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Anthropomorphic media exposure and preschoolers' anthropomorphic thinking in China

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ABSTRACT

Children's media is replete with human-like portrayals of animals and objects that wear clothing, speak, drive cars, and experience human emotions. Recent research has shown that anthropomorphic portrayals of animals in books lead children to think anthropomorphically about real animals. Here we asked whether this is also the case for an inanimate object. Specifically, does exposure to an anthropomorphized train, as compared to a real train, increase children's tendency to make anthropomorphic attributions to real trains? We also investigated whether this effect with books extends to another common medium of presentation: video. Chinese preschoolers (n = 258) ages 4–6 were randomly assigned to watch a video or listen to a book about either a real or an anthropomorphized train. Before and after this exposure, children completed a modified Anthropomorphism Questionnaire–Child Form (IDAQ-CF), which included questions about trains. Children who were exposed to the anthropomorphic book significantly increased in their tendency to view real trains as having human-like qualities, as compared to control children who had no exposure. Video exposure had no effect on the anthropomorphism of trains.

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Children's media frequently feature animals who are anthropomorphized: They walk, talk, think, and live like human beings. In fact, this is the predominant way of presenting animals in children's books. A study of over 1,000 children's picture books found that "Animal characters are typically anthropomorphized and exhibit all or most of the attributes of people" (Marriott, 2002, p. 178). As well as being common, books with anthropomorphized characters are popular. For example, the most frequently checked out library books in South Africa had anthropomorphized animal protagonists (McCrindle & Odendaal, 1994), and American parents predict that their children will prefer to read about an anthropomorphized animal over a realistically portrayed human (Guillot, 2014; see also Marriott, 2002). Children's television also anthropomorphizes animals – Big Bird on *Sesame Street, Arthur* the Aardvark, and the *Berenstain Bears* are just a few well-known examples. A study of British children's television programs in 1996 found that 44% included anthropomorphism (Paul, 1996). A new study demonstrates that anthropomorphism remains common in children's television in the United

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States: Among 88 currently popular children's television shows, culled from Nielsen ratings and parent reports, 69% contained anthropomorphized characters (Anonymous, 2018).

Interactions with anthropomorphized animals in books can influence children's thinking and learning about animals. Drawing on Carey's (1985) classic finding that if a human has a feature, children assume all animals have that feature, Waxman, Herrmann, Woodring, and Medin (2014) read 5-year-olds a book about bears depicted from either an anthropomorphic (*Berenstain Bears*) or a biological perspective (*Animal Encyclopedia*), and subsequently assessed children's inductive reasoning. Only children who had just read the *Berenstain Bears* showed the anthropocentric reasoning pattern, suggesting anthropomorphized portrayals influence children's biological reasoning.

The effects of anthropomorphism can also be seen in children's learning about novel animals. When preschoolers were read a book about a novel animal (a "cavy") that used anthropomorphized language and pictures, they were more likely to apply anthropomorphic emotional and social characteristics to the animal than when they were read a book that used realistic language (Ganea, Canfield, Simons-Ghafari, & Chou, 2014). In teasing apart the effects of anthropomorphic language and images, the researchers found that anthropomorphic illustrations have little effect by themselves, but that the combination of anthropomorphic language and pictures leads children to learn fewer real facts about animals and to anthropomorphize them more.

Children's books are frequently anthropomorphic, even when the aim is to teach children biological information. A recent survey of books about biological inheritance and illness contagion found that all of the books used anthropomorphic language and most paired it with anthropomorphic images (Geerdts, Van de Walle, & LoBue, 2016b). Meanwhile, the causal mechanisms of inheritance and contagion were rarely mentioned. This suggests that even in educational contexts, biological processes are ignored in favor of psychological motivations. Anthropomorphic explanations, as compared to realistic or biological explanations, appear to impair learning about animals and evolution (Ganea et al., 2014; Legare, Lane, & Evans, 2013; Waxman et al., 2014).

Although a range of studies have investigated whether children think anthropomorphically after exposure to an anthropomorphic book, this question has not been examined for another highly popular form of media: video. The present study examines whether the book or video presentation forms lead to more anthropomorphism in children.

Animals are not the only anthropomorphized entities in children's media. Objects, like tools and vehicles, are also frequently anthropomorphized, particularly on television. For example, *Dora the Explorer* is helped in her quests by an anthropomorphized backpack and map, and *Bob the Builder* and *Thomas the Tank Engine* feature anthropomorphized machines and vehicles. In addition to extending the current literature by comparing video with book presentation, this study examines the anthropomorphism of objects. Piaget (1930) argued that childhood was characterized by extensive animism based on children's treatment of objects. For example, children said that the moon knew where it was going and that rocks could feel pain. Piaget believed that children moved away from "animistic" thinking in a four-stage process that was only complete at age 12, when children used endogenous movement as a criterion to separate the animate from the

inanimate. Endogenously moving objects are perhaps the greatest source of confusion when it comes to anthropomorphism. Endogenous movement is a key characteristic even in adults' anthropomorphic attributions (Epley, 2014), and is a feature of the objects in the famous Heider and Simmel (1944) videos to which even young children attribute mental states (Springer, Meier, & Berry, 1996). Anthropomorphic representations of endogenously moving objects could, therefore, be particularly challenging for children to reconcile with their understanding of how real objects operate.

Less anthropomorphism is seen for nonmoving objects. Gelman, Spelke, and Meck (1983) demonstrated that 3- and 4-year-old children rarely attribute mental states to inanimate objects like dolls and rocks, even though only 4-year-olds can accurately describe whether animate and inanimate objects are capable of endogenous movement (Massey & Gelman, 1988). Because they move, vehicles seem to be especially likely (among the class of nonliving objects) to be recipients of anthropomorphic thinking. Consistent with this, 3-year-olds attributed the mental state of pretending to vehicles but not nonmoving objects (Lillard, Zeljo, Curenton, & Kaugars, 2000). Therefore, it seems that children might easily anthropomorphize vehicles because they appear to move endogenously. In fact, one recent study suggested this was the case when a vehicle appeared in board and touch-screen games. Specifically, young children showed greater anthropomorphism of real trains after exposure to either a board game or a touch-screen game that personified *Thomas the Tank Engine* (Li et al., 2017). Here we ask whether this is also the case for *Thomas* with two even more common, but also relatively more passive, presentations: a book and a video.

The present study

Although prior research has found that even short-term exposure to anthropomorphized animals in books prompts children to think anthropomorphically, little research has examined whether children will readily anthropomorphize objects, namely a vehicle. In addition, we know of no research examining whether videos might differ from books in generating anthropomorphism. To explore whether exposure to an anthropomorphized train presented via either book or video encourages children to make anthropomorphic attributions to a real train, children were first given a modified version of the Individual Differences in Anthropomorphism Questionnaire – Child Form (IDAQ-CF; Severson & Lemm, 2016, which was adapted from Waytz, Cacioppo, and Epley's 2010 adult IDAQ). The IDAQ-CF has been shown to have good measurement properties in a diverse sample of children ages 5–9; for example, it has a high alpha (.79) and scores predicted attribution of human characteristics to a puppet and a robot in the laboratory. After the IDAQ-CF pre-test, over three subsequent days, children were exposed to either a book or a video about a real or an anthropomorphized train, or they received no media exposure, and were then given the IDAQ-CF post-test. We hypothesized that anthropomorphized train exposure in either media form would increase children's anthropomorphic attributions to the characters' real-life counterparts relative to any change in anthropomorphism seen in unexposed children or children exposed to realistic trains.

In addition to children responding to the IDAQ-CF, participants' parents were asked to complete a questionnaire tapping into their child's media exposure, including prior exposure to *Thomas the Tank Engine* and real trains through videos/DVDs, books, play, and riding an actual train. The reason for this measure is that there is evidence that experience changes

anthropomorphic thinking. For example, although 5-year-olds are more likely to attribute anthropomorphic characteristics to nonhuman entities than 3-year-olds (Herrmann, Waxman, & Medin, 2010), such attributions are particularly common when children have less real-world animal exposure (Geerdts, Van de Walle, & LoBue, 2015; Medin, Waxman, Woodring, & Washinawatok, 2010; Ross, Medin, Coley, & Atran, 2003). In addition, when children play with small trains, they often anthropomorphize them, which could lead to special vulnerability to anthropomorphized trains in a story or video. Hence, parents were asked about their child's real and play train experience. Furthermore, children who watch *Thomas* videos or are read *Thomas* books at home frequently might differ at baseline in train anthropomorphism. Finally, anthropomorphism has shown change with age: On technology-nature items, children showed a trend of being less anthropomorphic from 5 to 9, and on animal items, they were more anthropomorphic across this age span (Severson & Lemm, 2016). Therefore, we also examined age differences in anthropomorphism regarding trains.

The study was conducted in a city in China because the first author is Chinese and supervised the study. We do not see any reason to think urban Chinese children might differ from children in other parts of the developed world on our measures.

Method

Participants

The sample included 258 participants, including 91 four-year-olds (M = 53.03 months, SD = 3.55 months, range = 48–59 months; 43 female), 77 five-year-olds (M = 65.11 months, SD = 3.58 months, range = 60–71 months; 38 female), and 90 six-year-olds (M = 75.64 months, SD = 2.89 months, range = 72–83 months; 39 female). Participants were recruited from 10 different classrooms from a preschool in a city in central China. Conditions were randomly assigned at the classroom level, with two classrooms for each condition: anthropomorphic book, anthropomorphic video, real book, real video, and control condition (no media exposure). There were no age differences across conditions (p = .80). The number of children per age group in each condition is displayed in Table 1. All children were from middle-class Chinese families and were given a sticker for their participation. The research was approved by the Institutional Review Board (IRB) at [Central China Normal University], No. 20150411, [the effect of media on children's anthropomorphism].

Materials

The books and videos used for the real and anthropomorphic conditions both featured trains (see Figure 1). In the anthropomorphic conditions (book and video), children were

Table 1. The number of children for each age group and condition.

	4-year-olds	5-year-olds	6-year-olds
Anthropomorphic video	19	16	18
Anthropomorphic storybook	21	16	18
Real video	15	15	16
Real storybook	18	20	20
Control	18	10	18
Total	**91**	**77**	**90**

Figure 1. Images from the anthropomorphic (top left) and real (top right) books and videos. Note that text also appeared in book images.

presented with the Chinese version of *Thomas the Tank Engine* (Plenderleith, 2012; Stinn, Tiernan, & Plenderleith, 2010), a common television show in China at the time of the study. The plot in both anthropomorphic (book and video) conditions depicted a train named James, one of Thomas's friends, being painted pink and taking children to a party with friends. In the real conditions (book and video), children were presented with a depiction of real trains in real-life situations and were taught about characteristics of real trains, such as the train's structure and the name and function of different parts (Hood, 1994). Both books featured the same information as their respective videos, but whereas the anthropomorphic book was commercially available, the real book was created in the laboratory using still shots and transcription from the real video. There were 23 pages in the book for both conditions.

Procedure

Children completed an adapted version of the IDAQ-CF both at pretest and posttest to measure their levels of anthropomorphism (Severson & Lemm, 2016). The questionnaire was translated into Chinese and then back-translated into English to ensure correct translation.

The IDAQ-CF began with three training questions to ensure proper scale use, as in Severson and Lemm (2016). The training items asked children if they like candy, broccoli, and carrots. Consistent with the original scale, the yes/no question was answered verbally or by pointing to a thumbs-up or thumbs-down picture; children who responded yes or thumbs-up were then asked how much: a little, a medium amount, or a lot. To assist children with this question, a very short, medium, and tall bar were presented to correspond with the choices, so children could either point at a bar or respond verbally. The training items were followed by 30 questions presented in random order within a category. The 12 questions from the IDAQ-CF asked about entities that fell into one of three categories: Technological items (robot, TV, car, and computer), inanimate nature items (mountain, ocean, tree, and wind), and animate nature items (cheetah, turtle, insect, and lizard). Only one target question was asked per entity: Whether it knows what it is, has feelings like happy and sad, does things on purpose, or thinks for itself. If children answered yes, they were asked to indicate how much using the 3-bar picture. Scores for each entity could range from 0 (no) to 3 (a lot); mean scores were obtained for each type of entity (e.g., animate nature).

In the present study, the IDAQ-CF was extended by the addition of a Train Anthropomorphic Subscale (see Table 2). To assess children's anthropomorphism of the objects presented in the media, we asked all four IDAQ-CF questions about the mental states of trains (e.g., "Does a train have feelings, like happy and sad?") and we also added four questions about trains' social characteristics ("Does a train talk?"). We also asked two questions about an attachment toy, an adult, a teenager, a child, and a baby: Whether each talks and does things on purpose. These last two sets of items are not discussed here because the focus is the anthropomorphism of trains.

The pretest IDAQ-CF was presented to each child individually on either Thursday or Friday before the exposure week by a trained experimenter who was blind to conditions. The following Monday through Wednesday, the regular teachers of each experimental classroom either read the real or anthropomorphic book or showed the real or anthropomorphic video to their students at 9:30 AM, for a total of three consecutive exposures. Both the video and the book exposure took 10 min each day. In the book conditions, teachers were told that they should read exactly what the book said and not add or omit any words. In the video conditions, teachers were told to simply play the video and not to narrate it. Teachers were asked to tell children beforehand to keep their questions in mind during exposure and ask them at the end. If children still had questions during their exposure to the book or video, teachers would respond, "That is a really good question and I can answer it after I finish reading the book [or after the video is over]." However, there were no questions after exposure in all conditions.

The posttest questionnaire, which was identical to the pretest, was administered by the same condition-blind experimenter to each child on Thursday or Friday of the exposure week. Children in the control condition received the pretest and posttest on the same schedule but had no media exposure in between.

As noted, parents also filled out a questionnaire regarding children's experiences of the train in the real life and media form including storybook and video (e.g., how often children had seen a train in the real life in the past six months).

Results

We first conducted exploratory and confirmatory factor analyses of pretest data on the 12 items of the IDAQ-CF and found, consistent with Severson and Lemm (2016), two factors – one for technology and nature items, and the other for animals. Our factor loadings and alphas were similar to those obtained by Severson and Lemm. Using these factors and the new train subscale, we examined baseline levels of anthropomorphism, and how responding to the scale a second time influenced anthropomorphism concerning non-train items. Then, we looked at the sample's experience with real and play trains, and finally, we examined whether either the book or the video changed children's

Table 2. Adapted IDAQ-CF train anthropomorphic subscale.

Mental States	Social and Physical Features
Does a train have feelings, like happy and sad?	Could a train have friends?
Does a train know what it is?	Could a train talk?
Does a train do things on purpose?	Could a train have a mother and father?
Does a train think for itself?	Could a train have a face?

level of anthropomorphism about trains at post-test, controlling for pre-test levels and age. Anthropomorphism about trains was calculated by averaging the mental and social subscales about trains at each time point because their sum scores were well-correlated (r = .70 at Time 1 and .51 at Time 2, both ps < .01).

Baseline anthropomorphism

Baseline levels of anthropomorphism at Time 1 (see Table 3) were examined using a repeated measures ANOVA with condition (control, anthro-video, anthro-book, real-video, real-book) as the between-subjects factor and pretest anthropomorphism about animals, technology-nature, and trains as within-subject factors. This showed that the conditions did not differ in anthropomorphism at pre-test, nor were children differentially anthropomorphic about trains than technology-nature items. Consistent with other research, there was a main effect of item type, $F(2, 506) = 62.22$, $p < .001$, $\eta_p^2 = .20$. Follow up tests using the Bonferroni correction indicated children were more anthropomorphic about animals than technology-nature items (Mean Difference = 0.40, $p < .001$), and more anthropomorphic about animals than trains (Mean Difference = 0.44, $p < .001$), but there were no interactions with the condition.

Next, paired samples t-tests were conducted on the Time 1 to Time 2 subscales for the control condition only, to see whether taking the IDAQ-CF a second time one week later (with no particular exposure to anthropomorphized trains) led to changes in children's thinking about the items having human qualities. On both the animal and the train subscale, control children were significantly *less* anthropomorphic at Time 2 than Time 1, $t(46) = 3.37$ and 2.57, respectively, both $ps \leq .01$, $ds = .50$ and .37, respectively; for the technology-nature subscale, there was a trend in this direction, $t(45) = 1.72$, $p = .09$, $d = .27$. Thus, children who were not exposed to a book or video about trains at school were less anthropomorphic at Time 2 than Time 1 and the "unexposed" pattern was to respond less anthropomorphically to this scale at the second administration. To examine this further, the same paired-sample t-test was run on the entire sample on the two subscales that did not involve trains. The reduction in anthropomorphism was significant for the technology-nature items $t(257) = 2.92$, $p = .004$, $d = .17$, and approached significance for the animal subscale $t(257) = 1.92$, $p = .06$, $d = .13$. Thus, the results suggest that young children become less anthropomorphic when reconsidering the questions after one week.

Effect of age and experiences with trains on baseline train anthropomorphism

Next, we looked at three variables that we expected might influence general anthropomorphism about trains. First, we examined the effects of age on the anthropomorphism of

Table 3. Descriptive data by the condition.

		Animals		Technology-Nature		Trains	
Group	*n*	*Pretest*	*Posttest*	*Pretest*	*Posttest*	*Pretest*	*Posttest*
Control	46	1.39 (.72)	1.07 (.72)	1.04 (.79)	0.88 (.77)	0.94 (.70)	0.75 (.72)
Real book	58	1.50 (.83)	1.32 (.89)	1.04 (.89)	0.89 (.81)	0.98 (.73)	0.98 (.79)
Real video	46	1.45 (.72)	1.37 (.79)	1.05 (.80)	0.88 (.72)	0.98 (.73)	0.92 (.79)
Anthropomorphic book	55	1.41 (.64)	1.13 (.68)	1.03 (.64)	0.97 (.68)	0.98 (.64)	1.13 (.68)
Anthropomorphic video	53	1.29 (.68)	1.38 (.81)	0.91 (.70)	0.86 (.76)	0.94 (.70)	0.95 (.76)
Total	258	1.41 (.72)	1.31 (.79)	1.01 (.77)	0.90 (.75)	0.97 (.71)	0.95 (.75)

trains at baseline. There was a significant difference across age groups, $F(2, 255) = 5.34$, $p = .005$, $\eta_p^2 = .04$. Follow-up Bonferroni tests showed that the difference was only between 4-year-olds ($M = 1.12$, $SD = .78$) and 6-year-olds ($M = 0.78$, $SD = .62$) (Mean Difference = 0.34, $p = .004$, $d = .61$). There was no significant difference between 5-year-olds ($M = 1.00$, $SD = .0.69$) and the other two age groups. At pre-test, 4-year-olds were significantly more anthropomorphic about trains than 6-year-olds.

Next, we looked at how much experience children had with trains, since more real train experience might reduce the anthropomorphizing of trains. According to their parents, 83% of the sample had seen a train in the last 6 months, and 68% had traveled on a train in the last 6 months. To examine the influence of train experience, we divided the sample between those who had either of these recent experiences with trains (had seen or ridden on one in the last 6 months) and those who had no such experience, and ran Independent Samples *t*-tests on their Time 1 anthropomorphic train subscale; this revealed that experience with trains made no significant difference in pretest level of train anthropomorphism.

Second, we looked at whether the experience of playing with toy trains was associated with different levels of anthropomorphism at pretest. The parent questionnaire asked both how often children played with toy trains, and how often they played with *Thomas the Tank Engine* trains specifically. The correlation between these two was high ($r = .73$), but 29.46% parents did not answer the question regarding *Thomas* specifically (whereas just 2.71% did not answer for playing with trains generally), so each was examined separately. Independent Samples *t*-tests were run on train subscale scores at Time 1 for the 25.97% of the children who played with trains frequently (weekly or daily) versus the 71.32% who played with trains infrequently (monthly or less) and for the 13.18% of the children who played with *Thomas* frequently versus the 57.36% who played with *Thomas* infrequently. In both cases, the frequent train-players were somewhat more anthropomorphic about trains at pretest, but not significantly so.

We also were interested in whether children whose parents reported they frequently were read stories about *Thomas* or watched *Thomas* on television were more likely to anthropomorphize trains at pre-test. However, although 92% of the parents said their child was familiar with *Thomas*, only 4.65% children's parents said they watched or read about him daily or weekly; 67% said they did so never or only every six months. Therefore, no analysis was done on this experience. One important aspect of this data is that overall, this sample watched and read about *Thomas* rarely; thus, home experience during the inter-test interval is unlikely to have contaminated results.

Effect of anthropomorphizing media on children's views about trains

Finally, we examined whether watching a video or being read a book about *Thomas the Tank Engine* or a realistic train for three consecutive days at school affected children's level of anthropomorphism about trains relative to that of control children. Specifically, we conducted an ANCOVA on post-test anthropomorphism about trains, controlling for pre-test anthropomorphism and age, with exposure condition (5: control, anthropomorphic book, anthropomorphic video, realistic book, realistic video) as the between-subjects factor. The results indicated a significant effect of an exposure condition, $F(4, 251) = 2.43$, $p = .049$, $\eta_p^2 = .04$. Follow-up tests using the Bonferroni procedure showed a significant mean difference only

between the anthropomorphic book and the control condition, Mean Difference = 0.35, $p = .02$, $d = .54$ (see Figure 2). Children in the *Thomas the Tank Engine* book condition, but not the *Thomas the Tank Engine* video condition, had higher anthropomorphism in the posttest relative to the pretest than children in the control condition (see Table 3).

We also conducted paired sample t-tests to compare children's anthropomorphism toward real trains from pre- to post-test in each condition. The results indicated a significant increase in the *Thomas the Tank Engine* book and this was the only condition in which there was a significant increase; as already noted, there was a significant decrease in anthropomorphism about trains in the control condition from pre-test ($M = .93$, $SD = .79$) to post-test ($M = .75$, $SD = .72$), $t(45) = 2.57$, $p = .014$.

Discussion

Children's media frequently depicts objects that can talk, move independently, and have human emotions and social relationships. The present study explored whether children are more inclined to attribute such anthropomorphic qualities to real trains after being exposed to anthropomorphic depictions of trains in media. Controlling for children's pretest levels of anthropomorphism, children who were exposed to a *Thomas the Tank Engine* book for three consecutive days, but not those exposed to a video, subsequently displayed more anthropomorphism of real trains as compared to control children who had no such exposure.

This study extends past research showing books with anthropomorphized animals affect children's conceptual understanding of non-human entities (Ganea et al., 2014; Waxman et al., 2014). We demonstrated that this effect is not limited to animals but also occurs with a vehicle. Animals are living beings with brains, so to ascribe human-like qualities to them is less surprising than to do so with an inanimate object like a train. However, trains do appear to move endogenously, which might make them easier to anthropomorphize than immobile objects.

Anthropomorphism of trains was not increased by the video portrayal in our study. Several researchers have noted a "video deficit," whereby young children are less liable to transfer what they see on screens to real life than they are to transfer from one real-life situation to another (Anderson & Pempek, 2005). The reasons for this are still unclear, although with younger children it has been hypothesized that the problem stems from the development of symbolic skills (Troseth, 2010) and the perceptual mismatch between 2D context and 3D contexts (Barr, 2013). However, by age 4, children clearly can learn from

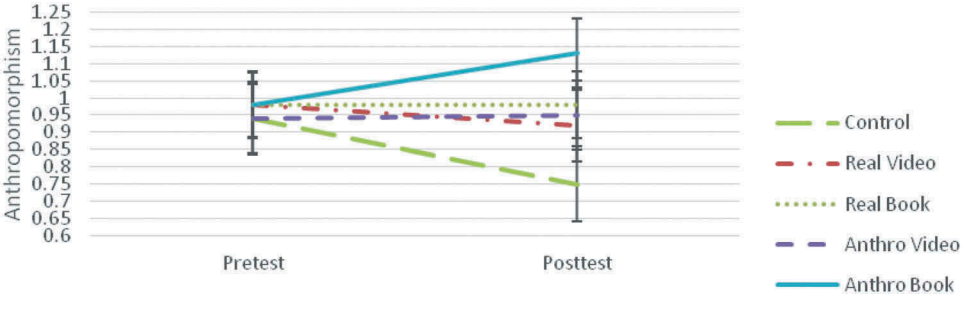

Figure 2. Change in anthropomorphism from pretest to posttest for each condition.

television (for a review, see Anderson & Hanson, 2010), and it seems unlikely that they failed to see the animated train as symbolizing a train in some way. Another possibility is that children are often told that what is on television is not real, and they, therefore, are less apt to transfer from video to reality than from book to reality. Other studies have also shown that children are biased to claim that what happens on television is pretend, even when what is portrayed is "real" (Li, Boguszewski, & Lillard, 2015; Ma & Lillard, 2013). However, a study of anthropomorphism in educational science television showed that it increases children's factual learning (Bonus & Mares, 2018), perhaps because it might increase attention.

A different possibility is that watching a video might be a more passive experience than being read a book, since the moving image is provided, whereas for a book one has to imagine non-pictured events. Greenfield, Farrar, and Beagles-Roos (1986) found that radio presentations, in which one also has to imagine non-pictured events, resulted in more imaginative story completions than did television presentations. Another study with adults found that people who like to think a lot feel more "transported" into books, whereas people with lower "need for cognition" feel more transported into filmed media (Green et al., 2008). Reading anthropomorphized books might lead to deeper cognitive engagement than watching anthropomorphized videos for many children, and hence stronger learning of anthropomorphism. Further research should explore this issue, as it is very pertinent to children's learning from television and books.

Returning to our primary finding, book portrayals of anthropomorphized objects might predispose children to think of those characters' real-life counterparts in a human way, which could negatively impact other learning about those objects. Since this study did not measure learning, we can only speculate about the impact of anthropomorphism on children's learning about trains, but the literature on anthropomorphism of biological entities suggests there are negative effects. For example, using anthropomorphic explanations during science lessons about evolution diminishes children's conceptual understanding (Legare et al., 2013). Other studies suggest that nonrealistic (as opposed to realistic) books lead to lower reading comprehension in preschoolers (Kotaman & Balci, 2016). Despite the allure of anthropomorphized characters, children's learning might be better-served by realistic portrayals of animals and objects, at least in books. Realistic media could be easier for children to understand and process.

A second reason for favoring realistic content is to ensure that knowledge gained from books is accurate. Realistic content is good both because it teaches children information that is true, and also because children might learn better when they believe what they are learning is true. Some studies support this, finding that children are more likely to learn when objects and events are presented in a realistic rather than a fantastical way (Ganea et al., 2014; Ganea, Pickard, & DeLoache, 2008; Richert, Shawber, Hoffman, & Taylor, 2009; Richert & Smith, 2011; Simcock & DeLoache, 2006; Walker, Gopnik, & Ganea, 2015; see also Lillard & Taggart, in press). However, some degree of anthropomorphism might improve learning. When characters are anthropomorphized to a lesser extent (i.e., given mental states and human-like posture and facial expressions but not dressed in human clothing), children's generalization of learned information is not negatively impacted (Geerdts, Van de Walle, & LoBue, 2016a). It is possible that in some cases unrealistic information heightens children's interest in a story, and thereby could improve learning about other aspects of the material (for discussion and examples of this, see Hopkins & Weisberg, 2017). In sum, it is still

unclear under which conditions fantasy information, including anthropomorphism, is and is not useful to young children. Future studies should test the effect of object anthropomorphism on children's learning directly, and whether children's beliefs about the reality status or anthropomorphic nature of entities serves as a moderator for children's anthropomorphism after exposure to different types of media.

One limitation of this study is that it occurred in a single setting. By showing children the media in a classroom, presented by the regular teacher whose role is to guide children in their learning, we might have induced more anthropomorphism than would be induced were children to view these materials alone at home. However, the consistency of our findings with that of earlier studies presenting anthropomorphized animals in books in laboratory settings mitigates against concerns regarding this limitation. Interestingly, teachers regularly present children with unrealistic books; only a small percentage of the books that preschool teachers select for their classrooms are informational, non-fiction books (Yopp & Yopp, 2012). Another limitation of the design is that conditions were randomly assigned to the classroom level. One might be concerned that teachers in the anthropomorphism book classrooms behaved differently towards their students than did the other teachers. However, there were no condition differences at pre-test, suggesting the teachers were not generally different on this score. Second, teachers were given explicit instructions about how to present the materials in a way that would not bias responses, and teachers were not informed about the hypotheses of the study or the other conditions. We believe that these precautions preclude the effects being attributable to teachers rather than conditions.

We are also limited by the lack of a measurement of children's attention or engagement during the media exposure. It is possible that children were not equally engaged in all conditions, but the exposure's placement during the same regular class time and with the regular teacher implies that children participated in the exposure as they would any other classroom activity.

Another limitation is that we used only one example of anthropomorphism (*Thomas the Tank Engine)*. As one of the first studies to examine the effects of viewing anthropomorphic objects in media, we consider this an initial step toward a greater understanding of non-biological anthropomorphism. Future research should examine whether this finding extends to other objects that display endogenous movement, such as machinery and robots, as well as still objects.

Much of the media that children regularly encounter depicts animals and objects behaving in distinctly human ways. Our study contributes to the growing literature suggesting that anthropomorphic media influences children's knowledge of the real world. Although this study focused on the impact of anthropomorphism on children's knowledge about trains, there remain many unanswered questions about the short- and long-term effects of viewing anthropomorphic media. By extending the literature to the domain of anthropomorphic objects, this study advances the field towards a more complete understanding of how anthropomorphism impacts children's cognitive development.

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