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The influence of anthropomorphism on children's learning and attitudes toward snakes

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Introduction: Previous research suggests that negative input contributes to children's fear development, while more positive input can reduce children's fear. The current study examined whether using anthropomorphic input can alter children's learning and attitudes toward snakes in ways that may promote more positive attitudes toward a commonly feared animal.

Methods: Children from the United States ($N = 89$; $M_{age} = 5.43$ years; 47 females, 42 males) reported their baseline knowledge and fear of snakes. Children then heard a story about a snake that did ($n = 44$) or did not ($n = 45$) contain anthropomorphic information. Following the story, children answered questions about their fear of snakes, knowledge acquired from the story, willingness to attribute anthropomorphic qualities to snakes, and willingness to help snakes.

Results and discussion: After hearing either story, children reported less fear of snakes. Further, while children in the anthropomorphic condition were more likely to attribute anthropomorphic qualities to snakes, there were no differences in the amount of information children learned. Most importantly, children in the anthropomorphic condition prioritized helping snakes more than children in the neutral condition. These findings demonstrate the impact of anthropomorphic information on children's attitudes and learning, and highlight the ways in which altering the input children receive may impact their learning and attitudes toward living creatures.

KEYWORDS

snake fear, anthropomorphism, learning, fear learning, anthropomorphic input

Introduction

Snakes are one of the most commonly feared animals among children and adults across the globe (Costello and Angold, 1995; Conrad et al., 2021b; Rakison, 2022). Although fear of snakes is adaptive in certain contexts, an extreme and persistent fear of snakes (ophidiophobia), makes up over half of all animal phobias experienced by humans (Klieger, 1987; Fredrikson et al., 1996). This is perplexing given the very low rates of threatening encounters between humans and snakes in industrialized and urbanized regions of the world. For example, within the United States, ~7,000–8,000 people are bitten by venomous snakes each year (<0.00001% of the population); among those, only a small number (10–44%) will sustain long-lasting injuries and even fewer will be fatal (~5 people per year; Centers for Disease and Control Prevention, 2016).

Researchers have long theorized about the origins of humans' common fear of snakes. According to the prepared learning model, humans have developed specialized fear

learning mechanisms allowing them to quickly acquire fear of evolutionarily recurring threats, such as snakes (Seligman, 1971; Öhman and Mineka, 2001). Research provides some support for this model and suggests that fear of evolutionarily recurring threats such as snakes can be acquired more rapidly than fears of other kinds of stimuli, and once such fears are acquired, they are more resistant to extinction (Öhman et al., 1976). In line with this perspective, a large body of work has demonstrated that humans detect snakes more quickly than other kinds of stimuli (see LoBue and Rakison, 2013 for a review). Even infants and young children, who have little knowledge or experience with snakes, detect these creatures faster in an array of stimuli (e.g., LoBue and DeLoache, 2008). Non-human primates also detect snakes more quickly than other stimuli (Shibasaki and Kawai, 2009; Kawai and Koda, 2016), suggesting this mechanism may have a biological and evolutionary basis.

However, while the robust literature on the rapid detection of snakes provides some support for the evolved learning mechanism, these findings do not suggest that humans are born with an innate fear of snakes. Indeed, several studies have found just the opposite: infants and young children do not tend to display fear of snakes, and instead most often demonstrate interest or approach behaviors toward these animals (Deloache and Lobue, 2009; LoBue et al., 2013). Collectively, this work suggests that fear of threat-relevant stimuli is not innate and may require learning (Seligman, 1971; Öhman and Mineka, 2001).

Three fear learning pathways have been proposed in the literature—direct experience (e.g., a negative encounter with snakes), vicarious observation (e.g., observing a fearful response to snakes), or the transmission of negative information (e.g., being told negative information about snakes; Rachman, 1977, 1991). Since most young children have not had any direct experiences with snakes, and even fewer have had negative encounters with snakes, it is likely that most snake fears are acquired through the information children receive. Indeed, when asked about the origins of one's fears, children most often cite hearing negative information as the source (Ollendick and King, 1991). In support of this claim, a recent survey of preschool-aged children reported that compared to other animals, children were less likely to have ever seen or held a snake compared with other animals, but yet, they were more fearful of snakes, and were more likely to cite negative or threatening information about snakes when asked what they had learned (Conrad et al., 2021b). Taken together, this work suggests that most snake fears are likely acquired through indirect learning experiences such as receiving negative input from caregivers, the broader culture, and media.

Several experimental studies have already demonstrated the causal impact of information on the development of animal fears. Several studies have reported that fear of a novel animal increases after hearing negative information (e.g., describing animals as being dirty or dangerous), and decreases after hearing positive information (e.g., describing animals as being cuddly and friendly; Field and Lawson, 2003; Muris et al., 2003; see Muris and Field, 2010 for a review). Naturalistic studies of parent-child conversations about animals have further shown that parents and children use more negative language when talking about snakes in everyday conversations with children, and they also report greater fear of snakes compared to other animals (e.g., Conrad et al., 2021b; Reider et al., 2022), further suggesting that negative information may be one pathway through which children learn to fear snakes.

While research provides some support for the role of negative information on children's acquisition of snake fears, the next step is to examine whether and how we can use the input children receive to *reduce* children's maladaptive fears toward snakes and other commonly feared stimuli. One study has demonstrated initial (albeit limited) success in reducing negative input to reduce children's fear of snakes (Reider et al., 2022), and other studies have demonstrated that the use of positive input can reduce fear of novel animals (e.g., see Muris and Field, 2010 for a review). However, using positive information to talk about animals like snakes is very uncommon in naturalistic parent-child conversations. As mentioned above, several studies have demonstrated that parents use a disproportionately larger amount of negative than positive information about snakes (Conrad et al., 2021b; Reider et al., 2022), leaving children with relatively few (or no) positive attributes about snakes. Indeed, parents may be reluctant to provide positive information about snakes because of the threatening properties associated with many species of snakes. But while it is important to learn the potential dangers of snakes (or any wild animal), it might be possible to provide children with information about snakes in a more positive or neutral way, so that children may receive information that is accurate, but does not increase fear for an animal they are very unlikely to encounter in most day-to-day contexts. One potential way to do this, which we explore here, is to manipulate the information children receive through anthropomorphic language.

Anthropomorphism involves the portrayal of an animal as having human-like qualities such as thoughts, feelings, mental states, preferences, and animate pronouns (e.g., Epley et al., 2007; Waytz et al., 2010). Children are often exposed to the anthropomorphizing of animals through books, television, and other media (McCrindle and Odendaal, 1994; Paul, 1996; Marriott, 2002; Taggart et al., 2019). Importantly, research suggests that the further an animals' phylogenetic position is in relation to humans (such as snakes), the less likely humans are to anthropomorphize the animal, and the less empathy they show for that animal (Harrison and Hall, 2010). Thus, one possibility is that incorporating anthropomorphic language to describe snakes will make snakes seem more human-like, potentially causing children to feel less fearful and more empathic toward them.

An alternative possibility is that using anthropomorphic language about snakes will inhibit factual learning, as anthropomorphism is often associated with fictional characters (e.g., The Berenstain Bears, Mickey Mouse). Indeed, several studies have now shown that the use of anthropomorphism may *decrease* children's factual learning and increase anthropocentric reasoning (e.g., Legare et al., 2013; Ganea et al., 2014). However, a recent content analysis of anthropomorphic language in commercially available books and television shows found mixed results, suggesting that anthropomorphic content can sometimes hinder or sometimes help learning depending on how the content is presented (Nguyentran and Weisberg, 2023). In fact, several studies have shown that the use of anthropomorphism

can promote children's factual learning in certain contexts (see Geerdts, 2016 for a review). In one study, 3- to 5-year-old children who watched an educational science television show that contained anthropomorphism (e.g., science concepts depicted with human-like faces and singing) showed an increase in their factual learning about science concepts (in this case, the cause of the day/night cycle and the characteristics of butterfly feet) when compared to children who did not watch the show, and at similar rates to children who watched the same show without anthropomorphism (Bonus and Mares, 2018).

In another study, 3-to 5-year-old children were randomly assigned to read one of four storybooks to learn about camouflage. Each storybook contained various levels of anthropomorphism, including a book with realistic pictures with factual language (no anthropomorphism), realistic pictures with anthropomorphic language, anthropomorphic pictures with factual language, anthropomorphic pictures with anthropomorphic language, or a control group with no book exposure (Geerdts et al., 2016). Children who read a storybook containing anthropomorphism were more likely to use anthropomorphic language when describing what they remembered from the story when compared to children who did not receive a story containing anthropomorphism. But importantly, children recalled a similar number of facts regardless of whether the story contained anthropomorphic information. Taken together, this work suggests that the use of anthropomorphic language does not necessarily hinder children's factual learning about animals, particularly when anthropomorphic input is subtle and paired with a real (as opposed to animated or cartoon) animal (Ganea et al., 2011; Geerdts et al., 2016).

The overarching goal of the current study was to examine whether the use of subtle anthropomorphic input about snakes could be used to change children's attitudes without negatively impacting what they learn about the animal. Based on the research reviewed above, we explored the use of subtle instead of overt anthropomorphic language because our goal was to provide children with *factual* information about snakes with anthropomorphic content. More overt anthropomorphism (e.g., having the snakes speak, dress like humans, etc.) would involve assigning snakes properties that they do not actually have in the real world. By using more subtle anthropomorphic language—which we define here as the use of pronouns and emotional/mentalizing terms)—we were able to highlight that snakes are living and breathing creatures, while at the same time, keeping the content of our information purely factual so that we could avoid potentially *decreasing* children's factual learning (e.g., Legare et al., 2013; Ganea et al., 2014).

Thus, in the following study, we first conducted a preliminary analysis from an existing dataset of naturalistic parent-child conversations to determine whether parents and 4- to 6-year-old children refer to commonly feared animals like snakes using a subtle form of anthropomorphic language (e.g., the use of animate pronouns), to get a sense of how common it is for parents to use this kind of subtle anthropomorphic language about snakes in the real world. Next, we conducted an experiment to determine whether we can reduce children's fear and promote positive attitudes toward snakes by subtly increasing the anthropomorphic input children receive. In the study, 4-to-6-year-old children reported their baseline knowledge and fear of snakes and were randomly assigned to hear one of two factual stories that either did or did not contain anthropomorphic language to learn about a snake. Following the story, children reported on their knowledge, fear, and attitudes toward snakes. We examined whether hearing anthropomorphic input about a snake would reduce children's fear beliefs. We also asked whether the type of story would lead to differences in how much children learned, their willingness to attribute anthropomorphic qualities to snakes, and their willingness to help snakes. We hypothesized that, compared to the story without anthropomorphic input (which we will refer to as the "neutral" story throughout), those who heard the anthropomorphic story would show reduced fear, similar learning outcomes, a greater willingness to attribute anthropomorphic qualities to snakes, and prioritize snakes among a group of animals in need of help.

Materials and methods

Transparency and openness

An unregistered preliminary analysis was conducted using an existing dataset (Reider et al., 2022). The primary study design, sample size, and main analytic procedures were preregistered on aspredicted.org (#97707). All statistical analyses were conducted using R version 4.0.3 (R Core Team, 2020).

Preliminary analysis

In a previous study, we found that parents and children use more negative input during conversations about commonly feared animals (snakes and spiders) and were more fearful of them compared to similar but less feared ones (frogs, lizards, and turtles; Reider et al., 2022)—animals that are also more likely to be anthropomorphized in children's daily lives. With this in mind, we became interested in whether commonly feared animals are also less likely to be anthropomorphized in parent-child conversations about animals. To begin to address this question, we first conducted a preliminary analysis from the existing dataset (Study 1 from Reider et al., 2022) of naturalistic parent-child conversations while looking at a wordless picture book to determine whether parents and children refer to commonly feared animals like snakes and spiders as well as similar but less commonly feared animals like frogs, lizards, and turtles with anthropomorphic language. More specifically, we compared how often parents used a very subtle form of anthropomorphism—animate or anthropomorphic (i.e., he, she) vs. inanimate (i.e., it) pronouns—to describe these animals. To do this, parents and children read through a wordless picture book which included five animal categories—snakes, spiders, frogs, turtles, and lizards—with one animal image shown per page and four different species represented from each animal category (for a total of 20 pages presented in a randomized order). Each page of the book presented a full body image of one animal in a neutral position and in their natural habitat. The animal species selected

TABLE 1 Preliminary data: descriptives for animal reference language by speaker and animal category.

Speaker	Animal	Total utterances		It		He/she	
		Mean	SD	Mean	SD	Mean	SD
Child	Snakes	20.70	13.50	3.22	3.154	0.93	1.796
	Spiders	21.67	12.81	3.48	3.906	0.93	1.73
	Frogs	21.07	13.34	2.89	2.778	1.11	1.761
	Lizards	20.59	13.22	2.74	2.611	1.33	1.981
	Turtles	19.78	12.53	2.52	2.792	1.67	1.961
Parent	Snakes	30.19	15.85	4.67	4.70	1.85	2.88
	Spiders	31.19	15.75	4.59	4.59	1.81	2.589
	Frogs	30.67	16.27	4.26	4.43	2.56	3.72
	Lizards	31.78	16.17	4.89	4.40	2.78	4.09
	Turtles	30.11	13.90	4.52	4.34	3.37	3.49

Mean number of total utterances and number of utterances using/it/and/he/she/when referencing each animal category by speaker (parent, child).

TABLE 2 Preliminary data: paired-samples *t*-tests comparing use of/it/vs/he/she/to reference each animal category and speaker.

	df	*t*	*P*	*d*	95% CI
Child					
Snake	26	3.22	0.003**	0.62	0.20, 1.03
Spider	26	3.75	0.001**	0.72	0.29, 1.14
Frog	26	2.73	0.01*	0.53	0.12, 0.92
Turtle	26	2.78	0.01*	0.53	0.13, 0.93
Lizard	26	1.28	0.21	0.25	−0.14, 0.63
Parent					
Snake	26	2.54	0.02*	0.49	0.08, 0.88
Spider	26	2.71	0.01*	0.52	0.11, 0.92
Frog	26	1.38	0.18	0.27	−0.12, 0.65
Turtle	26	0.98	0.34	0.19	−0.19, 0.57
Lizard	26	1.71	0.10	0.33	−0.06, 0.71

*$p < 0.05$, **$p < 0.01$.

within each category were also balance for threat relevance, such that each category contained two species of high threat qualities (e.g., being venomous) and two species of low threat qualities (see Reider et al., 2022 for additional details).

Parent-child conversations were transcribed by individual utterances provided by each speaker for each animal and page on the screen during the book reading, and were checked by a second researcher prior to coding. The transcripts of 27 parents (22 mothers, five fathers) and children (12 female, 15 male, Mage = 5.33 years, 18 White, one Hispanic, eight more than one race) were coded for the amount and type (/he/she vs./it/) of language used when referencing each animal (snakes, spiders, frogs, lizards, and turtles). A primary coder was trained and coded all transcripts, and an additional coder was trained and independently coded 8 (29.6%) of the transcripts. Of the 1,804 utterances that were double coded across the eight transcripts, there were only 64 disagreements (3.5%) between coders with respect to pronoun use. All discrepant responses were discussed and agreed upon prior to analysis.

We first ran paired-samples *t*-tests for children's and parents' utterances to determine whether participants used more inanimate (/it/) or animate (/he/she/) pronouns to reference each animal category in the picture book. We hypothesized that both parents and children would refer to snakes and spiders using the inanimate/it/pronoun more often than animate/he/she/pronouns, as these are commonly feared animals, and we expected the opposite pattern for frogs, lizards, and turtles, as these are less commonly feared animals. Descriptives are reported in Table 1 and results from the *t*-tests are reported in Table 2 and are summarized here. For children, there was a significant difference with reference to snakes, spiders, frogs, lizards, and turtles. For each animal, children used/it/(Snake: $M = 3.22$, $SD = 3.15$; Spider: $M = 3.48$, $SD = 3.91$; Frog: $M = 2.89$, $SD = 2.78$; Turtle: $M = 2.52$, $SD = 2.79$; Lizard: $M = 2.74$, $SD = 2.61$) more often than/he/she/(Snake: $M = 0.93$, $SD = 1.80$; Spider: $M = 0.93$, $SD = 1.73$; Frog: $M = 1.11$, $SD = 1.76$; Turtle: $M = 1.67$, $SD = 1.96$; Lizard: $M = 1.33$, $SD = 1.98$). For parents, there was only a significant difference with reference

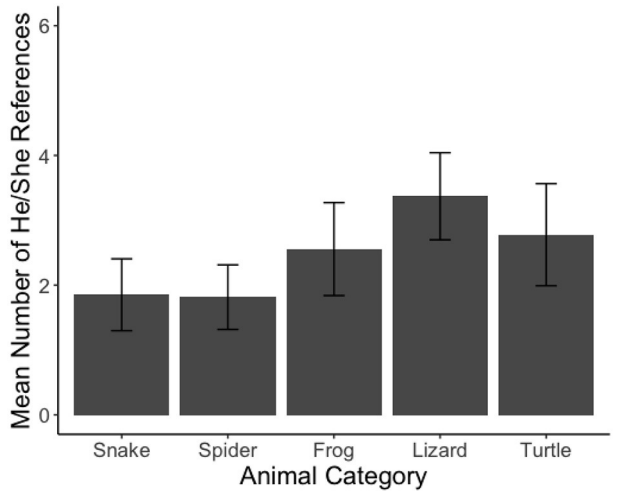

FIGURE 1
Preliminary data: mean number of/he/she/references made by parent about each animal category.

to snakes and spiders, with parents using/it/(Snake: $M = 4.67$, $SD = 4.70$; Spider: $M = 4.59$, $SD = 4.59$) to refer to snakes and spiders more often than/he/she/(Snake: $M = 1.85$, $SD = 2.88$; Spider: $M = 1.81$, $SD = 2.59$).

Next, we ran a series of repeated measures ANOVAs to determine if the use of each pronoun reference (/it/vs./he/she/) used by parents and children differed within each animal category (snakes, spiders, frogs, lizards, and turtles). Results are reported in Supplementary Table 1 and are summarized here. For children, we did not find any significant differences with their use of/it/or/he/she/between animal categories (p's > 0.20). For parents, we found a significant difference in the use of/he/she/by animal category, $F_{(1,26)} = 3.15$, $p = 0.02$, $\eta^2 = 0.11$, 95% CI [0.00, 0.34]. According to a series of *post-hoc* comparisons using paired-samples t-tests with a Bonferroni correction (critical $p = 0.005$), parents used/he/she/to refer to snakes less often than for turtles $t_{(26)} = 3.08$, $p = 0.005$, $d = 0.59$, 95% CI = [0.18, 1.00], and used/he/she/to refer to spiders less often than for turtles $t_{(26)} = 3.29$, $p = 0.003$, $d = 0.63$, 95% CI = [0.21, 1.04] (see Figure 1).

Preliminary discussion

Taken together, our preliminary analysis suggests that commonly feared animals, like snakes and spiders, are more frequently referenced in parent-child conversations using inanimate pronouns (/it/) than similar but less commonly feared animals like frogs, turtles, and lizards. Importantly, we found that this difference was most apparent when adults spoke with their children about these animals, which may be one subtle way in which the input children receive from adults shapes their attitudes toward commonly feared animals. Thus, in the primary study, we aimed to examine whether changing the input children hear about snakes, a commonly feared animal, shapes their attitudes toward the animal. Specifically, we examined whether increasing the anthropomorphic qualities of snakes by using a subtle manipulation of how the snake is referred to (use of pronouns, as well as emotional and mentalizing terms) can reduce children's fear and promote positive attitudes toward snakes.

Primary study

Participants

An a priori power analysis was conducted using G*Power 3.1 (Faul et al., 2007) for our main analysis, a 2 × 2 mixed effects ANOVA with one between-subjects factor (story condition: anthropomorphic vs. neutral) and one within-subjects factor (time: pre-story vs. post-story). The power analysis concluded that a total sample size of 34 participants per condition would be required to obtain 80% power to detect a medium effect ($f = 0.25$) with an alpha of 0.05. This effect size was based on studies finding that positive information about a novel animal can decrease fear beliefs in older children, with effects in the medium to large range (e.g., Field and Lawson, 2003; Field, 2006). To ensure we were sufficiently powered, we aimed to collect data from 88 children between 4 and 6 years of age, with 44 children in each condition. The final sample included 89 children (47 females, 42 males, $M_{age} = 5.43$ years, $SD_{age} = 0.81$, $Range_{age} = 2.95$) and parents (87 mothers, two fathers) across two conditions (Neutral $n = 45$, Anthropomorphic $n = 44$).

All participants completed the study online with a researcher through Zoom. All families resided in the United States, with parents self-reporting their location within the Northeastern ($n = 25$, 28.1%), Western ($n = 24$, 27.0%), Southern ($n = 21$, 23.6%), and Midwestern ($n = 19$, 21.3%) regions of the continental United States. Parents also reported as residing in rural ($n = 15$, 16.9%), suburban ($n = 56$, 62.9%), or urban ($n = 16$, 18.0%) areas, and an additional two (2.2%) families did not provide this information.

Parents self-identified as White, not of Hispanic origin ($n = 58$, 65.2%), Asian/Pacific Islander ($n = 10$, 11.2%), South Asian/Indian ($n = 6$, 6.7%), more than one race ($n = 4$, 4.5%), Black/African American ($n = 3$, 3.4%), Hispanic ($n = 3$, 3.4%), American Indian/Alaska Native ($n = 2$, 2.2%), other ($n = 2$, 2.2%), and one (1.1%) did not report this information. Parents identified their children as White, not of Hispanic origin ($n = 53$, 59.6%), more than one race ($n = 13$, 14.6%), Asian/Pacific Islander ($n = 7$, 7.9%), Black/African American ($n = 5$, 5.6%), South Asian/Indian ($n = 4$, 4.5%), American Indian/Alaska Native ($n = 3$, 3.4%), Hispanic ($n = 3$, 3.4%), and one (1.1%) did not report this information.

Most parents reported having an advanced degree ($n = 53$, 59.6%), with parents additionally reporting having some college or trade school ($n = 5$, 5.6%), or an AA/BA degree ($n = 30$, 33.7%), and one (1.1%) did not provide this information. Parents also reported their average household income in the last 3 years of <$20,000 ($n = 2$, 2.2%), $20,000–$39,999 ($n = 4$, 4.5%), $40,000–$59,999 ($n = 13$, 14.6%), $60,000–$100,000 ($n = 21$, 23.6%), or more than $100,000 per year ($n = 44$, 49.4%). Five (5.6%) parents did not report their household income. Parents also reported that most of the children had at least one sibling ($n = 72$, 80.9%), and only heard English in the home ($n = 73$, 82.0%). Additionally, we asked parents about the kinds of pets their child currently or has

ever lived with in their home (Supplementary Table 2). Only one (1.1%) family reported currently living with a pet snake.

Procedures

Parents and children were invited to take part in an online study through advertising on our lab website, childrenhelpingscience.com, social media platforms, and word of mouth. All data were collected during an online Zoom call with a researcher. All procedures were approved by the Institutional Review Board at Rutgers University (study title: "Learning, Perception, and Belief Revision in Infants, Children, and Adults"; Pro-2020000399). Informed consent was obtained at the start of the call. Children first completed a measure of their baseline knowledge and fear of snakes. Children were then randomly assigned to hear an anthropomorphic or neutral story about a snake. Following the story, children completed a brief assessment about the information they learned in the story. Children were then asked questions about their willingness to attribute anthropomorphic qualities to snakes and a post-story assessment of their fearful attitudes toward snakes. Finally, children completed a willingness to help snakes task, in which they were asked to rank a group of animals in need in the order from most priority to least priority to help. At the end of the child assessment, parents completed the same willingness to help snakes task, as well as a series of questionnaires related to children's and parent's experience with snakes, children's experience with nature, parent's fear of snakes, and demographic information. Participants were debriefed about the nature of the study at the conclusion of the session. All participants received a small compensation ($10 gift card) for their participation.

Materials

Baseline knowledge

Participants were asked a single, open-ended item asking the child to tell the researcher everything they know about snakes. Following each fact provided by the child, the researcher prompted the child to provide another fact (e.g., "Is there anything else you can tell me about snakes?") until the child could not provide additional information. Responses were transcribed offline using Excel and were checked by another researcher for accuracy. Transcripts were coded for the total number of spontaneously provided responses, and whether each response contained positive, negative, or neutral information (see Appendix A for examples). Responses were not coded for accuracy, as we were primarily interested in the quantity of information children were able to provide about their knowledge of snakes. Since this task required heavy verbal task demands, it is also possible that the results from this measure may be influenced by display of children's talkativeness, or narrative abilities, and thus results should be interpreted with this in mind. Repeated information or information that was provided after the caregiver prompted a response by using specific questions were excluded from coding and analysis. A primary coder was trained and coded all the transcripts. An additional coder was trained and independently coded 28 (31.5%) of the transcripts. Of the 56 responses that were double coded across the 28 transcripts, there were only three disagreements (5.4%) between coders with respect to the valence of each response. All three responses were discussed and agreed upon prior to analysis.

Fear beliefs

Children completed a modified version of the Fear Beliefs Questionnaire before and after hearing the story (FBQ; Field and Lawson, 2003; Reider et al., 2022). The questionnaire consisted of seven items regarding children's beliefs specifically about snakes (e.g., "Would you be scared if you saw a snake?") using a 5-point Likert scale presented visually, ranging from 1- no not at all to 5- yes, definitely. Items were verbally presented to the child by the researcher. This measure has been used previously with preschool aged children (e.g., Rifkin et al., 2016; Reider et al., 2022). When children deviated from the scale (e.g., only said "yes" in response to a question), the researcher asked the child to select one of two options on that side of the scale (e.g., "yes probably or yes definitely?"), and when a child was unable to make this distinction, the less extreme response was selected (yes, probably or no, not really). Scores for the seven items (four reverse scored) were averaged to obtain a fear of snakes score, with higher scores indicating higher fear beliefs.

Story manipulation

Children were randomly assigned to one of two story conditions (neutral, anthropomorphic) to learn information about a snake. Participants in each condition heard a story about a snake containing the same number of facts. The stories were matched for word count (word count = 158) and the duration of presentation across conditions (2:47 min). In each condition, the story was accompanied by five images of the snake presented in the same order and duration of time to keep children engaged while hearing the story. The use of images of a real snake were included, as previous research has demonstrated that the use of real or live animals may be more effective for learning via anthropomorphic input (e.g., Ganea et al., 2014). The conditions varied based on the use of objectifying language, pronoun use, and anthropomorphic information [inspired by and adapted from Conrad et al. (2021a)]. In the anthropomorphic condition, the snake was given a name (Hannah, mentioned to seven times), referred to by/she/her/pronouns (mentioned 12 times), and was given emotion and mental state properties (e.g., "Hannah likes to look for food at night," mentioned four times). We did not use stronger anthropomorphic language to avoid providing incorrect information about snakes. In other words, our goal was to describe snakes with subtle anthropomorphic language in a way that is accurate, and to avoid over-attributing mental state properties to snakes. In the neutral condition, the snake was referred to in a non-specific way (e.g., /it/) and the same facts were provided without anthropomorphic language (e.g., "it will look for food at night"). In each condition, the story was read twice by the same researcher using pre-recorded videos and contained the same number and kinds of facts, and the same images of a ball python snake. The ball python snake was selected because it is one of the most

commonly owned snakes due to its small size, calm temperament, and willingness to be handled by owners for extended periods of time (Valdez, 2021).

Learning interview

To assess how much children learned following the story, children were asked questions about the content from the book [inspired by Conrad et al. (2021a)]. This included nine forced-choice questions (e.g., "Does this snake live near the water or the mountains?") corresponding to the facts presented in each story. Answers to each question received a score of 1 if answered correctly, and a score of 0 for an incorrect or no answer. The total score was used to calculate how much children learned about the factual information presented in the story, with higher scores indicating greater learning. As a manipulation check, we also included two anthropomorphic memory questions about properties that the snake was depicted as possessing only in the anthropomorphic story as well as two control questions about properties about the snake that were not discussed in either story to ensure that children were not relying on any prior knowledge about the animals.

Anthropomorphic attribution task

Children also completed an anthropomorphic attribution task [adapted from Henseler Kozachenko and Piazza (2021)], and were asked seven questions about whether snakes have emotional or mentalizing qualities (e.g., "Can snakes have thoughts, or do snakes think about things?"). For each item, responses were scored as 0 (*not at all*), 1 (*a little*), or 2 (*a lot*), though the exact wording for each response option varied to match each item. The total score was used as a measure of children's willingness to attribute anthropomorphic qualities to snakes, with higher scores indicating a greater willingness to anthropomorphize snakes.

Willingness to help snakes task

Children and parents also completed a measure to determine their willingness to prioritize helping snakes compared to other animals using an adapted version of a ranking task (Henseler Kozachenko and Piazza, 2021). Children completed the task verbally with the researcher, and parents completed the task independently on Qualtrics at the end of the child protocol. Participants were presented with nine animals including eight vertebrates (one human, one non-human mammal, three reptiles, one bird, one amphibian, one fish) and one invertebrate (one spider). For mammals, we included one human and one non-human mammal. We included two snakes—the ball python snake that children heard a story about, and another low threatening snake (garter snake)—and a non-snake reptile (lizard) and amphibian (frog) to examine whether children's attitudes would change for the target animals in the study (snakes) or if it may generalize to other similar animals (lizard and frog). Participants were first introduced to each of the animals and were given the following prompt:

> "*Let's imagine for a minute that all the animals are sick. They all have a disease that is going to hurt them unless we do something about it. Thankfully, we have some medicine that can help the animals get better. However, we can't help all the animals at the same time. We can only help one at a time. We are going to have to make some difficult decisions.*"

Participants were then asked to rank the animals from the animal they wanted to help first to last. For children, each selection was removed from the screen (covered by a green box) to indicate when each animal was saved. Parents ranked the images in order from most priority to least priority to help. Lower scores indicate higher priority or willingness to help each animal.

Parent questionnaires

In addition to the willingness to help snakes task, parents also completed a measure of their own and their children's experience with snakes. Parents were asked whether they themselves or their child has ever seen or held a live snake in person, whether they have otherwise seen a real or animated snake in books or tv, whether they have ever felt threatened by a snake, and whether they have ever been hurt by a snake (all response options were yes/no/not sure, but results are presented collapsing across the no/not sure categories). Parents were also asked about their children's experience with nature [adapted from Soga et al. (2016)], including direct experiences (trips to parks, nature reserves) as well as indirect experiences (exposure to wildlife through media, games, or conversations with others). Parents responded to each item regarding the frequency with which their child engages in each activity (never, seldom, sometimes, or often, corresponding to "less than once a month," "almost every month," "almost every week," and "almost every day," respectively). Parents also completed the Snake Anxiety Questionnaire short form (SNAQ-12), a 12-item measure of adult fear and phobia of snakes (Zsido et al., 2018). For each item, participants responded to whether they agree (yes) or disagree (no) with each statement (e.g., "I'm more afraid of snakes than any other animal"). Higher scores are indicative of greater fear of snakes, with scores of 8 or higher indicative of snake phobia. Finally, parents completed a demographics form which included information about their relation to their child, their child's sex (as assigned at birth), their own and their child's racial/ethnic background, household income, education level, household size, pets in the home, and information about where they live.

Data analysis plan

We first report demographic and descriptive information of our key variables of interest (pre- and post-fear beliefs, learning factual and anthropomorphic information, anthropomorphic attributions, baseline knowledge, and the ranking of each snake in the willingness to help snakes task). We then present preliminary analyses exploring relations between children's age, biological sex, and baseline knowledge and fear with our main measures of interest. For our main and pre-registered analyses, a 2 (story condition: neutral vs. anthropomorphic) by 2 (time: pre-story vs.

post-story) mixed effects ANOVA was conducted to determine whether providing children with anthropomorphic information would *reduce* children's fear of snakes. Independent samples *t*-tests were used to examine whether there were differences in the amount of information children learned about snakes, children's willingness to attribute anthropomorphic qualities to snakes, and children's willingness to help snakes by condition. All other analyses were not preregistered and are thus exploratory. There were no outliers (defined as > 3SDs from the mean) for any variables used in our main analyses.

In addition to our main analyses, we re-ran the 2 (story condition: neutral vs. anthropomorphic) by 2 (time: pre-story vs. post-story) mixed effects ANOVA as an ANCOVA controlling for the total amount of information provided at baseline, as we found that the total amount of information at baseline was significantly different between the conditions. We also calculated a change in fear score and conducted an independent samples *t*-test to assess differences by condition in children's change in fear before and after the story, as we also found baseline differences in children's fear by condition. We also explored differences in children's average ranking of the frog and lizard in the willingness to help task to explore whether the influence of story conditions also generalized to similar kinds of animals as snakes. Finally, we explored whether parent's fear of snakes related to children's fear of snakes, whether parent's ranking of their willingness to help snakes related to children's ranking of snakes, whether children's baseline fear of snakes related to their willingness to help snakes, and whether children's baseline fear of snakes and their willingness to attribute anthropomorphic qualities to snakes related to their willingness to help snakes.

Results

Descriptives

Means and SDs for children's age in months, baseline knowledge (total responses, and total amount of neutral, negative, and positive information), pre- and post-fear beliefs, learning factual and anthropomorphic information, anthropomorphic attributions, ranking of each snake, and parents' fear of snakes across the entire sample and by condition are provided in the Supplementary Table 3. Table 3 provides correlations between key measures of interest (baseline knowledge (total responses, and total amount of neutral, negative, and positive information), pre- and post-fear beliefs, learning factual and anthropomorphic information, anthropomorphic attributions, and ranking of each snake), and children's age in months.

Children's age in months was positively correlated with their baseline knowledge total score ($r = 0.32$, $p = 0.002$), total neutral ($r = 0.22$, $p = 0.04$), and total negative ($r = 0.34$, $p = 0.001$) information, as well as their performance on the learning interview about factual information from the story ($r = 0.36$, $p < 0.001$). There were no other significant relations among our key measures of interest and children's age (p's > 0.17). We then examined differences in these same measures of interest by children's biological sex (Table 4). There was a significant difference in ranking of the ball python snake, with female participants ranking the snake lower in priority ($M = 5.96$, $SD = 1.94$) than male participants ($M = 4.98$, $SD = 2.40$), $t_{(87)} = -2.13$, $p = 0.04$, $d = -0.45$, 95% CI [−0.87, 0.03]. Females also reported slightly less information at baseline ($M = 2.21$, $SD = 1.90$) than males ($M = 3.31$, $SD = 3.17$), though this difference was not statistically significant at $p < 0.05$, $t_{(87)} = 2.00$, $p = 0.05$, $d = 0.43$ 95% CI [0.00, 0.85]. The remaining findings were not significant (p's > 0.07). We also examined whether there were differences in children's age and biological sex by condition, and neither was significant (p's > 0.60). Finally, we examined whether there were differences in children's baseline fear of snakes by condition, and children in the neutral condition were significantly more afraid of snakes at baseline ($M = 3.60$, $SD = 0.90$) than children in the anthropomorphic condition ($M = 3.20$, $SD = 0.90$), $t_{(87)} = 2.10$, $p = 0.04$, $d = 0.45$, 95% CI [0.02, 0.87].

Prior knowledge and experience with snakes

We next examined children's and parents' experience with snakes and children's prior knowledge about snakes (Supplementary Table 4). Using parent-report of their own and their child's experiences, most children and all parents had seen a live snake in person (Parent: $n = 89$, 100%; Child: $n = 74$, 83.1%), but fewer had ever held a live snake (Parent: $n = 47$, 52.8%; Child: $n = 24$, 27.0%). A smaller number of families reported feeling threatened by a snake in the past (Parent: $n = 29$, 32.6%; Child: $n = 8$, 9.0%), and only one parent (1.1%) and one child (1.1%) have been harmed by a snake.

We then examined children's experience with nature and wildlife (Supplementary Table 5). Most participants reported that they sometimes ($n = 39$, 43.8%) or often ($n = 31$, 34.8%) visit "natural places" (e.g., urban parks, woodlands, grasslands, or other green space) with their child. Most participants never ($n = 34$, 38.2%) or seldom ($n = 44$, 49.4%) visit zoos or aquariums with their child. Most participants endorsed engaging with real wildlife or animated wildlife through tv, games, books, or conversations with others (see Supplementary Table 5).

Next, we examined children's baseline knowledge of snakes, using data from the open-ended item at the beginning of the study. Across all participants and transcripts, a total of 243 responses were provided. The majority were neutral (169, 69.6%) or negative (73, 30.0%), and only one instance of (<1%) positive information was provided. Children provided an average of 2.73 ($SD = 2.62$) pieces of information about snakes, with an average of 1.90 ($SD = 2.18$) neutral, 0.82 ($SD = 1.08$) negative, and 0.01 ($SD = 0.11$) positive responses. Fourteen (15.73%) children did not report any prior knowledge about snakes.

We also explored whether there were differences in baseline knowledge by condition (see Supplementary Table 6). Participants in the anthropomorphic story condition provided more information at baseline overall ($M = 3.34$, $SD = 2.89$) than children in the neutral condition ($M = 2.13$, $SD = 2.20$), $t_{(87)} = 2.22$, $p = 0.03$, $d = 0.47$, 95% CI [0.05, 0.89]. This difference was driven by the total amount of neutral information provided, but this was not significantly different within conditions (anthropomorphic,

TABLE 3 Correlations between key measures of interest.

	Child Age (months)	Baseline knowledge (total)	Baseline knowledge (neutral)	Baseline knowledge (negative)	Baseline knowledge (positive)	Pre-fear beliefs	Post-fear beliefs	Learning (factual memory)	Learning (anthropomorphic memory)	Anthropomorphic attributions	Ranking snake 1 (ball python)	Ranking snake 2 (garter snake)
Child age (months)	-											
Baseline knowledge (total)	0.32**	-										
Baseline knowledge (neutral)	0.22*	0.91**	-									
Baseline knowledge (negative)	0.34**	0.55**	0.15	-								
Baseline knowledge (positive)	0.14	0.50**	0.40**	0.31**	-							
Pre-fear beliefs	0.02	−0.16	−0.15	−0.06	−0.15	-						
Post-fear beliefs	0.08	−0.16	−0.17	−0.03	−0.16	0.71**	-					
Learning (factual memory)	0.36**	−0.08	−0.11	0.04	−0.10	0.00	0.20	-				
Learning (anthropomorphic memory)	−0.03	0.01	0.04	−0.04	−0.14	−0.28*	−0.18	0.22*	-			
Anthropomorphic attributions	0.06	0.06	−0.01	0.16	0.08	−0.05	0.04	0.15	0.18	-		
Ranking snake 1 (ball python)	−0.13	−0.05	0.05	−0.21*	−0.07	−0.01	0.03	−0.09	−0.16	−0.08	-	
Ranking snake 2 (garter snake)	−0.07	−0.03	0.10	−0.24*	−0.11	0.10	0.05	−0.08	−0.06	−0.17	0.21	-

*$p < 0.05$, **$p < 0.01$.

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TABLE 4 Differences in key variables by sex and condition.

	df	t	P	d	95% CI
Biological sex					
Pre fear beliefs	87	−1.16	0.25	−0.25	−0.61, 0.17
Post fear beliefs	87	−0.54	0.59	−0.12	−0.53, 0.30
Anthropomorphic beliefs	87	0.30	0.97	0.01	−0.41, 0.42
Learning factual information	87	−0.23	0.82	−0.05	−0.46, 0.37
Learning anthropomorphic information	87	0.30	0.76	0.06	−0.35, 0.48
Ranking task: ball python	87	−2.13	0.04*	−0.45	−0.87, 0.03
Ranking task: garter snake	87	−1.25	0.22	−0.27	−0.68, 0.15
Baseline knowledge: total	87	2.00	0.05	0.43	0.00, 0.85
Baseline knowledge: total neutral	87	1.80	0.08	0.38	−0.04, 0.80
Baseline knowledge: total negative	87	1.09	0.28	0.23	−0.19, 0.65
Baseline knowledge: total positive	87	1.06	0.29	0.23	−0.19, 0.64
Condition					
Child age	87	−0.51	0.61	−0.11	−0.52, 0.31
Biological sex	87	0.52	0.60	0.11	−0.31, 0.53
Pre fear	87	2.10	0.04*	0.45	0.02, 0.87

*$p < 0.05$, **$p < 0.01$.

$M = 2.36$, $SD = 2.43$; neutral, $M = 1.44$, $SD = 1.82$), $t_{(87)} = 2.02$, $p = 0.05$, $d = 0.43$, 95% CI [0.01, 0.85]). There were no differences in the amount of positive or negative information provided by condition (p's > 0.24).

Fear

To examine whether providing children with anthropomorphic information can reduce children's fear of snakes, we conducted a mixed effects ANOVA with story condition (neutral vs. anthropomorphic) as a between-subjects factor and time (pre-story vs. post-story) as a within-subjects factor (see Figure 2 and Supplementary Table 7 for results). There was a significant effect of condition, $F_{(1,87)} = 4.62$, $p = 0.03$, $\eta^2 = 0.05$, 95% CI [0.00, 0.14], with participants in the anthropomorphic condition ($M = 3.13$, $SD = 0.90$) reporting less fear overall than those in the neutral condition ($M = 3.52$, $SD = 0.93$). There was also a significant ($p = 0.0485$) main effect of time, $F_{(1,87)} = 4.01$, $p < 0.05$, $\eta^2 = 0.04$, 95% CI [0.00, 0.13], with participants reporting less fear from pre- ($M = 3.40$, $SD = 0.92$) to post- story ($M = 3.25$, $SD = 0.95$). The time by condition interaction was not significant ($p = 0.83$).

Given that there were group differences in children's baseline fear beliefs, we then created a difference score to examine whether children's change in fear beliefs before and after hearing the story differed by condition. We ran a follow-up independent samples t-test on children's change in fear beliefs scores by condition and the result was not significant, $t_{(87)} = 0.21$, $p = 0.84$, $d = 0.04$, 95% CI [−0.37, 0.46], suggesting there were no differences in children's change in fear beliefs based on whether they heard the neutral or anthropomorphic story.

Finally, given that the total amount of information children reported at baseline were also significantly different by condition, we then conducted a mixed effects ANCOVA with story condition (neutral vs. anthropomorphic) as a between-subjects factor and time (pre-story vs. post-story) as a within-subjects factor, controlling for the total amount of information about snakes provided at baseline (Table 5). After controlling for the total amount of information provided at baseline, there was again a significant effect of condition, $F_{(1,86)} = 4.60$, $p = 0.03$, $\eta^2 = 0.05$, 95% CI [0.00, 0.14], and a significant effect of time ($p = 0.0498$), $F_{(1,86)} = 3.96$, $p < 0.05$, $\eta^2 = 0.04$, 95% CI [0.00, 0.13]. The effect of information provided at baseline was not significant ($p = 0.25$), the time by condition interaction was not significant ($p = 0.84$), and the information by time interaction was not significant ($p = 0.89$). Thus, the total amount of information provided at baseline did not influence children's fear over time.

Learning

To examine whether there were differences in the amount of information learned about snakes after hearing the neutral or anthropomorphic story, we ran an independent samples t-test by condition on the total amount children learned for the factual

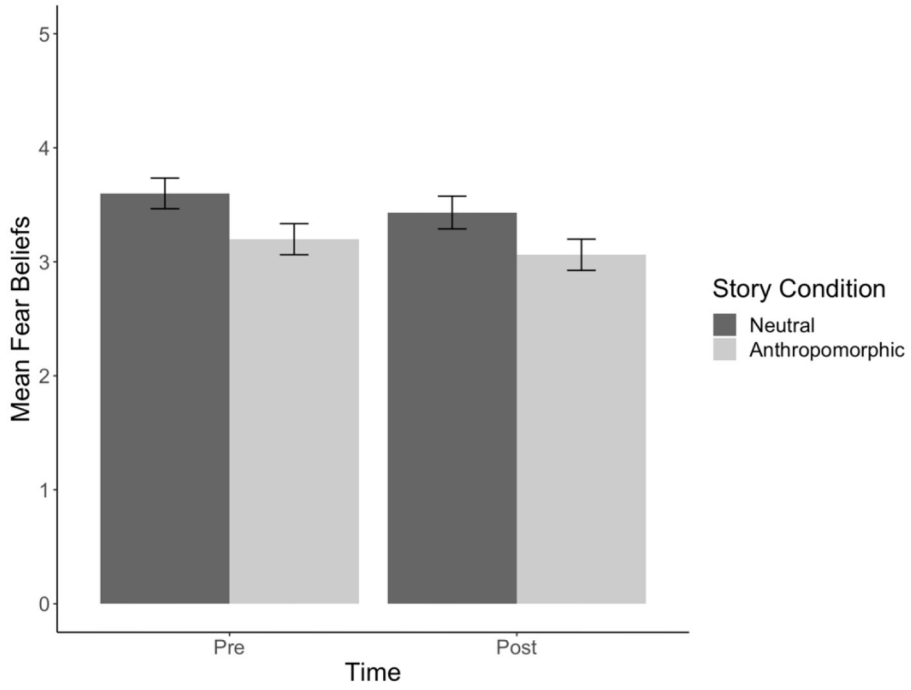

FIGURE 2
Children's mean fear beliefs before and after hearing the neutral or anthropomorphic story about a snake.

TABLE 5 Mixed effects ANCOVA with story condition (neutral vs. anthropomorphic) as a between-subjects factor and time (pre-story vs. pos-story) as a within-subjects factor on children's fear beliefs scores, controlling for total information provided at baseline.

Predictor	df	*F*	*P*	η^2	95% CI
Between-subjects					
Story condition	1	4.60	0.03*	0.05	0.00, 0.14
Total information	1	1.36	0.25	0.02	0.00, 0.08
Error	86				
Within-subjects					
Time	1	3.96	0.05	0.04	0.00, 0.13
Time × Condition	1	0.04	0.84	<0.001	0.00, 0.03
Time × Total information	1	0.02	0.89	<0.001	0.00, 0.02
Error	86				

*$p < 0.05$, **$p < 0.01$.

memory questions and anthropomorphic memory questions. We also ran independent samples *t*-tests on each control question to determine whether participants differed in their response to items that were not discussed in the book by condition.

There were no significant differences in children's responses to either control question (*p*'s > 0.30). As expected, there were no differences in the amount that children learned about snakes based on condition, $t_{(87)} = 0.93$, $p = 0.35$, $d = 0.20$, 95% CI [−0.22, 0.61]. For the anthropomorphic memory questions, unsurprisingly, children who heard the anthropomorphic story ($M = 1.41$, $SD = 0.73$) were more likely to recall information about the name and sex of the snake than children who heard the neutral story without this information ($M = 0.69$, $SD = 0.67$), $t_{(87)} = 4.87$, $p < 0.001$, $d = 1.03$, 95% CI [0.59, 1.46].

Anthropomorphic attributes

To examine whether there were differences in children's willingness to attribute anthropomorphic qualities to snakes based on condition, we ran an independent samples *t*-test by

TABLE 6 Child ratings from the willingness to help snakes task.

	Overall sample		Neutral condition		Anthropomorphic condition	
	Mean	SD	Mean	SD	Mean	SD
Human	6.72	2.90	7.07	2.65	6.36	3.13
Dog	4.02	2.52	3.69	2.63	4.36	2.38
Fish	4.60	2.32	4.33	2.23	4.86	2.42
Frog	4.52	2.20	4.49	2.18	4.55	2.25
Bird	4.36	2.61	3.82	2.48	4.91	2.65
Lizard	5.21	2.26	5.42	2.03	5.00	2.49
Snake 1 (ball python)	5.49	2.22	5.89	2.19	5.09	2.20
Snake 2 (garter snake)	5.44	2.29	5.87	2.11	5.00	2.40
Spider	4.64	2.87	4.42	2.81	4.86	2.94

Lower values indicate the animal was selected earlier, suggesting a greater willingness to help the animal.

TABLE 7 Parent ratings from the willingness to help snakes task.

	Overall sample		Neutral condition		Anthropomorphic condition	
	Mean	SD	Mean	SD	Mean	SD
Human	1.09	0.54	1.07	0.45	1.11	0.62
Dog	2.51	1.46	2.57	1.59	2.45	1.34
Fish	4.86	1.86	4.75	1.75	4.98	1.98
Frog	5.11	1.47	4.91	1.48	5.32	1.46
Bird	3.50	1.13	3.45	1.17	3.55	1.11
Lizard	5.82	1.48	5.95	1.28	5.68	1.67
Snake 1 (ball python)	6.82	1.65	7.05	1.68	6.59	1.60
Snake 2 (garter snake)	7.41	1.40	7.16	1.35	7.66	1.43
Spider	7.88	1.47	8.09	1.27	7.66	1.63

Lower values indicate the animal was selected earlier, suggesting a greater willingness to help the animal.

condition. Children in the anthropomorphic condition were more likely to attribute anthropomorphic qualities to snakes (M = 7.61, SD = 2.62) than children in the neutral condition (M = 6.38, SD = 2.58), $t_{(87)}$ = 2.24, p = 0.03, d = 0.48, 95% CI [0.05, 0.90].

Ranking task

Tables 6, 7 provide the average willingness of children and parents (respectively) to help each animal, with smaller numbers indicating a higher priority given to helping the animals. To examine whether there were differences in children's willingness to help snakes based on condition, we computed the average ranking of the two snakes and ran an independent samples t-test examining differences in the average ranking for the willingness to help snakes by condition (note that there were no significant differences in children's ranking between the two snakes across conditions, p's > 0.81). This difference was significant, with participants in the anthropomorphic condition prioritizing the snakes more (M = 5.05, SD = 1.90) than children in the neutral condition (M = 5.89, SD = 1.50), $t_{(87)}$ = 2.30, p = 0.02, d = 0.49, 95% CI [0.06, 0.91]. We also explored whether there were differences in children's willingness to help similar animals (frogs and turtles), to examine whether the manipulation generalized to similar kind of animals, but there was no significant difference by condition, $t_{(87)}$ = 0.55, p = 0.59, d = 0.12, 95% CI [−0.30, 0.53].

Additional analyses

In addition to our main research questions, we explored relations between parents' and children's fear of snakes and willingness to help snakes, and relations between children's baseline fear and willingness to attribute anthropomorphic qualities to snakes, and between children's baseline fear and their willingness to help snakes. We first examined whether parents' fear of snakes and children's fear of snakes were related to one another. Parents' self-reported fear of snakes was significantly related to children's self-reported fear of snakes at the pre-test (r = 0.23, p = 0.03) and post-test (r = 0.26, p = 0.02). We then examined whether children's willingness to help snakes in the ranking task was related to parents' willingness to help snakes. To do this we examined correlations between parents' and children's ranking of each snake among the

overall sample and by condition. Children's ranking of the ball python snake was not related to parents' ranking of the ball python snake across the entire sample ($p = 0.49$) or by condition (neutral $p = 0.20$; anthropomorphic $p = 0.51$). Children's ranking of the garter snake was also not related to parents' ranking of the garter snake across the entire sample ($p = 0.14$) or by condition (neutral $p = 0.53$; anthropomorphic $p = 0.31$).

We then examined whether children's baseline fear of snakes and their willingness to attribute anthropomorphic qualities to snakes was related to their willingness to help them in the ranking task. Children's baseline fear of snakes was not related to their ranking of either snake in the overall sample (p's > 0.36) or by condition (neutral p's > 0.15; anthropomorphic p's > 0.51). Children's willingness to attribute anthropomorphic qualities to snakes was not related to their ranking of either snake in the overall sample (p's > 0.10) or by condition (neutral p's > 0.05; anthropomorphic p's > 0.17).

Summary of results

In sum, the use of anthropomorphic information had a small impact on children's attitudes toward snakes, but not at the expense of learning accurate information about snakes. While children reported less fear after hearing the neutral or anthropomorphized story about a snake, when we accounted for the differences in fear at baseline, we saw no difference in the change in fear scores before and after hearing the story by condition. However, providing children with an anthropomorphized story about a snake led children to endorse greater anthropomorphic attributes toward snakes, but again, not at the expense of learning. Interestingly, children in the anthropomorphic condition not only attributed anthropomorphic qualities toward snakes, but they also prioritized saving snakes more than children who heard the neutral story. These findings suggest that anthropomorphic information may be one potential way to promote accurate learning and possibly reduce negative attitudes toward snakes.

General discussion

Fear of snakes are one of the most commonly cited animal fears across the lifespan worldwide (Costello and Angold, 1995; Conrad et al., 2021b; Rakison, 2022). Previous research has already documented the prevalence of negative information in parent-child conversations about snakes and has established that the input provided by parents may impact children's fear beliefs and attitudes toward animals (e.g., Remmerswaal et al., 2013; Reider et al., 2022). To build on this work, the current study first explored naturalistic parent-child conversations about animals, and found that commonly feared animals, including snakes, are more frequently referenced in parent-child conversations using inanimate pronouns (/it/) than less commonly feared animals. This suggests that not only do children receive an abundance of negative information about commonly feared animals like snakes (e.g., as previously reported in Reider et al., 2022), but they also receive information about snakes in ways that may discourage children from anthropomorphizing or attributing lifelike qualities toward snakes. To further explore the impact of anthropomorphic input on children's attitudes toward snakes, the primary study examined whether the use of subtle anthropomorphic input can reduce children's fear and promote positive attitudes toward snakes.

Our first aim was to examine whether providing children with anthropomorphic information can reduce fear of snakes. We hypothesized that children would show reduced fear of snakes after hearing an anthropomorphic story compared to a neutral story. We found that children reported less fear over time, regardless of whether the story did or did not contain anthropomorphic input. This was surprising, as we did not anticipate that the neutral story would change children's attitudes toward snakes. While we compared an anthropomorphic story to a "neutral" story, we recognize that the neutral story may not be reflective of the input children receive about snakes in real-world settings which tends to include more negative language (e.g., Reider et al., 2022). It is thus plausible that participants showed less fear after hearing either story because both the anthropomorphic and neutral stories were more positive than the typical input provided to children. However, when we accounted for baseline differences in fear that were present between conditions by assessing differences in children's *change* in fear, we did not find significant differences in children's change in fear by condition, suggesting that the anthropomorphic story did not change children's fear more than the neutral condition. Another possibility is that simply receiving facts about snakes may have increased children's knowledge toward them and children then had additional knowledge to reference when considering their attitudes toward a relatively unfamiliar animal. Future studies could expand on these findings by adding an additional condition that better reflects the input children receive about snakes from caregivers to better determine the extent to which anthropomorphic or "neutral" input shapes children's fear of snakes.

Our second aim was to examine whether anthropomorphic information would affect learning facts about the snake presented in the story. We hypothesized that there would be no differences in the amount children learned from each story. In line with our hypotheses, we found that participants recalled similar amounts of factual information from the story across conditions, suggesting that receiving subtle anthropomorphic input did not affect the amount that children learned from the story. This finding is consistent with several studies demonstrating that anthropomorphic language does not decrease children's learning, particularly when paired with a real or live animal (Ganea et al., 2011; Geerdts et al., 2016; Conrad et al., 2021a). Instead, given its commonality in children's books and other media, the use of anthropomorphic language may be particularly helpful for children as a way of generating interest in factual information (e.g., Parker and Lepper, 1992; Goldstein and Alperson, 2020).

Our third aim was to examine whether anthropomorphic information would impact children's willingness to attribute anthropomorphic qualities toward snakes. We hypothesized that children in the anthropomorphic condition would be more likely to attribute anthropomorphic qualities to snakes compared to children in the neutral condition. In line with our prediction, we found that children who heard the anthropomorphic story were more likely to attribute anthropomorphic qualities to snakes than children in the neutral condition. While this was not surprising given that the children in the anthropomorphic

condition received anthropomorphic input about the snake prior to the anthropomorphic attribution task, it was interesting, as previous research has noted that humans are less likely to anthropomorphize animals like snakes, which are phylogenetically dissimilar to humans (Harrison and Hall, 2010). One important but untested idea is that children may use anthropomorphic input differently when forming attitudes toward animals that vary with respect to threat level and the commonality with which the animal is anthropomorphized in children's daily lives. For example, future studies may further uncover the value of anthropomorphic input for children's attitudes toward animals that are more frequently anthropomorphized in children's daily lives but are still generally threatening (e.g., lions, bears) when compared to commonly anthropomorphized animals that are non-threatening (e.g., dogs, cats). Future studies may also examine how different cultural views impact both fear of snakes and anthropomorphic language. Indeed, the current study was only conducted with families in the U.S.; while snakes are commonly feared in the U.S., they are revered by several world religions, and used as *food* in places like China and Australia, all of which could impact how parents and children talk about snakes. Finally, future research can also help uncover how anthropomorphic information differentially impacts children's learning based on how afraid they already are of the target animal. Regardless, children's willingness to attribute anthropomorphic qualities to snakes did not impact their learning of the factual information provided in the stories, further supporting the idea that anthropomorphic information does not hinder learning in certain contexts, such as when paired with a real animal.

Our fourth and final aim was to examine whether anthropomorphic information about snakes would influence how children prioritize snakes in a helping task. When asked to help animals in order from most to least priority to help, children in the anthropomorphic condition ranked the snakes higher than children in the neutral condition. Although the difference was small (about 0.83 difference in the average ranking of snakes), the subtle manipulation of the information provided to children about snakes led children to prioritize helping them more than children in the neutral condition. Indeed, previous research suggests that children may hold fear and caring sentiments of animals, with children still fearing but also demonstrating concern toward an animal (Kahn et al., 2008). To our surprise, when we explored whether children's willingness to attribute anthropomorphic qualities to snakes was related to their ranking of helping the snake, we found no relations in either condition. While the explanation for these discrepant findings is unclear, one possible explanation is that the subtle use of anthropomorphism and the story itself may affect their representation of snakes in different ways and thus their explicit verbal willingness to anthropomorphize snakes and their behavioral willingness to help snakes may be impacted differently. Future studies are needed to further examine the impact of anthropomorphic language on children's explicit attitudes and behaviors. Another interesting finding from this task was related to differences in how parents and children ranked the animals. Parents demonstrated a systematic pattern of ranking, with the average responses showing clear distinctions in the value of animals, such as electing to save humans first, dogs second, and the snakes in 6th or 7th place on average. Children showed a more variable pattern of ranking, with the average ranking of most animals falling between 4th and 5th place on average, with the exception of the human, which was often selected as the last to save. Although older children generally rank humans higher in priority of moral concern when compared to other animals, the variable response pattern in younger children as well as their tendency to prioritize animals over humans found here is also common in previous literature (Henseler Kozachenko and Piazza, 2021; Wilks et al., 2021).

While our findings provide some insight into the role of different kinds of input on children's fear, attitudes, and knowledge of snakes, there are several limitations worth noting. First, the sample used in the current study comes from mostly high-income and highly educated families from the United States, which may limit the generalizability of our findings. Future studies with a more diverse sample may improve our understanding of the impact of information on animal fears and increase the generalizability of our findings to children from various socioeconomic and demographic backgrounds.

Another important area of future research is to further examine how parents' and children's experience with snakes impacts the role of anthropomorphic input on children's attitudes and knowledge about the animal. For example, while we found that about one-third of families in the study reported ever feeling threatened by a snake, we were underpowered to explore any relations between their experience with snakes and how it shapes their fears. Future studies with larger samples should examine how children and parents' prior experiences with snakes may shape how they think and feel about snakes.

Another limitation is that our story manipulation was brief and lacked a true control condition. In terms of brevity, the story was read to children twice, was relatively short, and measures of children's fear were collected right before and shortly after hearing the story within the same study session. It is possible that children may have reported less fear over time simply by being asked the same questions before and after the short story, and the study design may have biased children's responses. However, we did find differences by condition in terms of children's willingness to help snakes, which was only asked at post-test, suggesting that the anthropomorphic information may have had a meaningful impact on how children think about snakes. Future studies employing alternative methodological approaches can better address this limitation.

A related methodological limitation is that the anthropomorphic manipulation was also quite subtle, only changing the pronouns and name of the snake, and the inclusion of a few emotion and mental state words. As discussed previously, this subtlety was intentional to maintain the accuracy of the information provided about snakes, but it is possible that increasing the salience of the anthropomorphic information may be a stronger manipulation and lead to differences in fear compared to stories without anthropomorphic input. Future studies should also consider alternative control conditions (e.g., alternative story, no story, negative story) and a more explicitly anthropomorphic story to better get at how specific kinds of information shape children's attitudes and fear toward snakes.

In summary, the current study examined how anthropomorphic input may shape children's attitudes toward and knowledge of a commonly feared animal. Specifically, we explored the ways in which providing subtle anthropomorphic input may alter children's attitudes toward and knowledge about snakes. Although the findings do not provide strong support for the use of anthropomorphic language to reduce fear, we did find some evidence that subtle anthropomorphic language may foster more positive attitudes toward the welfare of snakes. These findings have important implications for the fields of education and children's media, and suggest that children's attitudes toward animals may be shaped by the input they receive about animals. Thus, it is important for educators to consider how information is presented, and how it may (or may not) support children's learning about the biological world. Further, the findings suggest that providing subtle anthropomorphic input may help children develop more caring attitudes toward commonly feared animals, which may support the conservation of commonly disliked but endangered species. Future studies should continue to explore how we can shape the kinds of input children receive about negatively perceived animals to help foster interest, learning, and unbiased attitudes toward living creatures.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation, upon request.

Ethics statement

The studies involving humans were approved by the Institutional Review Board at Rutgers University-Newark. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

LR: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Visualization, Writing—original draft, Writing—review & editing. VL: Conceptualization, Funding acquisition, Resources, Supervision, Writing—original draft, Writing—review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fdpys.2024.1356604/full#supplementary-material

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