Article

Learning About Real Animals From Anthropomorphic Media

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Abstract

While a large body of empirical research has investigated preschool-aged children's knowledge of the natural world, comparatively little attention has been paid to the relevant cultural and social input that shapes the content and development of children's factual knowledge and conceptual reasoning. In the current research, we experimentally examined the impact of exposure to one particularly common and relevant cultural tool for learning about living things: storybooks. While anthropomorphism—the attribution of human characteristics to nonhuman entities—has long been a staple of children's storybooks, researchers have only recently focused on directly measuring its effect on children's knowledge about real animals. Contrary to previous research, we found that anthropomorphic language and pictures in storybooks did not interfere with factual learning about real animals. Even though children did retell anthropomorphic stories using anthropomorphic language, they were nonetheless better at providing factual, biological explanations after being read an anthropomorphic storybook. Our results suggest that anthropomorphism in storybooks may not have the strong, negative impact as previously suggested and supports the need for further research on the potential educational role of fantasy elements such as anthropomorphism in children's media.

Keywords

anthropomorphism, storybooks, child development, biological knowledge

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Children receive information about the natural world from many different sources, either directly through engagement with animals (Geerdts, Van de Walle, & LoBue, 2015) or indirectly through sources such as parents (Rigney & Callanan, 2011), teachers (Kallery & Psillos, 2004), and media (Marriott, 2002). These early experiences have important consequences not only for early knowledge but also for developing early scientific interest (Crowley & Jacobs, 2002), both of which can provide the necessary support for later achievement in formal scientific knowledge (Callanan & Jipson, 2001; Jacobs & Bleeker, 2004; Strike & Posner, 1992). Despite the importance of early informal experience to later scientific achievement, little experimental research has investigated the direct impact of common, informal experiences on young children's knowledge. Here, we investigate one particularly salient and widespread indirect experience with animals for young children: anthropomorphic storybooks.

Storybook reading is a nearly universal experience for young children in the United States (Common Sense Media, 2011). In the United States, 83% of children under the age of 6, regardless of family income, are read to daily for an average of 48 minutes per day (Rideout & Hammel, 2006). However, much of the information about the natural world presented within storybooks is depicted in a highly unrealistic manner. Anthropomorphism—the attribution of physical and behavioral human characteristics to other animals or nonliving things—is characteristic of many of the most beloved and classic animal characters in children's media, such as Mickey Mouse and Winnie the Pooh. The prominence of these anthropomorphized characters in television, movies, and books is not all too surprising, as children prefer them: Children express preferences for hearing stories with animal characters over human characters (Boyd & Mandler, 1955). Similarly, an analysis of storybooks in a preschool lending library found that the most frequently checked out books by children featured anthropomorphic animals (McCrindle & Odendall, 1994). All of the top 15 highest grossing G-rated movies of all-time feature talking animals or inanimate objects (Bukszpan, 2011), and even infants preferentially attend to cartoon, anthropomorphic animals over real animals (DeLoache, Bloom Pickard, & LoBue, 2010).

Despite its prevalence and popularity, little is known about the consequences of anthropomorphic media on children's concepts of real animals. Given the importance of early experiences in the development of formal scientific and biological knowledge (Strike & Posner, 1992), further research is needed to determine whether anthropomorphic storybooks support interest and learning (Parker & Lepper, 1992) or interfere with the development of causal biological understanding (Ganea, Ma, & DeLoache, 2011). In the current research, we examined how imbuing storybook animals with social and psychological characteristics impacts preschool-aged children's knowledge about real animals.

Literature Review

Over the past 30 years, the origins and development of children's early understanding of biological concepts such as *animal*, *plant*, and *living thing* have been hotly debated. A large body of recent research highlights the critical role of children's early experiences with animals and cultural input in the development of scientifically accurate, biological knowledge (e.g., Atran et al., 2001; Geerdts et al., 2015; Ross, Medin, Coley, & Atran, 2003). For instance, children with parents who are *experts* in biology (i.e., zoo keepers, vets, researchers, or foresters) report talking to their children more about biology, and these children, in turn, score higher on measures of biological knowledge (Tarlowski, 2006). However, very few studies have experimentally manipulated social and cultural input, making it difficult to draw conclusions about the direct role of informal experiences in the development of scientifically accurate information about the natural world. Even experiences that are purportedly educational in nature may inadvertently hinder early learning, given a lack of understanding of the consequences for the development of factual, biological knowledge (e.g., Kallery & Psillos, 2004). To optimize early learning experiences and prepare children for success in later scientific conceptual understanding (Strike & Posner, 1992), it is critical that more research focuses on the impact of specific common early experiences both within and across cultures that may support children's early interest in and knowledge about the natural world.

One possible early source of biological information about animals in modern, Western culture is children's storybooks. However, media often present animals in highly unrealistic and human-like manners. An examination of over 1,000 modern picture books for young children found that nearly half of those books featured animals as significant characters, with only a quarter of those animals presented in natural settings. Even when portrayed in their natural environments, these animals were still anthropomorphized with names, communicative abilities, and recognizably human behavior (Marriott, 2002). An analysis of British children's TV shows found that a surprising 87% of the programs contained animals, with over half of those programs featuring anthropomorphic animals. Each program featured an average of 6 animal characters, totaling close to 20 animal characters per hour of viewing time (Paul, 1996). Even commercials viewed during these television shows are likely to contain anthropomorphized animals (Lerner & Kalof, 1999). Thus, children's media is a particularly common cultural tool through which children receive information about animals, though it is highly likely to be anthropomorphized.

Previous research has investigated how children's experiences with anthropomorphic media contribute to the development of knowledge about real animals. Some researchers argue that anthropomorphic media both encourages anthropomorphic beliefs about animals and decreases the generalization of factual information from storybook animals to real animals. Waxman, Herrmann,

Woodring, and Medin (2014) found that 5-year-old children who were read a realistic animal storybook (*First Animal Encyclopedia*) before completing a reasoning task exhibited a biological pattern of responses, attributing new biological properties between animals and humans equally. This biological response pattern is characteristic of older children and adults and reflects a more sophisticated, human-inclusive view of animals. On the other hand, children of the same age who were read an anthropomorphic animal storybook (*The Berenstain Bears*) exhibited an anthropomorphic, human-centered pattern of reasoning, reasoning about humans as a prototypical animal rather than one animal among many. Thus, anthropomorphic storybooks may support human-centered reasoning, while realistic storybooks may encourage biological reasoning, suggesting that realistic storybooks are better for preparing children for biological reasoning and learning. In addition, anthropomorphic storybooks may lead children to hold anthropomorphic beliefs about real animals. Ganea, Canfield, Ghafari, and Chou (2014) found that preschool-aged children who were read anthropomorphic storybooks about unfamiliar animals generalized the characters' anthropomorphic properties to real animals. Finally, anthropomorphic media may reduce the likelihood that children will generalize factual information from media to real animals. Several studies have shown that children are more likely to generalize factual information and novel solutions when presented in realistic, as opposed to fantasy, contexts (e.g., Ganea, Pickard, & DeLoache, 2008; Richert, Shawber, Hoffman, & Taylor, 2009; Simcock & DeLoache, 2006; Walker, Gopnik, & Ganea, 2015), suggesting that children will learn less about real animals from media that depicts animals in a highly unrealistically manner (e.g., talking, walking, wearing clothing, and living in houses). One recent study did find that preschool-aged children were less likely to generalize factual information from anthropomorphic storybooks; children who were read a storybook showing an unfamiliar rodent (cavy) dressed in clothing sitting down at a dinner table to eat grass were less likely to say that real cavies eat grass than children who were read a storybook realistically depicting cavies grazing on grass (Ganea et al., 2014). Based on these findings, researchers suggest that when the goal of storybooks is to teach children about real animals, factual and realistic language and visual representations should be used as opposed to fantastical, anthropomorphic depictions.

However, previous research has been limited in terms of the variety and degree of anthropomorphic representations studied. The anthropomorphic animals used in previous research (Ganea et al., 2014; Waxman et al., 2014) more closely resembled humans than animals; these animal characters were depicted as living in houses, wearing clothing, and performing human actions such as eating at a dinner table or taking a bath in a tub. This type of character may not be ideal for teaching children about animals but instead may be beneficial for teaching children social and moral human lessons (Mierek, 2010). The use of animal characters in place of humans helps to make difficult topics less

threatening (Burke & Copenhaver, 2004; Marriott, 2002) and avoids representations of gender or race that may influence identification (Krueger & Krueger, 2005). Thus, it is not surprising that children are not learning factual information about real animals from anthropomorphic books, as they are largely designed to teach children about human-specific social issues rather than animal's biological properties (Geerdts, Van de Walle, & LoBue, 2015). For instance, the learning goals for *The Berenstain Bears* series used in previous research include peer pressure, prejudice, diversity, meeting responsibilities, sibling rivalry, family and community, socioemotional development, and choices and decision making, which are all very human lessons ("Berenstain Bears Lesson Plans").

No previous research has examined how anthropomorphic storybook characters that more closely resemble real animals impact children's factual learning and biological reasoning. For instance, there is a large difference in terms of the type and level of anthropomorphic traits between Nemo, a fish that lives in the ocean and talks only to other animals, and Mickey Mouse, a character whom inhabits a world made up entirely of talking animals that live in houses and wear clothing. Previous research suggests that storybooks with more realistic animals imbued with social and psychological abilities may be beneficial for children's biological learning. Children's generalization from storybooks to real animals should be increased due to their closer resemblance to real animals (Walker et al., 2015). Learning may even be increased due to children's interest in fantasy contexts increasing attention and motivation (Parker & Lepper, 1992). Finally, researchers have suggested that personification of animals helps children to analogically extend knowledge about their own behavior and biological functioning to less familiar animals, making anthropomorphism potentially beneficial for biological reasoning (Inagaki & Hatano, 1987, 2002). Thus, this type of anthropomorphic storybook could be used as an educational tool, increasing attention and learning without increasing anthropomorphic reasoning. We explore this possibility in the current research.

Current Research

In the current research, we explored whether more realistic anthropomorphized characters, within both the style of the verbal narrative and the illustrations, can be beneficial for children's learning about real animals. In particular, we ask the following questions:

(1) Does anthropomorphism increase children's recall and generalization of factual information about a biological phenomenon to real animals?

Previous research with highly anthropomorphic storybook characters suggests that anthropomorphism decreases factual learning about real animals

(Ganea et al. 2014). However, the animals in this research were highly fantastical and humanized: wearing clothing, living in houses, eating at tables, and sleeping in beds. The anthropomorphized animals placed within a more realistic context in our storybooks are more similar to real animals (Walker, Ganea, & Gopnik, 2012) but also more interesting due to their novelty (Parker & Lepper, 1992) and thus may increase learning and generalization of factual, biological information to real animals.

(2) Additionally, does anthropomorphism increase general attributions of biological and psychological functioning to real animals?

We explored the impact of anthropomorphism on more general knowledge of animals' biological and psychological functioning. Previous research with highly anthropomorphic storybook characters suggests that anthropomorphism increases attributions of specific psychological properties (Ganea et al., 2014) and human-centered biological reasoning (Waxman et al. 2014), but neither of these studies looked at children's application of other, nonmentioned biological and psychological properties. Even if we find that children are more likely to generalize factual information from our anthropomorphic storybooks to real animals, children exposed to anthropomorphic characters may still be more likely to generalize other psychological properties to animals (Ganea et al., 2014). On the other hand, anthropomorphism may facilitate the application of biological properties to animals (Inagaki & Hatano, 1987, 2002). However, little is predicted, as this has been previously unexplored in the literature.

Method

Participants

Sixty preschool-aged children (30 girls, $M = 4$ years, 7 months, $SD = 151.84$ days, range: 3 years, 11 months–5 years, 5 months) participated in the current study. Children were randomly assigned to one of five conditions (four experimental conditions and one control condition) described later. The minimum number of participants required was determined by an a priori power analysis using the software package, G*Power (Faul, Erdfelder, Lang, & Buchner, 2007). The analysis indicated that a sample size of 60 would have adequate power to detect a significant interaction with a medium effect size (effect size of .2, power of .9, and an α of .05).

Families were recruited through a participant database of interested parents as well as through local preschools. Parents were invited to participate via phone, e-mail, or a letter sent home with their child. Participants lived in suburban communities within the New York/New Jersey metropolitan area. The sample included Caucasian (38.3%), Asian (13.3%), African American (5%),

Hispanic (10%), and mixed race (18.3%) participants. An additional 15% of families declined to disclose ethnicity information. Most parents (86.8%) had attained a college degree or higher. Participants took part in the study at a university laboratory ($n = 20$), a quiet area of the child's preschool ($n = 8$), or in the family's home ($n = 32$), based on preference and convenience for the family. Preliminary analyses revealed no significant differences in performance on any measures between children tested in their homes and those tested in the lab or their preschool, suggesting that performance was similar regardless of testing location. All procedures in the study were approved by the Rutgers University Institutional Review Board. Parents gave written consent for their child's participation and children gave verbal assent. Upon completion of the study, parents were compensated with $20, and children were rewarded with their choice of a small stuffed animal.

Materials

Picture books. Our goal was to create carefully controlled experimental stimuli featuring animals designed to teach children about a biological property—color camouflage. Our storybooks used the same animals as previous researchers studying camouflage learning (Ganea et al., 2011), a frog and a butterfly, to enable comparisons across studies. Additionally, we did not use animals that have unusual camouflage abilities, such as chameleons, to avoid children reasoning that animals can simply change colors to match their environment and escape predators. Four age-appropriate storybooks featuring animal characters (frog, butterfly, and bird) designed to teach children about camouflage were created for the book-reading session: (a) *realistic pictures with factual language,* (b) *realistic pictures with anthropomorphic language*, (c) *anthropomorphic pictures with factual language*, and (d) *anthropomorphic pictures with anthropomorphic language*. The complete scripts for both storybooks are presented in the Appendix. In the *realistic pictures with factual language* condition, factual language introduced biological facts devoid of social or personifying information. Additionally, the storybook used realistic line drawings of photographs. The *anthropomorphic pictures with anthropomorphic language* condition, in contrast, introduced biological facts within an intentional framework, which referred to the intentions and desires of personified, named animals (e.g., *Johnny the Bird*) with anthropomorphic pictures showing animals in human-like postures and displaying human facial expressions (Figure 1). The two cross conditions allowed us to evaluate the relative impact of anthropomorphism in pictures and language.

The books were designed such that both the anthropomorphic and realistic books present the same factual level of explanatory information about camouflage. For instance, both books explain "the frog [Sammy] is hard to find because its [his] skin is the same color as the leaves it [he] is sitting on." In the

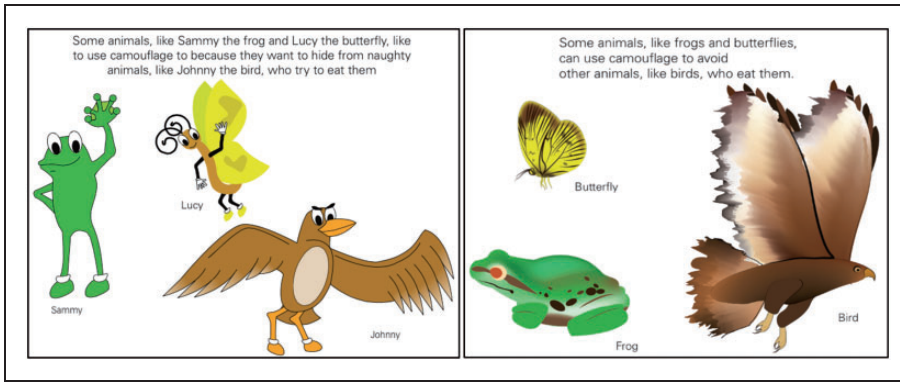

Figure 1. Sample images of the animals in the realistic and anthropomorphic storybooks.

anthropomorphic language conditions, mental states, desires, and intentions are used in addition to color camouflage information to explain the animals' behaviors (e.g., he *wants* to eat Sammy; Sammy is *smart* for hiding; they *like* to camouflage).

Procedure

Forty-eight children were randomly assigned to participate in the experimental conditions, with equal numbers of boys and girls in each condition. Children were read the storybook in a quiet area on a laptop computer. To ensure consistency in reading across book styles, only one experimenter was used across testing. Children rarely made comments or asked questions during reading, but when they did, every effort was made to respond neutrally (e.g., "Okay") and proceed through the storybook.

The 12 children randomly assigned to the control condition were not exposed to any storybooks but completed the camouflage knowledge and property attribution posttest measures, allowing us to estimate the baseline levels of animals and camouflage knowledge of children in our sample.

Posttest measures. After the book-reading session, children participated in two posttest assessments—story comprehension measures and a property attribution task. Measures of story comprehension included a story recall (measuring factual memory and anthropomorphic language use) and a camouflage knowledge task (measuring generalization to real animals and explanation of the property). The property attribution task measured children's application of both biological and psychological properties to humans, animals, and inanimate objects. Posttest measures were completed in the same order (story recall, camouflage knowledge, and property attribution) for all participants.

Story recall. To measure free recall, the experimenter asked the child to "tell me what happened in the story." General prompts such as "Do you remember anything else?" and "What happened after that?" were used until the child reported everything that he or she remembered. Responses were recorded and later transcribed verbatim. Trained research assistants coded children's responses for (a) the number of relevant facts recalled and (b) the use of anthropomorphic language. First, children's recall was coded using a weighted scale that accounted for the number of facts recalled from the story (e.g., character details, physical properties related to camouflage, intentional motivations of the animals, etc.) as well as the relevance of the facts to camouflage. Each fact was weighted with a score of 1 (irrelevant to camouflage, such as the type or name of the animal) or 2 (fact relevant to camouflage, such as colors or hiding for survival). Additionally, children's language use in free recall was categorized as (a) using only factual language (e.g., "the frog was on the green leaf so the bird didn't eat him") or (b) using any anthropomorphic language (e.g., "Sammy tricked the bird").

Reliability for each coding scheme was determined separately by comparing the codes of a primary coder with those of a second independent coder. Both coders were blind to condition. The intraclass correlation coefficient was calculated to determine reliability for the factual recall coding (Shrout & Fleiss, 1979). Overall, agreement was very high, $ICC(2,1) = .983$. Using Cohen's κ as the agreement statistic, reliability for language coding was .60 (82.2%), indicating a good level of agreement (Fleiss, 1981). The primary coder reviewed any disagreements and selected a final code.

Camouflage knowledge. A measure of generalization of camouflage knowledge was adapted from Ganea et al. (2011). The task assesses children's learning about color camouflage and generalization to real animals, using both the animals featured in the storybooks as well as new animals. On each trial, children were presented with a real picture of the predator animal in the storybook (a bird) and were told that he was still hungry and looking for something to eat. The child was then shown a pair of pictures of a camouflaged (e.g., a green frog on a green leaf) and a noncamouflaged animal (e.g., a green frog on an orange flower) and asked to predict which one the predator animal would eat. Each child received a total of eight trials featuring four real animals: two animals from the storybook (frog and butterfly) and two animals not featured in the storybook (lady bug and lizard). For each animal, there were two trials—one with similar-looking animals (e.g., two green frogs, one on a green leaf, and one on a yellow flower) and one with different-looking animals (e.g., one green frog and one red frog, both on green leaves).

After completing eight trials, the experimenter randomly chose one of the trials on which the child correctly responded that the predator would eat the noncamouflaged animal and asked the child to explain why the bird would eat

that one and why it would not eat the other one. Children's answers were recorded and later transcribed verbatim. Explanations were coded for (a) anthropomorphic language and (b) demonstration of camouflage knowledge. As with story recall, the language the child used to explain his or her choice was coded as factual (e.g., "he's not the same color as the flower") or anthropomorphic (e.g., "the bird likes that one more"). Additionally, the sophistication of the explanation was coded on a scale of 0 to 3, with higher scores indicating more complete explanations, as follows: 0 (information not relevant to camouflage), 1 (mentioning only one aspect relevant to camouflage, such as the color of just the animal), 2 (describing both elements relevant to camouflage—the color of the animal and the color of the background), or 3 (explicitly stating that the animal was camouflaged). Reliability for each coding scheme was determined separately by comparing the codes of a primary coder with those of a second independent coder. Both coders were blind to condition. Using Cohen's κ as the agreement statistic, reliability for anthropomorphic language was .80 (93.6%) and for explanatory completeness was .81 (83.3%), both indicating a very good level of agreement (Fleiss, 1981). The primary coder reviewed any disagreements and selected a final code.

Property attribution task. The property attribution task (Gutheil, Vera, & Keil, 1998; Inagaki & Sugiyama, 1988) measured children's attributions of common biological and psychological properties to humans, animals, plants, and objects. Children were shown an array of six targets (lion, crayon, ant, frog, human, and flower) and asked to name each picture to verify familiarity. On each trial, children were asked to choose the target(s) that possess a certain property (e.g., "Which of these things eat?"). Biological properties included eating, sleeping, growth, and having blood inside while psychological properties included thinking, feeling happy, feeling sad, and feeling scared. For each property, children could select as many or as few targets as they wanted. If the child paused during responding, the experimenter asked the child once if they thought anything else also had the property or if that was it. No additional prompts were used. On average, children selected 3.22 ($SD = .76$) of the six targets for each of the biological properties and 2.89 ($SD = 1.23$) of the six targets for each of the psychological properties.

For biological properties, each correct attribution to appropriate targets was scored as 1. An incorrect attribution (e.g., choosing a crayon on the sleep trial) or a failure to attribute a property to an appropriate target (e.g., failing to choose a lion on the growth trial) was scored as 0. A total biological accuracy score was calculated for each participant by summing scores for all six targets across the four trials, resulting in a possible score between 0 and 24, with higher scores indicating higher biological knowledge.

For psychological properties, we summed the number of times that each child attributed any of the four psychological properties to any of the five nonhuman

targets (lion, crayon, ant, frog, and flower). This resulted in a psychological attribution score for each child that ranged between 0 and 20, with higher scores indicating more frequent psychological attributions.

Results

Here, we present the results from the posttest measures, first addressing the story comprehension measures (story recall and camouflage knowledge) and then the property attribution task.

Storybook Comprehension Measures

We addressed whether anthropomorphic pictures and language influence children's recall and knowledge about the biological property being taught in the books: camouflage.

Storybook recall. Preliminary analyses revealed no effect of gender, so all recall results are collapsed across genders. First, we compared the number of facts recalled across storybook conditions. An analysis of variance (ANOVA) examining differences in children's recall score for the four different book conditions controlling for age found no effect of condition, $F(3, 43) = .32$, $p = .81$, suggesting that children recalled a similar number of camouflage facts from the storybooks regardless of anthropomorphic content.

Next, we compared children's use of factual and anthropomorphic language during story recall across the storybook conditions. A chi-square analysis was used to test whether children differed in their use of anthropomorphic language (yes, no) in recalling the storybook across the four conditions, revealing a significant relationship between these variables, $\chi^2(3, N = 44) = 20.02$, $p < .001$ (Figure 2). Children who were read a storybook with factual language and pictures almost never spontaneously added anthropomorphic language (10%), while children who were read a storybook with anthropomorphic language and pictures almost always recalled the storybook using anthropomorphic language (81.8%), confirming that children attended to the content of the storybooks.

To further test whether anthropomorphic pictures or language were driving the observed differences in children's use of anthropomorphic language, separate chi-square analyses were conducted for the language and picture conditions. The chi-square comparing anthropomorphic and realistic language conditions in children's use of anthropomorphic language in recall was significant, $\chi^2(1, N = 44) = 13.56$, $p < .001$, $w = 0.56$, while the chi-square comparing anthropomorphic and realistic pictures was not significant, $p < .17$. Thus, children's use of anthropomorphic language was driven specifically by the use of anthropomorphic language in the storybooks. In fact, children who were read a

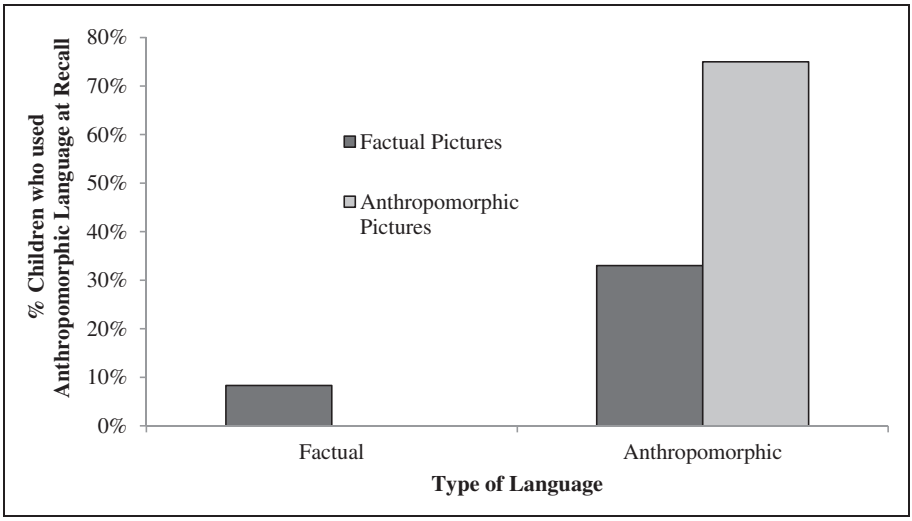

Figure 2. Percentage of children who used anthropomorphic language when recalling the story within each of the four storybook conditions.

storybook with anthropomorphic pictures but factual language *never* spontaneously used anthropomorphic language to describe the story. However, children did use anthropomorphic language to retell the story even in the absence of anthropomorphic pictures (33%).

Property generalization. Given that anthropomorphic language is reflected in children's recall of the events, the next question was whether anthropomorphic information also influences their generalization of the biological property to novel animals. To measure this, we examined children's performance on the generalization task across conditions. An ANOVA examining differences in generalization performance as a function of anthropomorphic language conditions (control, realistic language, and anthropomorphic language) and gender controlling for age found no effect of condition, $F(2, 52) = .21$, $p = .81$, gender, $F(1, 52) = 1.97$, $p = .17$, or interaction effect, $F(2, 52) = .96$, $p = .39$. However, an ANOVA examining differences in generalization performance as a function of anthropomorphic picture conditions (control, realistic pictures, and anthropomorphic pictures) and gender controlling for age revealed a significant interaction between gender and condition, $F(2, 59) = 3.40$, $p = .041$, $\eta_p^2 = .114$ (Figure 3). Separate ANOVAs conducted for each gender revealed that for girls, the type of storybook pictures had no effect on generalization, $F(2, 25) = .33$, $p = .72$. For boys, in contrast, the type of storybook pictures did affect generalization, $F(2, 29) = 6.55$, $p = .005$, $\eta_p^2 = .335$. Bonferroni-adjusted

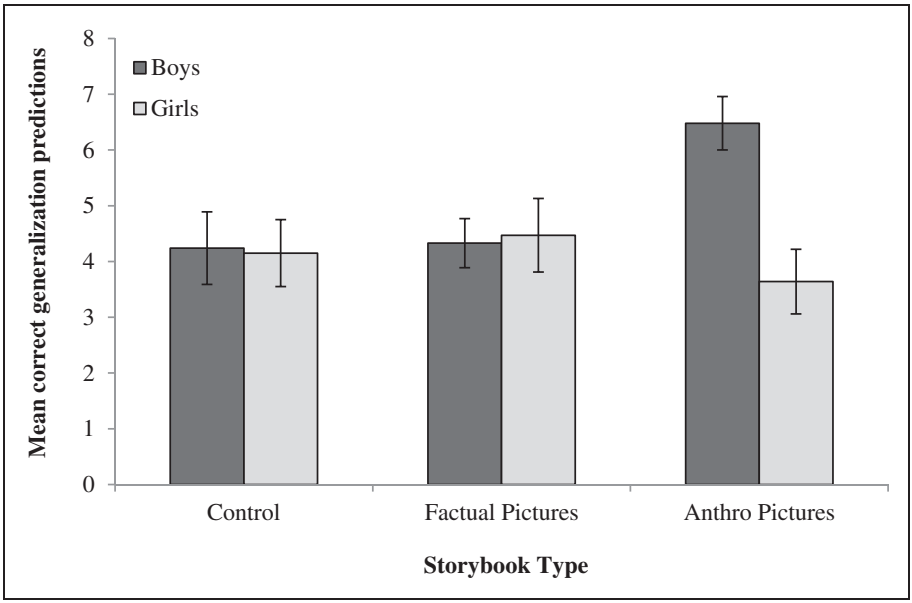

Figure 3. Mean number of correct generalization predictions by boys and girls in each of the three storybook picture conditions (control, realistic, anthropomorphic). Error bars represent standard error of the mean.

pairwise comparisons reveal that boys who were read storybooks with anthropomorphic pictures ($M = 6.46$, $SD = 1.29$) performed significantly better on the generalization task than boys in either the control group ($M = 4.33$, $SD = 1.75$), $p = .031$, or those who were read storybooks with factual pictures ($M = 4.31$, $SD = 1.80$), $p = .008$. Additionally, Bonferroni-adjusted pairwise comparisons revealed that boys who were read storybooks with anthropomorphic pictures performed significantly better than girls in either the anthropomorphic ($M = 3.69$, $SD = 2.87$), $p < .05$, or the factual storybook conditions ($M = 4.09$, $SD = 2.30$), $p < .05$. Overall, it appears that girls were not learning from any of the storybooks; generalization scores for girls were not significantly different from chance in any condition, including the control group. The performance of boys in the control and factual pictures conditions was similar to that of girls, hovering around chance. However, boys who were read stories with anthropomorphic pictures performed significantly better than chance on the generalization task, averaging 80% correct in this condition.

Finally, we addressed whether anthropomorphism influences children's ability to generate explanations about camouflage. Preliminary analyses revealed no effect of gender, so all results are collapsed across genders. First, we examined whether anthropomorphic storybooks encourage children to explain camouflage

anthropomorphically. A chi-square analysis comparing all five conditions and use of anthropomorphic explanations was not significant, $\chi^2(4, N = 46) = 3.62$, $p = .46$. Very few children (16.7%) used anthropomorphic explanations in any condition. Next, we examined whether anthropomorphic language and pictures affect children's understanding of why a predator would eat a noncamouflaged animal by comparing the sophistication of children's explanations across conditions. An ANOVA comparing language conditions and controlling for age revealed no effect of condition, $F(2, 55) = 2.33$, $p = .11$. However, an ANOVA comparing picture conditions and controlling for age revealed a significant effect of condition, $F(2, 55) = 3.86$, $p = .027$, $\eta_p^2 = .123$ (Figure 4). Bonferroni-adjusted pairwise comparisons revealed that children's explanations contained higher level details after they were read a storybook with anthropomorphic pictures ($M = 1.38$, $SD = 1.28$) than children in the control group ($M = .46$, $SD = .69$), $p = .027$. The level of detail in children's explanations in the factual picture conditions ($M = .71$ $SD = 1.04$) did not differ either from the control or anthropomorphic conditions, $p > .24$ for both the cases.

Attributing Biological and Psychological Functioning to Animals

Our final analysis focused on whether anthropomorphic storybooks influence children's attributions of biological and psychological properties to animals.

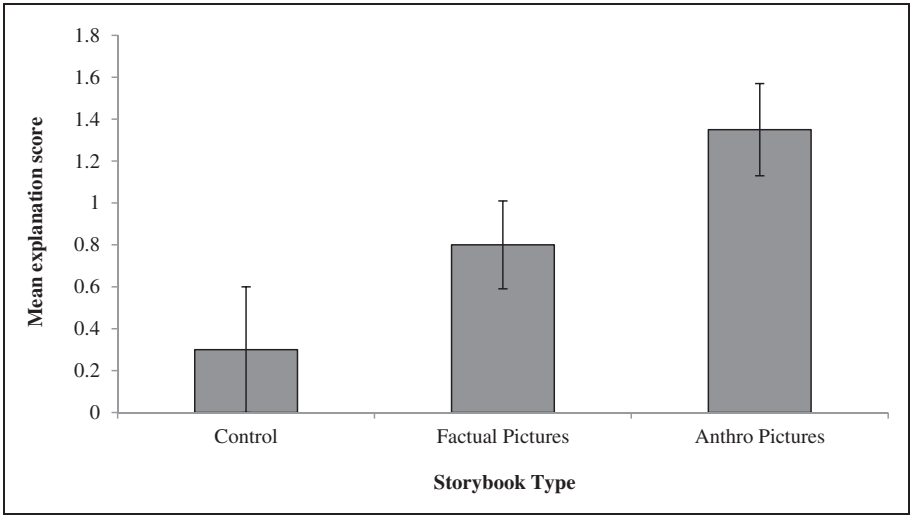

Figure 4. Mean explanation score of children in each of the three storybook picture conditions (control, realistic, anthropomorphic). Error bars represent standard error of the mean.

Property attribution task. Preliminary analyses revealed no effect of gender, so all results are collapsed across genders. A repeated-measures ANOVA using property type (biological, psychological) as a within-subjects factor comparing the five conditions (four storybook conditions plus the control) and controlling for age revealed no effect of property type, $F(1, 54) = .12$, $p = .73$, condition, $F(4, 54) = .15$, $p = .96$, or interaction effect, $F(4, 54) = .09$, $p = .97$. Overall, regardless of book experience, children scored very high on biological knowledge about nonhuman animals ($M = 18.82$, $SD = 2.63$, on a scale of 0–24) while rarely attributing psychological properties to nonhuman animals ($M = 8.12$, $SD = 4.63$ on a scale of 0–20).

Discussion

Children's storybooks often present the real world in highly unrealistic ways. Animals that talk, wear clothing, and live in houses are incredibly common in children's storybooks (Marriott, 2002). While previous research has suggested that these elements hinder children's learning about real animals (Ganea et al., 2014; Waxman et al., 2014), little attempt has been made to study the range of anthropomorphism that is found across children's media. In the current study, we examined the impact of less extreme anthropomorphic language and picture elements in children's storybooks on children's psychological and biological knowledge about real animals. Our results suggest that anthropomorphism can be used to support children's learning about animals and their biological processes.

We found that the content of the storybooks is relevant to what children remember; children described the characters anthropomorphically after being read a storybook containing anthropomorphic language. However, we did not find that anthropomorphism impeded factual recall; children were able to recall just as many camouflage facts in the anthropomorphic and realistic conditions. Furthermore, we found no increases in children's psychological property attributions to animals in any of the anthropomorphic conditions. Thus, anthropomorphism did not lead children to hold unrealistic beliefs about the psychological properties of real animals and did not hinder recall of factual properties, as found in previous research (Ganea et al., 2014; Waxman et al., 2014).

Importantly, we found partial evidence that our anthropomorphic storybooks, especially those with anthropomorphic pictures, increased children's learning of factual, biological information. After being read a storybook with anthropomorphic pictures, boys were better able to identify a noncamouflaged animal as being more likely to be eaten by a predator. That this finding was limited to boys was surprising; it may be that the combination of anthropomorphic pictures and the topic of animal survival were simply more engaging to boys than girls (Artola, Sastre, Gratacós, & Barraca, 2013) and as a result increased learning and generalization. However, further research will need to

be conducted in order to determine whether this finding is representative of other types of properties and for other groups of children. Additionally, both boys and girls were better able to explain why the predator would eat the noncamouflaged animal after being read a storybook with anthropomorphic pictures. We also found that children exposed to anthropomorphic stories were not more likely to use anthropomorphic language in their explanations about why a predator would eat the noncamouflaged animal. This is especially interesting given that children who were read an anthropomorphic story were very likely to remember and use anthropomorphic language in recalling the story. Despite remembering facts about intentional motivations, children were able to learn and provide factual explanations about camouflage that were introduced within anthropomorphic media.

Overall, the research presented here adds to the limited body of research on the impact of anthropomorphic media on children's knowledge about real animals. To date, both empirical findings and theoretical accounts of the role of anthropomorphic depictions of animals on children's biological understanding have been mixed. However, our results suggest that anthropomorphism may not always be bad and can even enhance learning about animals. It is important for future research to clarify and directly compare the effect of different types of anthropomorphic representations on children's knowledge about real animals. While previous research (Ganea et al., 2014; Waxman et al., 2014) used extremely personified animals that bore little resemblance to actual animals, our storybooks showed animals with human-like body postures and facial expressions in a natural habitat. It is possible that overly humanized animal depictions prevent children from identifying the characters as animals, priming children to think about humans instead and thereby increasing anthropomorphic beliefs. Anthropomorphic animals that more closely resemble real animals may increase children's connection with and attention to animals, leading to an increase in factual biological reasoning. Additionally, children may see more humanized animals as more fantastical, making the generalization of information to real animals less likely (e.g., Ganea et al., 2008; Simcock & DeLoache, 2006; Walker et al., 2015). Further research in our lab is directly addressing this by systematically varying the degree of anthropomorphism to reconcile differences across studies.

It is important to note that the current study represents only a small fraction of children's daily experiences with animals and media. Although previous work suggests that daily social experiences with real animals relates to increased biological knowledge and reasoning (Geerdts et al., 2015), it is unknown how daily exposure to anthropomorphic media over an extended time period relates to biological knowledge. Some have suggested that although anthropomorphism may initially relate to increases in learning, consistently embedding biological facts within an intentional framework may not facilitate biological causal reasoning in the long term (Ganea et al., 2011). Further research in our lab is

exploring how consistent exposure to anthropomorphic or factual media over extended time periods affects the development of children's biological and anthropocentric reasoning. Additionally, the current experimental research was limited to the effects of one form of media—storybooks. Exploring the effects of other types of media, including television and more interactive digital media such as "apps," on children's biological knowledge is another important goal of our future research.

This work has important implications for the creation of scientific educational media. As a result of a renewed interest in improving preschool education and boosting scientific literacy, early science learning has become a major focus of many leading educational and research groups, including the National Association for the Education of Young Children, National Science Foundation, and the U.S. Department of Health and Human Services (Brenneman, 2011). These early experiences serve an important role in supporting later scientific reasoning (Callanan & Jipson, 2001; Crowley & Jacobs, 2002; Jacobs & Bleeker, 2004; Strike & Posner, 1992), making this an important educational issue relevant far beyond early childhood. Our results suggest that anthropomorphic media can be used to increase children's factual learning about biological properties. Although further research is still needed to validate and extend these findings to other media formats, levels of anthropomorphism, and additional biological properties, our research does highlight the continued need for researchers and creators of educational media to consider how animal representations in children's educational media can support or hinder children's early biological learning. As media is highly prevalent in nearly all children's homes (Common Sense Media, 2011; Rideout & Hammel, 2006), it is critical that more research focuses of the kinds of information children transfer from media representations of animals to their real-world counterparts to maximize early learning opportunities.

Appendix. Scripts for the Factual and Anthropomorphic Storybooks With Anthropomorphic Language Italicized

Factual story	Anthropomorphic story
Some animals, like frogs and butterflies, can use camouflage to avoid other animals, like birds, who eat them	Some animals, like *Sammy* the frog and *Lucy* the butterfly, *like* to use camouflage to because they *want to hide* from *naughty* animals, like *Johnny* the bird, who *try* to eat them

(continued)

Continued

Factual story	Anthropomorphic story
Look! Can you find the frog on the green leaves? Right! The frog is hard to find because its skin is the same color as the leaves it is sitting on. The frog is camouflaged!	Look! Can you find *Sammy* on the green leaves? Right! *Sammy* is *smart*! He is hard to find because his skin is the same color as the leaves he is sitting on. *Sammy* is camouflaged!
Hungry animals like this bird who eat frogs can't see this frog because it is the same color as the things around it.	*Johnny* is hungry and *wants* to eat Sammy, but he can't see *Sammy* if he is the same color as the things around him. *Sammy tricked Johnny!*
Look! Can you find the frog on the red log? The frog is not hidden this time! Because the color of the frog is different from the color of the things around it, it is easy for the hungry bird to find the frog and eat it!	Look! Can you find *Sammy* on the red log? Oh no! *Sammy forgot* to hide! Because *Sammy* is different from the color of the things around him, *Johnny* can easily find *Sammy* and eat him!
Other animals have camouflage too.	*Sammy* has other animal *friends* who *like* to camouflage too.
Look! Can you find the butterfly on the yellow flower? Right! The butterfly is hard to find because it is the same color as the flower it is sitting on. The butterfly is camouflaged!	Look! Can you find *Lucy* on the yellow flower? Right! *Lucy* is *smart*! She is hard to find because she is the same color as the flower she is sitting on. *Lucy* is camouflaged!
Hungry animals like this bird who eat butterflies can't see this butterfly because it is the same color as the things around it.	*Johnny* is still hungry and *wants* to eat Lucy but he can't see *Lucy* if she is the same color as the things around her. *Lucy tricked Johnny!*
Look! Can you find the butterfly now? The butterfly is not hidden this time! Because the color of the butterfly is different from the color of the things around it, it is easy for the hungry bird to find the butterfly and eat it!	Look! Can you find *Lucy* now? Uh oh! *Lucy forgot* to hide. Because *Lucy* is different from the color of the things around her, *Johnny* can easily find *Lucy* and eat her!
Camouflage helps animals like the frog and the butterfly escape hungry enemies like the bird.	Animals like *Sammy* and *Lucy like* to camouflage because they *want* to escape *mean*, hungry enemies like *Johnny*!

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