. (2014) also found that anthropomorphic language did not interfere with learning about an unfamiliar animal; they found decreased factual learning only when anthropomorphic language was paired with anthropomorphic pictures. Thus, anthropomorphic language and images together are so vastly different from real animals that young children may have difficulty in realizing that the factual information presented in the storybook context applies to their real-world counterparts. However, across all three studies, the presentation of

anthropomorphic language *only*, coupled with realistic images of the animals, did not appear to interfere with applying newly learned facts to real animals.

However, Ganea et al. (2014) also found that anthropomorphic language increased anthropomorphic attributions to real animals, suggesting that language alone may cause children to have inaccurate expectations about the behavior of unfamiliar animals. Similarly, Legare et al. (2013) found that 5- to 12-year-olds were more likely to endorse anthropomorphic explanations for evolution after hearing anthropomorphic language about evolutionary change (e.g., the birds *wanted* to change their beaks to adapt to their surroundings because they *like* the hard seeds). The current research aimed to add to this limited body of research by designing a storybook about an unfamiliar animal using anthropomorphic language alone and examining children's factual learning as well as anthropomorphic learning.

Anthropomorphism and learning about live animals

Although storybook reading is a common experience that exposes children to a wide variety of non-native animal species, other kinds of experiences are also likely relevant. Importantly, children rarely explore the world independently; adults shape children's experiences with animals both through the opportunities they provide for observation of live animals and through conversation about animals. One learning context where adult–child interaction has received substantial attention is informal learning environments such as museums, zoos, and science centers (e.g., Allen, 2002; Callanan, Castañeda, Luce, & Martin, 2017; Crowley et al., 2001; Haden, 2010; Haden, Cohen, Uttal, & Marcus, 2015; Kisiel, Rowe, Vartabedian, & Kopczak, 2012; Kopczak, Kisiel, & Rowe, 2015; Rowe & Kisiel, 2012). In these settings, children have the opportunity to observe a range of unfamiliar animals and engage in conversation with knowledgeable others, including parents and docents. Especially for children in urban environments, zoos and science centers may be the most common situation in which children can observe a wide range of live animal species.

Relatively few studies have specifically analyzed anthropomorphic language in informal learning environments. In an analysis of family conversations at a large frog exhibit at an interactive science museum, Ash (2003) found that parents often used personification, modeling and providing anthropocentric information about animals for their children. Rigney and Callanan (2011) analyzed the content of parent–child conversations about marine animals at a science center exhibit and found that parents often guide children to think about some kinds of animals as human-like. Although families could potentially talk about a lot of different aspects of animals, about 10% of parents' utterances about the animals related to psychological properties or intentions; less than 2% of children's utterances fell into this category. Most recently, Geerdts et al. (2015b) looked at parent–child conversations about animals across two settings: an animal exhibit at a zoo and an insect exhibit at a science museum. In these conversations, parents often presented social information about animals; parents frequently made anthropomorphic references to the animals (e.g., interacting with them socially, attributing mental states, using social relational terms). Parents used this anthropomorphic talk significantly more often with preschool-aged children (3- to 5-year-olds) than with school-aged children (5- to 8-year-olds). Similar to Rigney and Callanan (2011), children made these statements less often than their parents, suggesting that parents play a guiding role in supporting anthropomorphism in these conversations about live animals.

However, none of these studies included posttest measures of children's factual or anthropomorphic learning, precluding any conclusions about the direct impact of anthropomorphic language in this context on learning. A number of other studies examining science learning in museums and science centers do support the important role that adults can play in fostering interest, highlighting relevant evidence, providing explanations, and enhancing learning (e.g., Benjamin, Haden, & Wilkerson, 2010; Crowley & Jacobs, 2002; Fender & Crowley, 2007; Haden et al., 2014; Jant, Haden, Uttal, & Babcock, 2014; Tscholl & Lindgren, 2016). Although these studies did not explore learning about animals, they suggest that providing specific information to facilitate parent–child interaction may affect children's learning within zoo and museum experiences. Understanding the role of anthropomorphic language

in learning about animals in informal learning environments can provide important information about how best to design exhibits and provide informational material to families to support children's early factual learning.

The current research

Based on our review of the literature, a number of questions remain about what young children learn from fictional anthropomorphic language about animals across the two contexts: storybook reading and informal learning environments such as zoos. Currently, there is very limited experimental research on anthropomorphic language in storybooks and no prior experimental research conducted at live animal exhibits. We know very little about the consequences of anthropomorphic language for learning at informal learning environments despite its frequent appearance in naturalistic conversations in these settings. The question remains whether anthropomorphic language in the context of live animals has the same effect on learning as anthropomorphic language in a mediated (storybook) experience.

In the current studies, we examined the impact of anthropomorphic language in storybooks and at a zoo on both factual learning and anthropomorphic thinking. To avoid previous knowledge of the animals from affecting children's performance on the tasks, we chose an animal at the zoo that was expected to be unfamiliar to most young children. The fossa, a mammal native to Madagascar, is a relative of the mongoose and resembles a large cat with a long tail. In Study 1, we exposed preschool-aged children to storybooks that used either realistic or anthropomorphic language to teach children factual information about fossas. Study 2 took place at a fossa exhibit at a local zoo. We adopted the storybooks from Study 1 into scripts that a confederate posing as a zoo docent read to children.

In addition, in both studies we included a measure of individual differences in anthropomorphism. Although anthropomorphic beliefs are generally widespread and found across the lifespan, research has also shown that there are substantial individual differences. The Individual Differences in Anthropomorphism Questionnaire (IDAQ) measures stable individual differences in attributing mental states such as consciousness, intentions, and emotions to animals and nonliving objects (Epley, Waytz, & Cacioppo, 2007). These scores show temporal stability and predict a range of behaviors toward these entities such as moral care and concern (Waytz, Cacioppo, & Epley, 2010). Recently, the IDAQ–Child Form (IDAQ–CF) has been adapted from this adult measure and validated for use with children as young as 5 years (Severson & Lemm, 2016). No previous research with young children has explored whether individual differences in anthropomorphizing are related to differences in learning from anthropomorphic media. For instance, children who have a greater tendency to anthropomorphize animals may pay more attention to the provided anthropomorphic information and may consequently have higher scores on the anthropomorphism memory and attribution posttest.

In Study 1, in line with previous research, we expected to find that after reading a storybook with anthropomorphic language about one fossa, children would be more likely to extend anthropomorphic properties to all fossas (Ganea et al., 2014). In addition, because previous research suggests that anthropomorphic language alone does not interfere with learning (Ganea et al., 2011; Geerdts et al., 2016a), we expected to find that children's factual memory would be similar after hearing realistic and anthropomorphic language storybooks. We generally expected the same results in Study 2, but there was an absence of previous literature on learning from anthropomorphic information in informal learning environments to support strong hypotheses. However, there was a large body of previous research on children's trust in informant testimony and learning from experts that relates to the current design. Previous research has found that children are very sensitive to speaker expertise in trusting testimony (Lane & Harris, 2015). Thus, they may be very willing to accept the information from the docent, who should be assumed to be an "expert" with regard to the animal's behavior, and thus show equal factual learning across both conditions and increased anthropomorphic attributions in the anthropomorphic language condition.

Study 1

Method

Participants

A total of 48 preschool-aged children (25 female; M_{age} = 4;10 years, SD = 0.57, range = 4;0–6;3 years) participated in the current study. Previous research has shown that 5-year-old (but not 3-year-old) children begin to espouse biological or anthropocentric reasoning in line with larger cultural views toward animals (Waxman et al., 2014). Thus, we can expect to see significant learning and revision happening during the preschool years. We based our sample size on previous research using similar storybook manipulations that ranged from 12 to 24 participants per condition (Ganea et al., 2008, *N* = 16; Ganea et al., 2014, *N* = 22–24; Ganea et al., 2011, *N* = 16–20; Geerdts et al., 2016a, *N* = 12). Families were recruited through local preschools and day-care centers. The sample self-identified as Caucasian (76.7%), African American (13.3%), or mixed race (10.0%). The study took place in a quiet area of the preschool or day-care center. All procedures in the study were approved by the authors' university institutional review board. Parents gave written consent for children's participation and completed a demographic form, and children gave verbal assent. On completion of the study, children were rewarded with their choice of a small prize or sticker.

Instruments and materials

Materials for this study included the IDAQ, two storybooks about fossas, and a posttest assessment. A Theory of Mind Battery, an Animal Behavior task, and two animal categorization measures were also administered after these measures for the purposes of another study but are not analyzed here.

Individual differences in anthropomorphism questionnaire. We administered the IDAQ–CF, as described in Severson and Lemm (2016). The IDAQ–CF is a 12-item questionnaire, presented in random order, that measures children's anthropomorphism. Children were asked whether technological, inanimate, and animate entities possess a range of mental and social properties such as feelings, self-awareness, independent thought, and behavioral control (e.g., "Does a lizard do things on purpose?"; "Does a bug think for itself?"). Using forced-choice options on a visual scale, children responded *no* (0), *a little bit* (1), *a medium amount* (2), or *a lot* (3). Total scores on the measure ranged from 0 to 36. Materials of this task included pictures for scale responses of "thumb up" (*yes*) and "thumb down" (*no*) as well as increasingly tall bars indicating *a little bit, a medium amount,* and *a lot.* Two variables were then computed, in line with previous research (Severson & Lemm, 2016; Waytz et al., 2010): an animals subscale score (mean rating for the 4 animal items) and a nonanimals subscale score (mean rating for the 8 technology/nature items).

Storybooks. Two age-appropriate storybooks about a fossa were created for use in this study: a *realistic* storybook and an *anthropomorphic* storybook (see Appendix A for the full scripts of both storybooks). In the realistic storybook, factual language presented multiple facts about a fossa, including information on its habitat, behavior, diet, and size. The anthropomorphic storybook presented similar facts about a named character ("Gary the fossa") but added information about the animal possessing human mental states, desires, behaviors, preferences, and social relationships. The storybooks were designed to be as similar as possible with the exception of the anthropomorphic information. Both storybooks also featured photographs of real fossa in natural habitats (Fig. 1).

Posttest assessment. Each child was asked a set of 16 yes/no questions about fossas (see Appendix B for all questions). The measure included 8 *factual memory* questions (e.g., "Are fossas from Madagascar?"; "Are fossas the same size as an elephant?") about information that was presented in both conditions. An additional 2 *factual control* questions not mentioned in either book were also included to ensure that children were not relying on any prior knowledge about the animals. The measure also included 4 *anthropomorphic memory* questions (e.g., "Do fossas have friends?"; "Are fossas tricky?") about properties that fossas were depicted as possessing in the anthropomorphic storybook only. To avoid yes/no

Fig. 1. Sample image of a fossa used in Study 1 storybooks.

biases, the correct answer to half of these 14 questions was *yes* and the correct answer to the other seven questions was *no.* The factual memory, factual control, and anthropomorphic memory questions were scored as 1 for a correct answer and 0 for an incorrect answer. In the case of the anthropomorphic memory questions, the "correct" answer (as shown in Appendix B) refers to its presentation in the anthropomorphic book. An additional 2 *anthropomorphic control* questions not presented in the anthropomorphic storybook were also included to see whether children extended additional anthropomorphic traits after hearing an anthropomorphic storybook. The control anthropomorphic questions were scored as 1 if answered *yes* (attributing anthropomorphic traits to fossas) and 0 if answered *no.* Thus, higher scores here reflect higher levels of anthropomorphizing.

Procedure

Children were tested in a quiet area in their preschool. Participation took place over two 15-min testing sessions spaced approximately 1 week apart (*Mdn* = 7 days, range = 4–14). Separate testing sessions were chosen to prevent children from becoming fatigued. Differences in time between testing appointments across children was due to coordinating schedules between the research team and the preschool. Children were randomly assigned to either the realistic storybook condition (n = 24) or the anthropomorphic storybook condition (n = 24).

During the first testing session, children gave verbal assent and an experimenter administered the IDAQ–CF. In the second testing session, children were read the storybook based on their randomly assigned condition and the posttest assessment was administered. The procedure used was modeled after Ganea et al. (2014). Children sat at a table to read storybooks with Experimenter 1 (E1) while Experimenter 2 (E2) sat nearby with a pile of paperwork and headphones. E1 introduced children to E2 by saying "This is my friend. She's going to do some work while we play." E2 then replied "Yes, I have to organize all of these papers and pictures! I'll just be working while you play." E2 then put on headphones so that she remained blind to the experimental condition. E1 then told children that they were going to read a storybook about a fossa. Children were asked if they had ever heard of a fossa before, and their response was noted. Children were encouraged to pay attention to the storybook ("I'm going to teach you some new facts about fossas"), and any interruptions were responded to neutrally before continuing to read the storybook. The experimenter read the storybook twice with each child to ensure that they heard the entire story. After the storybook reading, E1 left to retrieve stickers for children.

After E1 left, E2 removed her headphones and came over to children and said, "I heard you reading about fossas! I don't know anything about fossas. Can you help me answer some questions?" The 16 factual and anthropomorphic questions were then asked in a randomized order for each child. After

completing the posttest assessments, E2 said "Great job! Thanks so much for all of your help. I'm going to go back to work now!" E1 then returned and offered children their choice of a small prize or sticker before bringing then back to their classroom.

Results

Preliminary analyses revealed no significant main effects of sex or interaction between sex and any other variables, so all results reported below are collapsed across sex. Preliminary correlational analyses using age in days found that age was significantly positively related to factual memory scores, $r(48) = .54$, $p < .001$, and negatively related to the IDAQ nonanimals subscale, $r(48) = -.29$, $p = .044$. Age was not significantly related to factual control scores, anthropomorphic memory scores, or anthropomorphic control scores (all $ps > .40$).

Mann–Whitney tests were conducted to look for differences in factual and anthropomorphic memory questions across the storybook conditions. Descriptive data for each type of question (factual memory, factual control, anthropomorphic memory, or anthropomorphic control) are presented in Table 1. There was no statistical difference in factual memory scores between the realistic ($Mdn = 6.5$) and anthropomorphic ($Mdn = 7.0$) storybook conditions, $U = 225.50$, $p = .175$, $r = .20$, so learning appears to be similar across conditions. The data here were also examined by estimating a Bayes factor, comparing the fit of the data under the null hypothesis and the alternative hypothesis. We interpret this factor in line with Jeffreys (1961); a Bayes factor between 1 and 3 constitutes weak or inconclusive evidence, between 3 and 10 constitutes moderate evidence, and greater than 10 constitutes strong evidence. The Bayes factor of 2.24 provides weak evidence in favor of the null hypothesis. There was also no statistical difference in factual control scores between the realistic ($Mdn = 1$) and anthropomorphic ($Mdn = 1$) storybook conditions, $U = 334.50$, $p = .284$, $r = .15$. A Wilcoxon signed-ranks test indicated that, as expected, performance was better on memory questions ($Mdn = 7$) than on control questions ($Mdn = 1$), $z = 6.06$, $p < .001$, $r = .88$., suggesting that children learned about fossas specifically from our storybooks rather than relying on prior knowledge.

For anthropomorphic facts presented in the books, a Mann–Whitney test indicated that, as anticipated, children who were read the anthropomorphic storybook ($Mdn = 3$) were more likely to attribute those anthropomorphic properties than children who read the realistic storybook ($Mdn = 3$), $U = 194.50$, $p = .039$, $r = .30$, indicating that children in the anthropomorphic condition were attentive to the anthropomorphic facts presented in that storybook. In addition, children in the anthropomorphic storybook condition were more likely to attribute the control anthropomorphic properties, not mentioned in the storybook, to fossas ($Mdn = 1$) than children in the realistic storybook condition ($Mdn = 0.5$), $U = 198.00$, $p = .028$, $r = .32$.

Finally, we looked at whether individual differences in anthropomorphic beliefs predicted learning anthropomorphic facts in the anthropomorphic condition or attributions of anthropomorphic control facts in either condition. Partial correlations controlling for age found no significant relationship between anthropomorphic memory scores and either subscale of the IDAQ in the anthropomorphic storybook condition (all $ps > .52$). In addition, there was no significant relationship between anthropomorphic control scores and either subscale of the IDAQ in the anthropomorphic or realistic storybook condition (all $ps > .39$). Thus, individual differences in anthropomorphic beliefs did not appear to relate to children's learning or attributions of anthropomorphic control properties in either condition.

Discussion

The results from Study 1 generally support our predictions. We found that children in both the anthropomorphic and realistic language conditions learned factual information about an unfamiliar animal, performing near ceiling (median score of 7 of 8). Although the statistical evidence in support of the null hypothesis was weak, these findings are in line with previous work on anthropomorphic language storybooks (Ganea et al., 2011; Geerdts et al., 2016a). In addition, we found that children in the anthropomorphic language condition learned and applied the unrealistic anthropomorphic properties in the storybooks to real animals, in line with Ganea et al. (2014). Furthermore, children

Table 1
Means, ranges, and medians of factual and anthropomorphic memory and control questions in the realistic storybook and anthropomorphic storybook in Study 1.

Question type	Realistic storybook (n = 24)			Anthropomorphic storybook (n = 24)		
	M (*SD*)	Range	Median	*M* (*SD*)	Range	Median
Factual memory (possible range: 0–8)	6.29 (1.16)	4–8	6.5	6.71 (1.08)	4–8	7
Factual control (possible range: 0–2)	1.13 (0.61)	0–2	1	0.92 (0.72)	0–2	1
Anthropomorphic memory (possible range: 0–4)	2.63 (0.88)	1–4	3	3.13 (0.68)	2–4	3
Anthropomorphic control (possible range: 0–2)	0.50 (0.51)	0–1	0.5	0.83 (0.48)	0–2	1

in the anthropomorphic condition were significantly more likely to attribute additional anthropomorphic properties *not* included in the storybook to fossas than children in the realistic condition. The results show that although children are capable of learning factual information about unfamiliar animals from both types of storybooks, anthropomorphic language may *increase* children's anthropocentric beliefs about real animals. We also included a measure of individual differences in anthropomorphic beliefs to see whether these individual differences were related to differences in learning from anthropomorphic storybooks. However, we did not find that learning was related to scores on this measure, suggesting that the storybooks themselves drove anthropocentric reasoning rather than any individual differences in anthropomorphic beliefs.

In Study 2, we extended this work to investigate whether similar patterns emerge in a different context: at a live animal exhibit in a local zoo. We expected to find similar levels of factual learning from the two scripts, as we did in Study 1. We hypothesized that either the same pattern of results would emerge as in Study 1, where children learned and attributed anthropomorphic properties in the anthropomorphic condition but did not spontaneously attribute anthropomorphic properties in the realistic condition at the same high rate, or we may find that children in the anthropomorphic language condition are *not* more likely to extend anthropomorphic traits to fossas than children in the realistic language condition because they are also seeing a real live fossa. Because a real fossa does not exhibit behaviors in line with the information from the confederate, anthropomorphic attributions may be less likely. Such observation of the live fossa thus may function as a cognitive scaffold, providing the help that younger children need to counter the fantastical information in the script with any realistic information they have already previously learned about real animal behavior.

The scripts used in Study 2 were similar to the storybooks created in Study 1, with a greater number of facts and anthropomorphic properties. In Study 1, we did not find any difference in factual learning between the conditions. However, performance overall was very high, with a median score of 7 of 8, suggesting that the task may have been too easy. To further explore differences in learning, we added recall memory measures in addition to recognition questions. Expanding our factual memory measures provided us with additional opportunities to test whether factual learning differs between the conditions. Prior research using free recall as a measure has found significant differences between the realistic and anthropomorphic storybook conditions (Geerdts et al., 2016a). In addition, in Study 1 we examined a limited number of anthropomorphic traits using a yes/no binary scale. In Study 2, to increase sensitivity and variance, we adapted the same response scale as the IDAQ–CF, allowing us to look at binary yes/no responses in addition to the strength of attributions (0–3 scale).

Study 2a

Method

Participants

Parents with children aged 4 to 7 years visiting a zoo's fossa exhibit were invited to participate in a study of learning about animals in informal settings. A total of 29 children (14 female; M_{age} = 5;11 [years;months], *SD* = 0.88 years, range = 4;5–7;10) participated in the current study. The sample largely self-identified as Caucasian (86.2%) or African American (10.3%). All procedures in the study were

approved by the authors' university institutional review board. Parents gave written consent for their children's participation and completed a demographic form, and children gave verbal assent. On completion of the study, children were rewarded with their choice of a small prize and sticker.

Setting

The study took place at a local outdoor zoo that was part of a larger science center. We focused on the fossa exhibit, an outdoor enclosure containing one male fossa. There was a large glass viewing area so that children could see inside easily, and the fossa was always visible during our testing times. Participation took place at a table near the fossa exhibit.

Instruments and materials

Children completed the IDAQ–CF as described in Study 1 as a pretest measure. Two different versions of an informational script were used to teach children about the fossa (Appendix C). A factual memory assessment and an anthropomorphic attribution assessment were administered as posttest measures (Appendix D).

Individual differences in anthropomorphism questionnaire. We administered the IDAQ–CF, as detailed in Study 1.

Informational script. Two age-appropriate scripts about a fossa were created for use in this study: a *realistic* script and an *anthropomorphic* script. The scripts were very similar to the language used in the storybooks from Study 1. In the realistic script, factual language was used to present 10 facts about a fossa, including information on its habitat, behavior, diet, and size. The anthropomorphic script presented the same 10 facts about a named animal ("Ronnie the fossa") but added information about the animal possessing human-specific mental states, desires, behaviors, preferences, and social relationships. The two scripts were designed to be as similar as possible with the exception of the anthropomorphic information (see Appendix C for full scripts).

Factual memory posttest. In the factual memory posttest (see Appendix D for all questions), we tested children's *free recall, cued recall,* and *recognition* for the 10 pieces of factual information in the scripts. First, children were asked to tell the researcher everything they could remember that they learned about the fossa (*free recall*). Facts that were spontaneously recalled were tallied and counted for the free recall score. Any facts that were not spontaneously mentioned were then asked directly in *cued recall* (e.g., "Where do fossa come from?"). If children failed to produce the correct answer in cued recall, a forced-choice format was used to assess *recognition* (e.g., "Are fossa from Madagascar, Maldives, or Malaysia?"). One of the 10 questions was excluded due to experimenter error, so scores were based on the remaining 9 questions. Children received a score from 0 to 9 for each of the three measures tallying how many they got correct. Cued recall scores included correct responses at cued recall as well as those recalled freely, and recognition scores included facts that were recognized as well as those recalled without recognition prompts. Recognition scores also served as an overall knowledge score (total number of questions correct at any level).

Anthropomorphic attribution posttest. In the anthropomorphic attribution posttest, the researcher asked children whether they thought that fossas in general have the anthropomorphic traits mentioned in the anthropomorphic script. This allowed us to see whether children in the anthropomorphic condition widely attributed these facts to other fossas after being taught about this particular fossa and also whether children in the factual condition spontaneously attributed anthropomorphic attributes to these animals. Using the same forced-choice options and visual scale as we used in the IDAQ–CF, children could respond *no* (0) or *yes.* If they responded *yes,* they were asked to indicate *some* (1)*, many* (2)*,* or *all* (3). We analyzed the data based on (a) number of absolute attributions (how many *yes* responses out of the 10 traits) and (b) how strongly anthropomorphic their attributions were (calculated average score across all 10 questions, with higher scores reflecting greater anthropomorphic beliefs about these animals).

Procedure

A recruitment booth was set up on the path that led to the fossa exhibit. Parents were told that an experimenter who was acting as a docent would give their children some information about the fossa and afterward we would ask their children some questions to see what they had learned about the fossa from the interaction. Parents gave written consent for their children's participation and completed a demographic form, and children gave verbal assent.

First, children completed the IDAQ–CF with E1. Following the IDAQ, children were randomly assigned to receive factual information about the fossa or anthropomorphic information. E1 then introduced children to E2 (the experimenter posing as a docent) by asking them to go over to the fossa exhibit and saying that "my friend who works at the zoo will be waiting there to tell you all about the fossa." Children then went over to the exhibit, where E2 read the script. Because preschool-aged children show greater trust in oral testimony when it is backed by written text (Robinson, Einav, & Fox, 2013), we chose to have the docent read off of a clipboard. Finally, children were introduced to a third experimenter (E3). E2 said, "Let's go see my friend so you can tell her all about the fossa!" E3, who was blind to the experimental condition, said, "I heard you learned about the fossa! I don't know anything about fossas." E3 then conducted two posttest assessments, the factual memory posttest and the anthropomorphic attribution posttest, as detailed above. After testing, children were thanked and given a choice of a small prize.

Results

Factual memory

Here we present the results for free recall, cued recall, and recognition measures of factual learning. Preliminary analyses have found no significant impact of age or sex on any of the three measures within either condition, so these variables were excluded from the analyses. Independent-samples *t* tests were conducted for each of the three measures to test for differences in scores across the anthropomorphic and realistic script conditions. The data here were also examined by estimating a Bayes factor, comparing the fit of the data under the null hypothesis and the alternative hypothesis. Summary statistics are presented in Table 2. There were no significant differences in learning between anthropomorphic and realistic script conditions for either free recall, $t(27) = 0.792$, $p = .435$, or cued recall $t(27) = 0.361$, $p = .721$, or recognition $t(27) = 0.601$, $p = .553$. In addition, the Bayes factors of 2.88 for free recall scores, 3.55 for cued recall scores, and 3.22 for recognition scores provide moderate evidence in favor of the null hypothesis.

Anthropomorphic attributions

Next, we were interested in whether average anthropomorphic attribution scores differed across script conditions. Preliminary analyses have found no significant difference in anthropomorphic attributions based on sex for either condition (all $ps > .20$), so this variable was excluded from the following analyses. In the realistic script condition, there was no significant relationship between age and the number of anthropomorphic attributions ($p = .95$) or average degree of anthropomorphism ($p = .97$). In the anthropomorphic script condition, there was a significant relationship between age and both the number of anthropomorphic attributions, $r(15) = .56$, $p = .028$, and average degree of anthropomorphism $r(15) = .71$, $p = .003$. Thus, we did not find a general age-related trend toward higher anthropomorphism, but rather found a tendency for older children to be more likely to extend anthropomorphic properties to other fossas after hearing an anthropomorphic script.

Fisher's exact tests were used to compare total attributions (yes/no responses) across the two conditions. Children in the anthropomorphic script condition attributed significantly more anthropomorphic traits to fossas (78%) than children in the realistic script condition (64%) (Fisher's exact $p = .009$). Table 3 presents the results for each individual trait. Traits such as emotions and preferences were generally attributed to fossas regardless of condition. Traits about human-specific behaviors, such as activities and having names, were generally more likely to be attributed to fossas by children who had just been exposed to anthropomorphic scripts.

Table 2
T-tests and Bayes factors comparing the mean numbers of correct responses for three memory types in the realistic script and anthropomorphic script in Study 2a.

Question type	Realistic script (n = 14)		Anthropomorphic script (n = 15)		Null hypothesis significance testing		
	M	*SD*	*M*	*SD*	*t*	*p*	*BF*
Free recall	1.57	1.02	1.87	0.99	0.792	.435	2.88
Cued recall	4.00	1.92	4.27	2.05	0.361	.721	3.55
Recognition	7.43	1.45	7.13	1.19	0.601	.553	3.22

Finally, average attributions (mean response of 10 traits on a scale from 0 to 3) did not significantly differ between anthropomorphic (M = 1.72, SD = 0.51) and realistic (M = 1.46, SD = 0.63) script conditions, $t(27) = 1.22p = .233$.

Individual differences in anthropomorphism

We looked at whether individual differences in animal anthropomorphism were related to scores on the anthropomorphic or factual questions within both script conditions. In the realistic script condition, there were no significant correlations between IDAQ scores (animal or technology/nature) and either factual memory (free, cued, recognition, or overall) or anthropomorphic attributions (all $ps > .19$). In the anthropomorphic script condition, we found a significant positive correlation between scores on the IDAQ animals subscale and the number of attributions of anthropomorphic traits (count of *yes* responses), $r(15) = .524$, $p = .045$, suggesting that individual differences may play a role in learning from anthropomorphism such that information that aligns with children's beliefs may be remembered better even in the presence of a live animal. However, no similar relationship was found in Study 1, limiting the ability to draw a strong conclusion from this finding.

Discussion

In this study, we explored how anthropomorphic information about an unfamiliar animal from a docent at a zoo exhibit affected children's factual learning and anthropomorphic beliefs.

For factual learning, we found a pattern of results similar to that of Study 1. Factual learning was equivalent across realistic and anthropomorphic conditions, again suggesting that anthropomorphic language alone does not hinder factual learning (Ganea et al., 2011; Geerdts et al., 2016a). Across both conditions, children averaged 7 of 9 factual memory questions correct. This is significant given the brief interaction and the presence of distractors given that testing took place outside at a public zoo with many other children and parents around. This also highlights the important potential role of informal learning environments for gaining new information about unfamiliar animals.

For anthropomorphic attributes, our findings mirrored the results of Study 1. Overall, children in the anthropomorphic condition were more likely to say that other fossas have anthropomorphic traits, but significant differences were observed only within a few specific traits. This may be a limitation due to the relatively small sample size and the fact that some traits were more anthropomorphic than others. Older children who were given anthropomorphic information about the fossa were more likely than younger children to apply those anthropomorphic properties to other fossas, suggesting that they were paying attention to the anthropomorphic information from the docent and incorporating it into their knowledge about fossas. There were no similar age differences in factual learning, suggesting that the age difference found for anthropomorphic learning is not a general age-related memory capacity issue.

We also explored whether individual differences in anthropomorphic beliefs was related to learning. Unlike in Study 1, we did find a difference in learning based on individual differences in anthropomorphic beliefs. For children who heard the anthropomorphic script, there was a positive correlation between IDAQ Animal scores and anthropomorphic attributes to fossas. Thus, it seems that children who already have greater anthropomorphic beliefs about animals are more likely to attribute anthropomorphic properties to the unfamiliar animal. Specifically, we see this relationship only when

Table 3
Counts of total anthropomorphic attributions to fossas and Fisher's exact test results comparing the realistic script and anthropomorphic script conditions in Study 2a.

Anthropomorphic trait attribution question	Realistic script (n = 14)		Anthropomorphic script (n = 15)		Fisher's test
	Yes [n (%)]	No [n (%)]	Yes [n (%)]	No [n (%)]	p
Do fossas have names?	8 (57)	6 (43)	14 (93)	1 (7)	.035*
Do fossas play tag in the trees?	4 (29)	10 (71)	13 (87)	2 (13)	.003*
Do fossas like to use their claws for hanging on trees?	14 (100)	0 (0)	13 (87)	2 (13)	.483
Do fossas trick people?	7 (50)	7 (50)	6 (40)	9 (60)	.715
Do fossas play hide-and-seek?	7 (50)	7 (50)	13 (87)	2 (13)	.050*
Do fossas have a favorite food?	12 (86)	2 (14)	13 (87)	2 (13)	1.00
Do fossas play with their friends at night?	10 (71)	4 (29)	11 (73)	4 (27)	1.00
Do fossas beat other animals in races?	8 (57)	6 (43)	11 (73)	4 (27)	.450
Do fossas purr when they are happy?	13 (93)	1 (7)	15 (100)	0 (0)	.483
Do fossas live in houses in the forest?	6 (43)	8 (57)	7 (50)	7 (50)	1.00
Total	89 (64)	51 (36)	117 (78)	33 (22)	.009*

*$p < .05$.

primed by a docent with anthropomorphic information; children with greater anthropomorphic beliefs about animals were not more likely to *spontaneously* attribute anthropomorphic properties in the realistic condition. Although the evidence here is tenuous, our findings suggest that it may be useful to consider individual differences in reasoning and thinking when measuring learning outcomes from informal learning environments.

One potential concern in Study 2a was that even in the realistic storybook condition, anthropomorphic traits were attributed to fossas the majority of the time (64%). It could be that children of this age (and of this particular demographic background) are already likely to adopt anthropocentric beliefs regardless of provided scripts, which is why we found significant differences across only a few traits. Another possibility is that our traits were simply not anthropomorphic enough. Many of the traits were psychological dispositions, including emotions and preferences, rather than some of the more human-specific fantastical behaviors common to much of the visual anthropomorphism of prior studies and of children's media (e.g., talking frogs walking on two feet and wearing clothing). An adult comparison group was included in Study 2b to explore whether children are particularly prone to anthropomorphism or whether the traits are widely believed to be shared by animals and humans, even by adults in a realistic script condition.

Study 2b

Method

Participants

A total of 82 college students (57 female; *Mdn* age = 20 years, range = 18–38) participated in the current study. Participants were recruited from the psychology department research pool. All procedures in the study were approved by the first author's university institutional review board.

Instruments and materials

Measures for this study were the same as those used in Study 2a, including the informational script, recognition questions from the factual memory posttest, and anthropomorphic attribution posttest.

Informational script. The same scripts used in Study 2a were used in the current study.

Factual memory posttest. A forced-choice format was used to assess *recognition* (e.g., "Are fossas from Madagascar, Maldives, or Malaysia?") of the 9 facts analyzed in Study 2a. Participants received a score from 0 to 9 tallying how many they got correct.

Anthropomorphic attribution posttest. In the anthropomorphic attribution posttest, participants were asked whether they thought that fossas in general have the anthropomorphic traits mentioned in the anthropomorphic script. As in Study 2a, participants could respond *no* (0), *some* (1), *many* (2), or *all* (3). As in Study 2a, we analyzed the data based on (a) number of absolute attributions (how many *yes* responses out of the 10 traits) and (b) how strongly anthropomorphic their attributions were (calculated average score across all 10 questions, with higher scores reflecting greater anthropomorphic beliefs about the animal).

Procedure

An online questionnaire using Qualtrics was designed for the current study. After completing a passive consent form, participants were randomly presented with either the anthropomorphic or realistic script. Participants were asked to read the paragraph carefully, and it was accompanied by a photograph of a fossa (taken from Study 1). Participants then completed the recognition questions from the factual memory posttest of Study 2a, presented in a randomized order. Next, participants completed the 10 questions of the anthropomorphic attribution posttest from Study 2a, presented in a randomized order. Finally, participants were asked to list any biology courses they had taken in college. Participants were awarded course credit upon completion.

Results

Factual memory

An independent-samples *t* test was conducted to test for differences in scores across the anthropomorphic and realistic script conditions. The data here were also examined by estimating a Bayes factor, comparing the fit of the data under the null hypothesis and the alternative hypothesis. As in Study 1 and Study 2a, there was no significant difference in learning between anthropomorphic script conditions ($M = 8.10$, $SD = 0.58$) and realistic script conditions ($M = 8.05$, $SD = 1.13$), $t(80) = 0.23$, $p = .819$. In addition, the Bayes factor of 5.78 provides moderate evidence in favor of the null hypothesis.

Anthropomorphic attributions

Next, we were interested in whether average anthropomorphic attribution scores differed across script conditions. Preliminary correlation analyses have found no significant relationship between number of college biology courses taken and anthropomorphic attributions in either the realistic or anthropomorphic condition (all ps > .37). Fisher's exact tests were used to compare total attributions (yes/no responses) across the two conditions. As in Study 2a, participants in the anthropomorphic script condition attributed significantly more anthropomorphic traits to other fossas (73%) than participants in the realistic script condition (51%), (Fisher's exact $p < .001$). Table 4 presents the results for each individual trait to explore whether specific traits were more likely than others to be attributed to fossas. Fisher's exact test results for 6 of 10 traits showed significantly higher attribution rates in the anthropomorphic condition than in the realistic condition. In addition, unlike in Study 2a, average attributions (mean response of 10 traits on scale of 0 to 3) significantly differed between anthropomorphic script conditions ($M = 1.65$, $SD = 0.51$) and realistic script conditions ($M = 1.20$, $SD = 0.46$), $t(80) = 4.23$, $p < .001$.

Discussion

Study 2b supports the findings of Study 1 and Study 2a. Adults, like children, showed equal levels of factual learning across realistic and anthropomorphic script conditions. In addition, as in Study 1 and Study 2a, adults in the anthropomorphic condition were significantly more likely to attribute the traits from the storybook to other fossas as compared with adults in the realistic storybook condition.

One finding to note is that even in the realistic condition, nearly 50% of adults' attributions were anthropomorphic. Even in the absence of anthropomorphic information, adults often assumed that animals have preferences and emotions. However, even among questions pertaining to animal emotions (e.g., "Do fossas purr when they are happy?"), we still saw a significant difference across conditions, suggesting that anthropomorphic information does prime even adults to think more

Table 4
Counts of total anthropomorphic attributions to fossas and Fisher's exact test results comparing the realistic script and anthropomorphic script conditions in Study 2b.

Anthropomorphic trait attribution question	Realistic script (n = 40)		Anthropomorphic script (n = 42)		Fisher's test
	Yes [n (%)]	No [n (%)]	Yes [n (%)]	No [n (%)]	p
Do fossas have names?	11 (28)	28 (72)	23 (56)	18 (44)	.014*
Do fossas play tag in the trees?	10 (25)	30 (75)	29 (69)	13 (31)	.000*
Do fossas like to use their claws for hanging on trees?	37 (93)	3 (8)	41 (98)	1 (2)	.354
Do fossas trick people?	13 (33)	27 (68)	29 (69)	13 (31)	.002*
Do fossas play hide-and-seek?	20 (50)	20 (50)	36 (86)	6 (14)	.001*
Do fossas have a favorite food?	27 (68)	13 (33)	32 (76)	10 (24)	.464
Do fossas play with their friends at night?	20 (53)	18 (46)	36 (86)	6 (14)	.002*
Do fossas beat other animals in races?	29 (73)	11 (28)	37 (88)	5 (12)	.097
Do fossas purr when they are happy?	31 (78)	9 (23)	39 (95)	2 (5)	.026*
Do fossas live in houses in the forest?	4 (10)	36 (90)	4 (10)	38 (90)	1.00
Total	202 (51)	195 (49)	306 (73)	112 (27)	.000*

*p < .05.

anthropocentrically. On the other hand, some of the more heavily anthropomorphic traits (e.g., "Do fossas live in houses in the forest?") were unlikely to be attributed to fossas in either condition, suggesting that there may be a limit to the degree to which anthropomorphic information can shift both children's and adults' thinking.

General discussion

In the current article, we focused on the impact of anthropomorphic descriptions of animals in two different contexts on children's factual learning and anthropomorphic beliefs about real animals. Previous studies have found that anthropomorphism encourages anthropocentric reasoning (Waxman et al., 2014), increases attributions of anthropomorphic properties to real animals of the same species, and decreases factual learning (Ganea et al., 2014). Although anthropomorphic language has been observed in parent–child conversations at zoos (Geerdts et al., 2015b; Rigney & Callanan, 2011), there has been no experimental work examining whether children are actually learning factual or anthropomorphic information from such experiences. Given that a major goal of these centers is to foster early learning about animals, it is important to experimentally explore the impact of anthropomorphic language on factual learning. Furthermore, no previous studies looked at the potential moderating role of individual differences in anthropomorphic beliefs.

The findings from the current study are in line with previous work that found that anthropomorphic language alone does not decrease factual learning (Ganea et al., 2011; Geerdts et al., 2016a). In previous studies where anthropomorphism was deemed to be detrimental to factual learning, the animals were visually depicted in a highly anthropomorphic manner. In these studies, the animals visually resembled humans more than animals (e.g., they were shown wearing clothing, living in houses, and walking upright). Previous literature has found that it is more difficult for children to make generalizations from such fantastical contexts to real-world contexts (e.g., Ganea et al., 2008; Simcock & DeLoache, 2006; Walker et al., 2015). We found no significant differences in factual learning between our anthropomorphic and factual language conditions in both contexts, supporting conclusions that anthropomorphic language alone is not detrimental to factual learning. It is important for further research to confirm these findings, however, because the results of our Bayesian analyses provided only weak (Study 1) to moderate (Studies 2a and 2b) statistical evidence in favor of the null hypothesis. With small sample sizes, we can only make these conclusions tenuously.

In addition, children in the anthropomorphic storybook and zoo script conditions were paying attention to the anthropomorphic language in the storybooks and applying those properties to other animals of the same species. Children who heard about Ronnie the fossa and were given information regarding his dispositions, emotional states, and psychological capabilities were more likely to say

that all fossas have those traits compared with children who were not given that information. This also increased their anthropomorphic beliefs *in general* about the unfamiliar animal, attributing other human-specific properties in Study 1 not explicitly taught at a greater rate than children in the factual conditions. Study 2b further supported these findings, with adults showing the same pattern of results. Although we used psychological and behavioral properties similar to those in previous research on children's anthropomorphic beliefs, we acknowledge that even adults were attributing about 50% of the properties to fossas in the realistic condition. It remains to be seen whether adults and children would react similarly to much more anthropomorphic descriptions of the animals, more similar to the levels of anthropomorphism in visual anthropomorphic conditions. Future research should continue to explore different levels of realism. In addition, anthropomorphic beliefs are likely to differ across animal types. Both children and adults may be less inclined to anthropomorphize animals that are more distant from humans, such as fish, reptiles, and insects (Geerdts et al., 2015b), so varying the target animals may also be a goal for future research.

We also considered whether individual differences in anthropomorphism relate to differences in learning and anthropomorphic attributions, especially in the anthropomorphic language conditions. In Study 2, we found that children in the anthropomorphic condition with greater preexisting anthropomorphic beliefs were more likely to attribute the anthropomorphic properties in our scripts to fossas than children who had lower anthropomorphic beliefs. In other words, children who already thought anthropocentrically about animals in general were more likely to extend the anthropomorphic properties about an unfamiliar animal that we introduced in our scripts. However, we did not find the same result in Study 1, making it difficult to draw strong conclusions from this finding. It is important for future work to continue to examine individual differences, including beliefs and daily animal experience, to clarify the role of experience in learning. For instance, previous research that explored children's relationships with their pets found that children largely treat cats and dogs as social partners, acting as if they are capable of advanced reciprocal social interactions like humans (Geerdts et al., 2015a).

The current set of studies served as a first step in answering important research questions in the area of learning about animals in informal contexts. However, there are still additional questions that remain for future research. Our sample sizes, especially in Study 2a, were relatively small and make drawing conclusions regarding our findings difficult. Larger and more diverse samples may clarify the nature of the relationships we observed. The upper age range in Study 2a (7;10) was slightly higher than that in Study 1 (6;3). Although it would have been ideal to have matched ages across Study 1 and Study 2, the higher age range in Study 2 was largely driven by availability of participants (i.e., reflective of the range of ages most often visiting the zoo during our data collection periods). An important goal of future research should be to include larger age ranges in the same research study to understand more about the relationships between early experiences with anthropomorphic information and individual differences in anthropomorphic beliefs and learning how these relationships change over childhood and across contexts. In addition, the current study focused only on factual learning about animals. Other research should explore the impact of anthropomorphism on other kinds of learning. For instance, one recent study looked at whether children were more likely to share after reading an anthropomorphic storybook or one with human characters and found that the human story increased altruism, whereas the anthropomorphic study decreased it (Larsen, Lee, & Ganea, 2018). Future research could explore differences between biological learning and other kinds of properties. The current study also did not address whether attention or motivation is increased in one condition over the other. Future research can explore what kinds of stories children are more interested in and whether increased interest would then be related to learning.

Another potential area for future work relates to our use of docents rather than parents in Study 2. Research has found that children display differences in how much they trust information from others deemed to be knowledgeable and how they use that information to guide behavior. For instance, 3- to 5-year-olds are more likely to endorse testimony from a zookeeper than from a parent, especially when that information is negative, but are more likely to use positive information from a parent than from a zookeeper when deciding whether or not to approach an unfamiliar animal (Boseovski & Thurman, 2014). Although expertise was not a variable being explored in the current studies, it is something to consider in future research.

Previously, both empirical findings and theoretical accounts of the role of anthropomorphism in children's biological knowledge and factual learning have been mixed. Our results suggest that anthropomorphic language, while not harming factual learning, may support anthropocentric reasoning. This has important implications for the design of educational media about animals as well as the provision of different kinds of information within informal learning contexts. If fostering biological reasoning and factual learning is the goal, then designers of informal learning environments may want to avoid fostering anthropocentric reasoning. Because parents often use this language themselves, it may be beneficial to explore the efficacy of providing parents with factual informational scripts to share with their children. Informal learning environments often use physical signage and even digital apps to provide visitors with additional information, and being cautious about the use of anthropomorphic language may be important if trying to reduce anthropocentric reasoning and foster factual biological reasoning. Similarly, given the prevalence of children's media, more research should focus on the relevant benefits and drawbacks to using anthropomorphic animal representations in educational media.

CRediT authorship contribution statement

Megan Conrad: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Visualization, Writing - original draft. **Stuart Marcovitch:** Conceptualization, Methodology, Resources, Writing - review & editing. **Janet J. Boseovski:** Conceptualization, Methodology, Resources, Writing - review & editing.

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Appendix A

Realistic storybook script

This animal is a Fossa! He comes from the forests of Madagascar where he lives on the ground and in the trees. Scientists know very little about the fossa because he can climb high up in the trees to hide and is really difficult to find. Can you find the fossa? The fossa eats small animals like snakes and birds. But his main food source is lemurs. The fossa will grow to weigh around 20 pounds, the same size as a dog! This fossa makes sounds a lot like a cat, meowing to other fossas and even purring when near his mother.

Anthropomorphic storybook script

This is Gary the Fossa! Gary is from the forests of Madagascar where his home is on the ground and in the trees. Scientists know very little about Gary and his friends because they are tricky and like to play hide-and-seek in the trees. Can you find Gary? Gary loves to eat small animals like snakes and birds. But his favorite food is lemurs. When Gary is a grown-up, he will weigh around 20 pounds, the same size as a dog! Gary makes sounds a lot like a cat, meowing to talk to his friends and even purring when he is happy!

Appendix B

Question	Questions type	Memory or control	Correct answer
Do fossas meow and purr like cats?	Factual	Memory	Yes
Do fossas climb and hide high in the trees?	Factual	Memory	Yes
Are fossas from Madagascar?	Factual	Memory	Yes
Do scientists know very little about fossas?	Factual	Memory	Yes
Are fossas the same size as an elephant?	Factual	Memory	No
Do fossas live in the water?	Factual	Memory	No
Are fossa easy to find?	Factual	Memory	No
Do fossas eat mostly pizza?	Factual	Memory	No
Are fossas born with their eyes closed?	Factual	Control	Yes
Do fossas hunt during the day?	Factual	Control	No
Are fossas tricky?	Anthropomorphic	Memory	Yes
Do fossas have friends?	Anthropomorphic	Memory	Yes
Are fossas' favorite food spiders?	Anthropomorphic	Memory	No
Do fossas purr when they are sad?	Anthropomorphic	Memory	No
Are fossas scared of lions?	Anthropomorphic	Control	–
Do fossas go to preschool?	Anthropomorphic	Control	–

Appendix C

Realistic script

This animal is a Fossa! He comes from the tropical rainforests of Madagascar. He spends lots of time in the trees, hanging from branches and jumping between trees. The fossa has sharp claws, which it uses for hunting and for hanging on the trees. Scientists know very little about fossas because they are always hiding. *Can you find the fossa?* The fossa is a carnivore, meaning it eats small animals like snakes and birds. But his main food source is lemurs. The fossa will grow to weigh around 20 pounds, the same size as a dog! The fossa is cathemeral, meaning it might be awake during the day or at night. The fossa is a really fast runner. He can run as fast as 35 miles per hour. This fossa is very quiet but sometimes makes sounds a lot like a cat, meowing to other fossa and even purring when near his mother. Fossas are endangered, which means there are very few of them left because the forest they live in is being destroyed.

Anthropomorphic script

This is Ronnie the Fossa! Ronnie comes from the tropical rainforests of Madagascar. Ronnie spends lots of time playing in the trees, hanging from branches and playing tag in the trees. Ronnie has sharp claws, which he likes to use for hunting and hanging on the trees. Scientists know very little about Ronnie and his friends because they are tricky and like to play hide-and-seek in the trees. *Can you find Ronnie?* Ronnie is a carnivore, meaning he loves to eat small animals like snakes and birds. But his favorite food is lemurs. When Ronnie is a grown-up, he will weigh around 20 pounds, the same size as a dog! Ronnie is cathemeral, meaning you might see him play during the day or at night. Ronnie likes to run in races. He can beat his friends going as fast as 35 miles per hour. Ronnie is very shy, but sometimes he makes sounds a lot like a cat, meowing to talk to his friends and even purring when he is happy! Ronnie is an endangered animal, which means that he doesn't have a lot of friends left because the forest where his house is is being destroyed.

Appendix D

Factual memory posttest
Where do fossas come from? (Madagascar)
Where do fossas spend lots of time? (in the trees)
What do fossas use their sharp claws for? (hanging from branches and jumping between trees)
Why do scientists not know a lot about fossas? (fossas are always hiding)
What do fossas eat? (small animals)
What animal are fossas the same size as? (a dog)
What time of day are fossas active? (both during the day and at night)
How fast can fossas run? (35 miles per hour)
What animal do fossas sound like? (a cat)
How many fossas are there in the wild? (a few fossas in the wild)
Anthropomorphic attribution posttest
Do fossas have names?
Do fossas play tag in the trees?
Do fossas like to use their claws for hanging on trees?
Do fossas trick people?
Do fossas play hide-and-seek?
Do fossas have a favorite food?
Do fossas play with their friends at night?
Do fossas beat other animals in races?
Do fossas purr when they are happy?
Do fossas live in houses in the forest?

Appendix E. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jecp.2020.104985.

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