



Contents lists available at [ScienceDirect](#)

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp



The *Magic School Bus* dilemma: How fantasy affects children's learning from stories



Emily J. Hopkins*, Angeline S. Lillard

Department of Psychology, University of Virginia, Charlottesville, VA 22904, USA

ARTICLE INFO

Keywords:

Learning
Fiction
Fantasy
Analogical transfer
Problem solving
Preschool

ABSTRACT

Although children's books often include fantasy, research suggests that children do not learn as well from fantastical stories as from realistic ones. The current studies investigated whether the type of fantasy matters, in effect testing two possible mechanisms for fantasy's interference. Across two studies, 110 5-year-olds were read different types of fantastical stories containing a problem and then were asked to solve an analogous problem in a real lab setting. Children who were read a minimally fantastical version of the story, in which the story occurred on another planet "that looked just like Earth," were no more likely to transfer the solution than children who heard a story that was slightly more fantastical in that the story occurred on another planet and that planet looked different from Earth (e.g., orange grass, a green sky). In contrast, significantly higher rates of learning were observed when the story contained those elements and two physically impossible events (e.g., walking through walls). Furthermore, this improvement was obtained only when the impossible events preceded, and not when they followed, the educational content. Although fantasy may sometimes detract from learning (as other research has shown), these new studies suggest that minimal fantasy does not and that particular types of fantasy may even increase learning. We propose that the mechanism for this may be that a small dose of impossible events induces deeper processing of the subsequent events in the story.

© 2021 Elsevier Inc. All rights reserved.

* Corresponding author at: Department of Psychology, University of Scranton, Scranton, PA 18510, USA.

E-mail address: emily.hopkins@scranton.edu (E.J. Hopkins).

Introduction

Fictional books contain a mixture of real and fictional events. For example, Sherlock Holmes is fictional, but London is a real place. Determining which aspects of a story can apply to real life and which cannot is known as the “reader’s dilemma” (Gerrig & Prentice, 1991; Potts, St. John, & Kirson, 1989). For the youngest readers, this dilemma is complicated by the fact that educational media for children often contain unrealistic or fantastical elements (see Hopkins & Weisberg, 2017, for a review). A prototypical example is the *Magic School Bus* series; although these books aim to teach children about science, they also present a magical bus that can travel through time and shrink down small enough to travel through the human body. Similarly, many other children’s books that aim to teach content as diverse as science, vocabulary, number skills, and moral lessons contain unreal elements ranging from animals that dress and talk like people to characters or objects that defy the laws of physics. Children are expected to incorporate the educational content into their knowledge of the real world, but not the fantastical content. Are they able to solve this *Magic School Bus* dilemma? Does fantasy content affect children’s learning?

A number of studies have shown that children do not in fact learn as well from stories with fantastical content as they do from more realistic stories. For example, in a series of studies, children heard a story wherein a character employed a novel strategy to solve a problem (Richert, Shawber, Hoffman, & Taylor, 2009; Richert & Smith, 2011). In one study, a character needed to carry a pile of apples so large that she could not hold them all at once; the character wrapped the apples up in a blanket in order to carry them. Children were later given an analogous problem to solve: They were asked to carry a large pile of marbles across a room in order to deposit the marbles in another container. If children applied the solution used by the story protagonist by putting the marbles in an available towel, this was taken as evidence that children learned from the story. In these studies, children were less likely to learn from stories containing fantastical elements (e.g., monsters, outer space) than from realistic stories.

Other types of learning from fantastical stories have been examined as well. For example, Walker, Gopnik, and Ganea (2015) found that children who heard a fantastical story were less likely to generalize novel information from story to real life than children who heard a realistic version of the story. Ganea, Canfield, Simons-Ghafari, and Chou (2014) found that children learned fewer facts about novel animals from a story that contained unrealistic anthropomorphized animal characters. Similarly, children performed more poorly on a test of story comprehension after hearing a story about anthropomorphized animals compared with a matched story about humans; these results held when children were retested 1 week later (Kotaman & Balci, 2017). Pinkham, Kaefer, and Neuman (2014) found that children were less able to draw inferences about story content when a story concerned animal characters who behaved in unrealistic ways (a bird that slept in a bed compared with a bird that slept in a nest). Lehr (1988) found that children were less able to identify the broad themes presented in folk tales than the themes presented in more realistic stories.

These studies suggest that children do not learn as well from fantastical stories. Yet, we do not know whether this negative impact is true of all types of fantasy. Fantasy can take many forms, including unrealistic settings (e.g., a planet in outer space), supernatural characters (e.g., monsters, fairies), anthropomorphized characters (e.g., animals or inanimate characters with human-like behaviors and traits), unlikely events (e.g., having an alligator as a pet), and impossible events (e.g., flying on a magic carpet, eating stardust). Some of these we might characterize as *surface-level* fantasy—superficial differences from the real world such as unrealistic settings and unlikely events. Others represent a deeper level of fantasy—things that cannot possibly occur in the real world such as impossible events that violate real-world causal principles. Anthropomorphized and supernatural characters likely fall somewhere in the middle. Obviously, talking bears cannot exist in reality; however, anthropomorphic characters in children’s media often behave in completely realistic ways and occupy otherwise realistic worlds (e.g., *Arthur, The Berenstain Bears*). Furthermore, characters like these are so ubiquitous in children’s literature and media that children might not immediately code them as impossible. In fact, several studies have found that exposure to such anthropomorphized characters leads children to believe

that real animals can have human traits such as wearing clothes and talking (Ganea et al., 2014; Li, Boguszewski, & Lillard, 2015; Mayer, 1995).

The prior studies that found negative impacts of fantasy primarily used surface-level fantasy and anthropomorphized characters in their stimuli. Richert et al. (2009) used stories with nonhuman characters (e.g., monsters, fairies, puppets), but the events of the stories seemed to be otherwise realistic. Other studies used anthropomorphized animals engaging in ordinary events (Ganea et al., 2014, Kotaman & Balci, 2017; Pinkham et al., 2014). Lehr (1988) investigated various folk tales such as the *Three Little Pigs*, *Billy Goats Gruff*, and *Snow White*; although some of these stories contain magic, many are mostly about anthropomorphized characters. They were not analyzed separately, so we cannot determine whether the different types of fantasy had different effects. Similarly, Walker et al. (2015) used a story that contained many fantasy events, mostly surface-level events or supernatural characters (e.g., a fairy, a talking tree, a chocolate pond) and one deep-level event (e.g., flying with a magic cape). No studies appeared to use stimuli that contained predominantly deep-level fantasy.

Because prior studies have not systematically compared types of fantasy, we do not know whether all fantasy has the same impact on learning. Furthermore, we know little about the possible mechanisms by which fantasy might affect learning and whether different types of fantasy affect learning via different mechanisms. One possible mechanism is that fantastical stories overtax children's cognitive system. Fantasy stories are, by definition, dissimilar from reality. Research on children's analogical transfer has established that similarity between source and target contexts facilitates transfer (Brown, Kane, & Echols, 1986; Daehler & Chen, 1993; Holyoak, Junn, & Billman, 1984). The dissimilarity between fantasy stories and reality could inhibit children's ability to learn from such stories. In addition, processing unusual fantasy events could use up attentional and cognitive resources that could otherwise be devoted to processing the educational material (Fisch, 2000; Lillard, Drell, Richey, Boguszewski, & Smith, 2015).

Alternatively, children may actually be employing a responsible strategy when they avoid learning from fantastical stories (Richert & Smith, 2011). Learning from any fictional story requires children to make decisions about whether events in the story can be applied to real life. When a story contains impossible fantastical events, children need to distinguish the fantastical content that should not be transferred to reality (e.g., a flying school bus) and the intended educational content that should be transferred (e.g., red blood cells that carry oxygen throughout the body). This poses a risk of acquiring incorrect information (Brabham, Boyd, & Edgington, 2000; Li, Eisen, & Lillard, 2019), and therefore children may make the conservative assumption that the presence of fantasy events in a story indicates that the other characters and events in the story are not real and have no application to real life (Bonus & Mares, 2019). In fact, a number of studies have demonstrated that children are less likely to judge characters and events in a story as real when the story contains fantastical elements (Corriveau, Kim, Schwalen, & Harris, 2009; Woolley & Cox, 2007; Woolley & Van Reet, 2006). There is further evidence that adults similarly use the degree of realism in a story to determine how likely it is that the story world overlaps with reality (Weisberg & Goodstein, 2009).

Either or both of these mechanisms may be at play when children are confronted with fantastical stories, and the current literature does not discriminate between them. Superficial differences from the real world, as used in many of the studies to date, may affect learning via the first mechanism—that general dissimilarity from reality makes transfer more difficult. Impossible events may be more likely to affect learning via the second mechanism—that the presence of violations of real-world laws leads children to conclude that the story is not applicable to reality.

In the current studies, we attempted to differentiate these two mechanisms by investigating the effects of three different types of fantasy on children's analogical transfer from stories. The baseline condition was a *fantasy setting*, where the only nonreal element in the story was that it was described as taking place on "another planet that looks just like Earth." The second condition was *surface fantasy*, where the world of the storybook was superficially dissimilar from reality but the laws of reality still applied (i.e., all events in the story could also occur in real life). The third condition was *deep fantasy*, where the storybook had unrealistic illustrations, as in the *Surface Fantasy* storybook, as well as events that violated real-world laws of physics. This design allowed for the isolation of the effect of each fantasy element by comparing pairs of stories that differed by only that one element (Table 1). For example, both the fantasy setting and surface fantasy conditions take place in nonreal settings but differ in

Table 1
Summary of fantasy characteristics of storybooks used in Study 1.

Condition	Non-real setting	Unrealistic illustrations	Impossible events
Realistic			
Fantasy setting	•		
Surface fantasy	•	•	
Deep fantasy	•	•	•

the realism of the illustrations; thus, any differences in transfer observed between these two stories can be attributed to the fantastical appearance. We also compared these three conditions with a pilot sample of participants who heard a completely realistic version of the story.

If any suggestion of fantasy interferes with learning, even the fantasy setting condition should lead to less learning than the completely realistic story. If the negative effects of fantasy previously observed are due to difficulty in transferring from dissimilar contexts, children’s learning should be worse in the surface fantasy condition compared with the fantasy setting condition. However, if children are making inferences about whether the events of a story are plausible in reality, they may learn from the surface-level fantasy story but not from the deep fantasy story.

Study 1

Method

Participants

The sample consisted of 95 5-year-olds (46 boys; $M_{age} = 65.3$ months, range = 60.2–72.9). We tested 5-year-olds because children at this age are frequently exposed to both educational and fantastical storybooks, and they are generally able to differentiate between realistic and fantastical stories (e.g., [Corriveau et al., 2009](#); [Woolley & Van Reet, 2006](#)). Furthermore, this age group is consistent with prior studies on this topic. An additional 4 children were tested but excluded due to experimenter error ($n = 1$), equipment failure ($n = 1$), the child being uncooperative or unable to complete the procedure ($n = 1$), or the parent not completing the questionnaires ($n = 1$). Parent-reported racial/ethnic identity was as follows: 79% Caucasian, 3% Hispanic, 1% Black or African American, 2% Asian, and 5% multiracial (10% did not report race/ethnicity). Participants were recruited by phone and e-mail from a university town in the southeastern United States, and they were primarily from middle-class backgrounds.

Based on effect sizes in prior research, this sample size provides sufficient power. The effect size (Cohen’s d) in Experiment 1 of [Richert and Smith \(2011\)](#), which is most similar to our method, was 0.78, a large effect; a comparable effect size for the chi-square analyses used in the current study (Cohen’s w) would be 0.50. A sample size of 32 children per group provides 99% power to detect an effect of that size and provides 80% power to detect a small effect ($w = 0.32$).

To determine a baseline for comparison, a pilot sample of 20 participants ($M_{age} = 66.2$ months, range = 60.5–71.4) was given the same problem-solving task after hearing a completely realistic version of the story that contained no elements of fantasy. We include their data for comparison in some of the analyses presented below.

Materials and procedure

Children were read one of four different storybooks ($n = 31$ or 32 per book). All books consisted of 11 pages of full-color drawings depicting the same sequence of events (Appendix A). The first page introduced the protagonist (Eddie or Janie, gender matched to the participant) and his or her family ([Fig. 1A](#) and [B](#)). On pages 2–6, the protagonist woke up, went down the stairs to the kitchen, had cereal and orange juice for breakfast, had friends over to play, and then left the house to take his or her dog for a walk. The target problem was presented on pages 7 and 8 ([Fig. 1E](#) and [F](#)). The protagonist wanted to give some food to the dog next door but could not reach the dog’s bowl through the fence. The

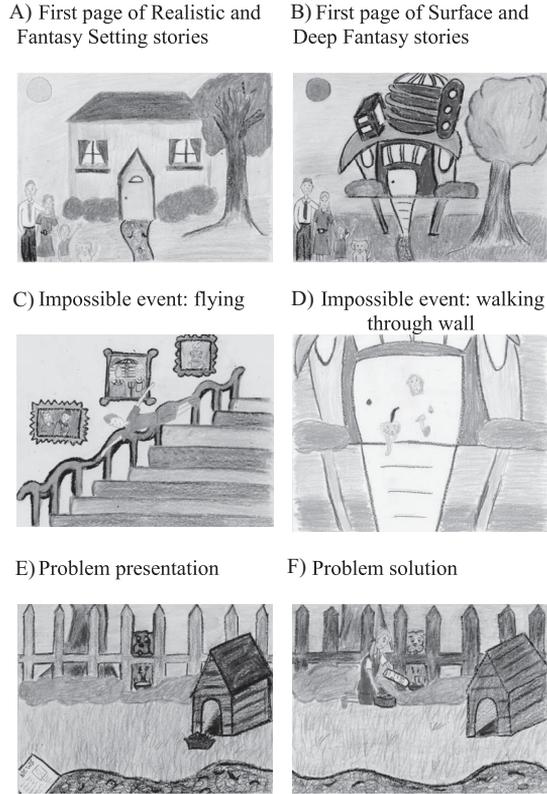


Fig. 1. Sample illustrations from storybooks.

protagonist rolled a newspaper into a tube, poked it through the fence, and rolled the food down into the dog's bowl. After this, on the final 3 pages, the protagonist played fetch in the park with his or her dog, had spaghetti and meatballs for dinner, and went to bed.

The four stories varied in the type of fantasy they contained. Table 1 summarizes these features of the stories. The realistic story used in pilot testing contained no fantasy at all. The first experimental book contained the same realistic illustrations and events as the realistic story (Fig. 1A) but was described as taking place on another planet that "looked just like Earth" (fantasy setting condition, $n = 32$). The other two storybooks contained fantastical illustrations; the grass was orange, the sky was green, and the house and other objects were futuristic in appearance (Fig. 1B). The first of these stories (the surface fantasy condition, $n = 31$) was otherwise identical to the fantasy setting story. In the deep fantasy condition ($n = 32$), in addition to the nonreal setting, the protagonist flew down the stairs for breakfast (Fig. 1C) and walked through the wall to leave the house (Fig. 1D).

Immediately after hearing the story, the experimenter asked children to recall the problem solution ("What did Eddie/Janie do when he/she wanted to feed the dog next door?"). If children did not answer or provided an incomplete response (e.g., "She gave him some of her dog's food"), the experimenter prompted them for more information (e.g., "How did she get the food into the other dog's bowl?"). If children still did not give a complete response or said something incorrect, the experimenter reminded them of the solution (e.g., "She rolled up the newspaper and put the food through the tube into Max's bowl"). Children's responses to the *solution memory* question were coded as correct (2), correct after prompting (1), or incorrect (0).

At this point, the experimenter asked children to sit on the floor and brought out a large cardboard box with windows and slits cut in the front to resemble a fence. There was a bowl toward the back of

the inside of the box; children were told that they needed to move some marbles into the bowl without putting their hands inside the box. They were given a magazine, a piece of fabric, a length of string, and two wooden sticks to use in solving the problem (Fig. 2). The correct solution was to roll the magazine into a tube, insert it through the opening in the front of the box, and roll the marbles into the bowl. No child ever generated another strategy that was successful at getting the marbles into the bowl.

Children were given 3 min to attempt to solve the problem. During this time, the experimenter gave general feedback such as “That didn’t work” and “What else could we try?” but gave no guidance on how to solve the problem. If children did not produce the correct solution within 3 min, the experimenter gave a prompt to think about the story: “Was there anything in the story we read that could help?” Children were then given an additional 1 min to work. If they had still not solved the problem after the additional time, they were coded as not having solved the problem and the experimenter guided them to the correct solution.

After the transfer task, a subset of children ($n = 60$) were asked three questions about whether the events in the story could happen in real life (Appendix B). This was done to ensure that children perceived the stories as fantastical in the way intended by the experimenters.

Results

We first confirmed that the condition manipulations were effective in that children interpreted the fantasy stories as fantastical. Next, we looked at how transfer differed across conditions.

Fantasy manipulations

To confirm that children did in fact perceive the fantasy elements as nonreal, children’s responses to four questions about the stories were assessed. Across all three experimental conditions, the majority of the children queried (55 of 60) said that the story’s setting was “just in the story” and not “a real place you could visit”; only 1 or 2 children in each condition were incorrect on this question. Nearly all children reported that the impossible events used in the deep fantasy condition could not happen in reality (58 of 60 for “walking through a wall” and 57 of 60 for “flying down the stairs”). This was true even in the deep fantasy condition when children saw these events depicted in the story, with 19 of 20 children queried saying that a person could not really fly down the stairs and all 20 saying that a person could not really walk through a wall. Thus, the fantasy manipulations were indeed perceived by children as things that could not exist or occur in the real world.



Fig. 2. Materials provided for the problem-solving task.

Transfer scores by condition

The distribution of children who solved the problem on their own versus solved it after the prompt to think about the story was not significantly different across conditions (Fisher's exact test, $p = .26$), so all children who solved the problem, with or without the prompt, were classified as passing the transfer task for all future analyses. The numbers of children who correctly recalled the problem solution immediately after hearing the story are shown in Table 2. This did not differ significantly across the three experimental conditions, $\chi^2(4, N = 95) = 7.74, p = .102, w = 0.29$. However, we included it as a control variable in our analyses to ensure that hearing a reminder of the solution from the experimenter did not affect the likelihood that children solved the subsequent transfer problem.

Fig. 3 shows the proportion of children in each condition, as well as in the *realistic* condition from the pilot sample, who solved the real-world problem using the solution presented in the story. We conducted a logistic regression to determine whether condition predicted solving the problem after controlling for age, gender, and memory for the solution. Condition was coded to compare each condition with the reference level (the realistic story). Regression results are shown in Table 3. Neither age, nor gender, nor solution memory significantly moderated the condition effect, so we present only the more parsimonious model without the nonsignificant interactions here.

Age was a significant predictor—not surprising given that problem-solving skills typically improve with age as children's cognitive skills mature—but gender and memory for the solution at the end of the story were not. After controlling for these variables, there was a marginal effect of condition. Children in the deep fantasy condition were marginally more likely than children in the realistic condition to solve the problem ($p = .090$, odds ratio = 3.09). We next conducted two planned comparisons between adjacent pairs of conditions (surface fantasy vs. fantasy setting and deep fantasy vs. surface fantasy; comparisons conducted using the *glt* function from the multcomp package in R). Children in the deep fantasy condition were significantly more likely to solve the problem than children in the surface fantasy condition, $B = 1.67, SE = 0.60, \text{adjusted } p = .010, \text{odds ratio} = 5.29$. However, children in the surface fantasy condition were not significantly different from children in the fantasy setting condition, $B = -0.62, SE = 0.53, \text{adjusted } p = .404, \text{odds ratio} = 0.54$.

Discussion

This study attempted to differentiate two mechanisms for the negative effect of fantasy on children's learning that has been demonstrated in past studies. The first is that dissimilarity between fantasy stories and the real world may impede transfer. The second is that the presence of fantastical events or characters in a story may lead children to infer that other information in the story is not applicable to reality. Our predictions were not supported. Although children in the surface fantasy condition (where the story setting had strange shapes and colors) did show the lowest levels of transfer, they were *not* significantly different from the fantasy setting condition (in which the story simply took place on another planet but was otherwise realistic) or the baseline realistic story. This result goes against our hypothesis that dissimilarity is behind the negative impact of fantasy on learning. Surprisingly, children who heard the deep fantasy story containing physically impossible events and surface dissimilarity were significantly *more* likely to solve the transfer problem than children in the surface fantasy condition and were marginally more likely to do so than children in the fantasy setting condition. This was in direct opposition to our predictions and to the many studies showing that fantasy interferes with learning.

Table 2
Children's memory for the problem solution immediately after hearing the story.

Solution memory	Fantasy setting ($n = 32$)	Surface fantasy ($n = 31$)	Deep fantasy ($n = 32$)
Remembered on their own	11	13	13
Remembered after prompting	19	13	10
Did not remember	2	5	9

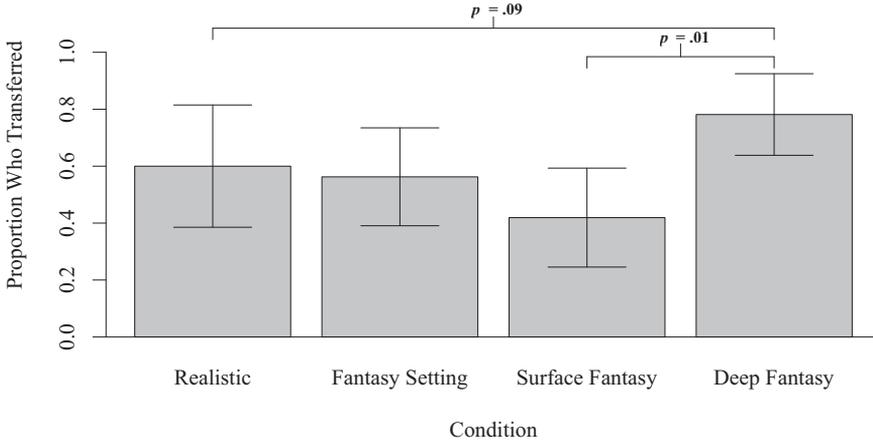


Fig. 3. Proportion of children who solved the transfer task by condition in Study 1. Error bars represent 95% confidence intervals. The realistic condition is from the pilot study.

Table 3
Results of logistic regression predicting successful problem solving.

Predictor	B	SE	z	p
Intercept	0.25	0.48	0.52	.605
Age	0.13	0.06	2.08	.037*
Gender	-0.69	0.42	-1.64	.100
Solution memory	0.40	0.31	1.28	.201
Condition				
Fantasy setting	0.08	0.61	0.14	.892
Surface fantasy	-0.54	0.61	-0.88	.377
Deep fantasy	1.13	0.67	1.70	.090*

Note. Each level of the condition variable is compared against the reference level (the realistic story).

* $p < .10$.

† $p < .05$.

To probe this unexpected result, we conducted a post hoc exploratory study within the data collection for Study 1. As data were being collected for Study 1, the first author (who was the experimenter for some of the participants) noticed that a number of children in the deep fantasy condition were unexpectedly solving the transfer problem. Therefore, we elected to add some additional questions to the end of the procedure for the remaining participants to explore a possible explanation (nothing else about the procedure was changed). We hypothesized that the impossible events might be more interesting to children and thus might increase their attention to the story. If this were true, we would expect children to show better memory for the events of the deep fantasy story than for the other stories.

Study 2a

Method

Participants

The sample for this exploratory study consisted of 35 of the participants from Study 1 (17 boys; $M_{age} = 64.5$ months, range = 60.2–72.1). These participants were not significantly different in age from the rest of the Study 1 sample, $t(93) = 1.54, p = .127$. Of the Study 2a participants, 12 were in the

fantasy setting condition, 11 were in the surface fantasy condition, and 12 were in the deep fantasy condition.

Materials and procedure

Participants completed the storybook reading and transfer task as described above in Study 1. They then completed two additional memory measures. The first was a free recall measure where children were asked to retell the story. First, coders recorded the number of story events that children correctly recalled (possible range = 0–11). They also coded whether children included specific details of the problem and solution in their free recall (possible range = 0–3): the goal (feed the hungry dog), the obstacle (the fence was in the way), and the solution (the protagonist rolled up the newspaper to feed the dog). This coding scheme was modeled on Brown et al. (1986). The second assessment was a set of 11 questions about details from the story (Appendix B). Responses to each question were coded as correct or incorrect and were summed for a possible score from 0 to 11.

Results

For each of these three memory variables (Table 4), we conducted three *t* tests comparing pairs of conditions: fantasy setting versus surface fantasy, fantasy setting versus deep fantasy, and surface fantasy versus deep fantasy. Although none of these comparisons was significant when the alpha level was corrected for multiple comparisons, a few interesting patterns emerged. First, children in the fantasy setting condition scored higher on the general memory questions than children in the other two conditions, suggesting that either surface or deep fantasy may interfere with overall story memory. Second, children in the surface fantasy condition, but not children in the deep fantasy condition, were less likely to spontaneously describe the problem and solution in their free recall than children in the fantasy setting condition.

Discussion

We hypothesized that children might learn better from the deep fantasy stories because the impossible events captured their attention more than the other stories. However, the differences in memory between conditions were not significant, suggesting that differential attention to the stories was not affecting learning. If anything, fantasy may impede, rather than enhance, children’s ability to accurately remember story events because children in both the surface fantasy and deep fantasy conditions scored lower on questions about the story than children in the fantasy setting condition. However, children in the deep fantasy condition were somewhat more likely to include specific details of the problem in their free recall than children in the surface fantasy condition and did not differ from children in the fantasy setting condition. Although not a significant difference, this suggests a possible mechanism by which the impossible events may have affected learning; they may have induced deeper processing of the problem itself if not the story as a whole.

If this is the case, children may indeed be making inferences about the possibility of events in the story, although in the opposite way than we expected. Rather than assuming that any impossible event indicates that everything in the story is untrue, the impossible events may cue children that they need to think more carefully about the other events in the story. Having seen the impossible

Table 4
Mean scores on memory measures by condition.

Memory measure	Fantasy setting (n = 12)	Surface fantasy (n = 11)	Deep fantasy (n = 12)
Free recall: All story details (max = 11)	3.64 (2.98)	3.18 (3.16)	5.09 (3.05)
Free recall: Problem solution (max = 3)	1.00 (0.77)	0.36 (0.67)	1.09 (1.04)
General memory questions (max = 11)	6.92 (1.36) ^a	5.45 (1.97)	5.75 (1.73)

Note. Standard deviations are in parentheses.

^a Higher than the surface fantasy condition (*p* < .05).

events earlier in the story, children might have been in a sense primed to consider whether subsequent story events would also be possible in the real world. By preschool, children know that some types of events, such as walking through walls, cannot happen in the real world (Johnson & Harris, 1994; Rosengren & Hickling, 1994; Shtulman & Carey, 2007), and as such the impossible events in the story would have been very salient to them. Children expect physical laws to be consistent within a story (Weisberg & Sobel, 2012), so they may have been monitoring subsequent story events to determine whether they were also possible in reality. In this light, when they encountered the problem solution in the story, they assessed whether it was likely to work in reality, which then increased the likelihood that they could and would transfer it to the analogous real-world problem. This idea that fantasy may put children in a positive mindset, or *mise en place*, for learning has been previously proposed by Weisberg, Hirsh-Pasek, Golinkoff, and McCandliss (2014).

If such a mindset or priming effect is truly driving the positive effect in the deep fantasy condition, the effect of impossible events would depend on them appearing *prior* to the problem in the story as opposed to after the problem. If the impossible events occurred after the problem and solution, children would not be put into the frame of mind to process the possibility of the problem solution and would show significantly less learning than in the deep fantasy condition. We conducted an additional exploratory study to address this possibility.

Study 2b

Method

Participants

The sample consisted of 15 5-year-olds who had not participated in Study 1 (9 boys; $M_{\text{age}} = 64.4$ months, range = 60.5–72.3). By parent report, the racial/ethnic composition of the sample was as follows: 60% Caucasian, 7% Hispanic, 7% Asian, and 13% biracial or multiracial (13% did not provide racial/ethnic information). Participants were recruited by phone and e-mail from the same community as in the previous study, and they were primarily from middle-class backgrounds.

Materials and procedure

A reordered version of the impossible events storybook from Study 1 was used (Appendix A). The problem and solution occurred before both of the impossible events; the illustrations and text were otherwise identical. The procedure of Study 2b was identical to that of Study 1.

Results

The numbers of children who correctly recalled the problem solution immediately after hearing the story were as follows: 6 remembered the solution on their own, 6 remembered it after a hint, and 3 did not remember it. This did not differ significantly from the three experimental conditions in Study 1, $\chi^2(6, N = 110) = 7.80, p = .253$, Cohen's $w = 0.27$.

Transfer scores

The positive effect of impossible events on transfer scores seen when impossible events preceded the problem in Study 1 was not observed when the impossible events occurred *after* the problem in the reordered version of the story. In the *reordered* condition, 47% of children solved the problem. Compared with the results from Study 1, this was significantly lower than the deep fantasy condition (78% success), $\chi^2(1, N = 47) = 4.65, p = .03$, Cohen's $w = 0.31$, odds ratio = 4.08, but it was not significantly different from the surface fantasy condition (42% success), $\chi^2(1, N = 46) = 0.09, p = .76$, Cohen's $w = 0.04$, odds ratio = 1.21, or the fantasy setting condition (56% success), $\chi^2(1, N = 47) = 0.38, p = .54$, Cohen's $w = 0.09$, odds ratio = 1.47.

Discussion

In Study 2b, children read a modified version of the deep fantasy story where the impossible events occurred after the problem and solution. As predicted, the positive effect of the impossible events on transfer was not observed when using this reordered story; transfer from the reordered story was lower than the story where impossible events occurred first and was no different than stories that contained no impossible events. This, combined with the results of Study 2a, supports the interpretation that the effect seen in Study 1 is due to some type of priming, whereby exposure to the impossible events induces different processing of the subsequent story events. However, these two exploratory studies were based on small samples and post hoc procedural decisions. Although they shed some light on possible explanations for our unexpected finding, more research is needed to fully understand this result that impossible events boost children's learning.

General discussion

The studies presented here are inconsistent with prior studies showing that fantasy interferes with children's learning from stories; transfer from our fantasy setting condition (a mostly realistic story) and surface fantasy condition was no different than that from a completely realistic story. In contrast, we saw the *most* transfer in the deep fantasy condition, which contained superficial dissimilarity from reality as well as physically impossible events. This did not appear to be due simply to greater attention to or memory for the fantastical story.

This one study does not overturn the conclusion of the large body of work showing a fantasy disadvantage (see Hopkins & Weisberg, 2017, and Strouse, Nyhout, & Ganea, 2018, for reviews). However, it suggests that degrees of fantasy are not the same, and studies that collapse all fantasy together to ask whether fantasy or reality is better for learning may be missing important nuances of the learning process. Some, or even most, fantasy stories may have negative effects on learning, but there may be particular circumstances where fantasy can actually benefit children's learning.

In fact, this study joins a small but growing body of literature showing that fantasy occasionally leads to improved reasoning or learning. For example, Stahl and Feigenson (2015, 2017) demonstrated that surprising events that appear to violate physical laws facilitated learning in both infants and preschoolers. In another study, children were better able to solve logical syllogisms when they were told to imagine that they were on another planet where the premises were true (Dias & Harris, 1988, 1990). They were also more likely to reason correctly about the role of the mind in pretense when asked about fantastical entities rather than real ones (Lillard & Sobel, 1999; Sobel & Lillard, 2001). Weisberg et al. (2015) observed better learning of novel vocabulary words from fantastical storybooks than from realistic ones. Weisberg and Hopkins (2020) found in two studies that children learned some pieces of novel information better from fantastical stories than from realistic ones. However, not all these studies used the same types of fantastical content, and so it is still unclear exactly how and when fantasy may benefit learning. More studies that attempt to isolate fantasy variables are needed to help untangle the inconsistent pattern of results that exists in the current research literature. For example, the stimuli in the current studies used only a small number of impossible events embedded within an unrealistic context and presented separately from the educational material. We do not know how learning would be affected if more impossible events were included, if the impossible events were included in an otherwise realistic story, or if the educational information were embedded within an impossible event.

In these studies and in the current studies, fantasy may have a positive effect because it changes children's mindset toward the current activity (Weisberg et al., 2014). When solving syllogisms, the use of a make-believe frame cues children that they should not take the premises literally (Dias & Harris, 1990). Fantasy stories may benefit word learning because the fantasy content highlights for children that the story is going to contain unfamiliar content and thus induces deeper processing of the material (Weisberg et al., 2015). Furthermore, unexpected or impossible events may prompt children to seek additional evidence or generate explanations, leading to better learning outcomes (Legare, Gelman, & Wellman, 2010; Stahl & Feigenson, 2015). Richert and Schlesinger (2017) found

that fantastical videos where the fantasy content was integral to the educational content led to better learning than videos where the fantasy content was tangential; the integrated fantasy video was not significantly different from a realistic video. This again suggests that fantasy may change the way in which children process educational material, but only under certain conditions.

Future research should continue to probe this potential positive impact of fantasy as well as investigate the mechanisms by which fantasy may affect learning. If drawing attention to possibility is the key, as suggested by the current studies, other manipulations that highlight possibility should also have positive effects on learning even if the story itself contains no fantastical events. For example, children could engage in a possibility judgment task prior to reading the story. Alternatively, the adult reading the story could ask children questions about whether the story events could happen in real life.

The effects of fantasy on learning appear to be more complex than previously thought and may vary based on the type of fantasy, the type of information being taught, and the knowledge or skills of the children (Strouse et al., 2018). For example, children’s ability to distinguish fantasy from reality is likely to play an important role in their ability to learn from fantastical stories (Mares & Sivakumar, 2014; Richert & Schlesinger, 2017). The sample in the current study was relatively homogeneous (mostly White and middle to upper middle class); children from different backgrounds may be affected by fantasy content in different ways based on their experiences, prior knowledge, and/or cultural beliefs.

Furthermore, this study investigated only one type of learning—analogue transfer of a strategy for solving a physical problem. Fantasy may affect learning of different types of information in different ways. Learning of abstract or counterintuitive information, such as analogical reasoning or scientific principles, may be affected more than learning facts, such as properties of novel animals or vocabulary words. For example, similar to the studies presented here, Walker et al. (2015) used stories that contained surface-level fantasy along with a small number of impossible events, but they found that fantasy interfered with learning. However, they assessed a different type of learning—whether children would generalize a novel fact. Future research should investigate different combinations of story type and information type, along with assessing individual differences between children, to better understand how these variables interact to influence children’s learning.

These findings highlight the need for a more fine-grained consideration of the effect of fantasy on children’s learning. Small differences in the type of fantasy content in a story could have important implications for children’s ability to learn from the story. Although some types of fantasy may negatively affect learning, others could be benign or even beneficial. Future research should continue to probe the different effects that fantasy content has on children’s learning so that we can design educational materials for children that are engaging and entertaining as well as effective.

Acknowledgments

This research was supported by a National Science Foundation grant (1024293) to the second author. We thank Kelly Holmes for illustrating the storybooks, Jessica Taggart and Allyson Snyder for making comments on a previous draft, and the members of the Early Development Laboratory at the University of Virginia for assisting in data collection.

Appendix A

Story texts

Page	Realistic	Fantasy setting	Surface fantasy	Deep fantasy	Reordered (Study 2b)
1	This is a story about a little boy	This is a story about a little boy	This is a story about a little boy named Eddie. He lives on another planet where the grass is orange		

Appendix A (continued)

Page	Realistic	Fantasy setting	Surface fantasy	Deep fantasy	Reordered (Study 2b)
	named Eddie. He lives in Virginia. This book is about what he did last week. This is Eddie with his mom, dad, and dog Buddy. They live here in this house.	named Eddie. He lives on another planet that looks just like Earth. This book is about what he did last week. This is Eddie with his mom, dad, and dog Buddy. They live here in this house.	and the sky is green. This book is about what he did last week. This is Eddie with his mom, dad, and dog Buddy. They live here in this house.		
2	Eddie wakes up in the morning and is ready to start the day!				
3	Eddie walks down the stairs to the kitchen.			Eddie flies down the stairs to the kitchen.	Eddie loves to eat cereal and drink orange juice for breakfast every morning.
4	Eddie loves to eat cereal and drink orange juice for breakfast every morning.				<i>A dog is barking out in the yard, but it doesn't sound like Buddy! The neighbor's dog Max must be hungry. Maybe Eddie can share Buddy's food with Max. Uh-oh! It looks like the fence and bushes are in the way. Eddie can't reach Max's bowl!</i>
5	Later, Eddie's friends, Jimmy and Peter, come over to play.				<i>Look! If Eddie rolls up this newspaper, he can use it to feed Max through the fence. Eddie takes some of Buddy's food and rolls it down the newspaper tube into Max's bowl. Now Max won't be hungry anymore!</i>
6	Now it's time to leave the house and take Buddy for a walk. Eddie and Buddy go out the front door.			Now it's time to leave the house and take Buddy	Later, Eddie's friends, Jimmy and Peter, come

(continued on next page)

Appendix A (continued)

Page	Realistic	Fantasy setting	Surface fantasy	Deep fantasy	Reordered (Study 2b)
				for a walk. Eddie and Buddy walk through the wall to go outside.	over to play.
7	<i>A dog is barking out in the yard, but it doesn't sound like Buddy! The neighbor's dog Max must be hungry. Maybe Eddie can share Buddy's food with Max. Uh-oh! It looks like the fence and bushes are in the way. Eddie can't reach Max's bowl!</i>				Now it's time to leave the house and take Buddy for a walk. Eddie and Buddy walk through the wall to go outside.
8	<i>Look! If Eddie rolls up this newspaper, he can use it to feed Max through the fence. Eddie takes some of Buddy's food and rolls it down the newspaper tube into Max's bowl. Now Max won't be hungry anymore!</i>				On to the park! Eddie and Buddy love playing fetch together.
9					After the park, Eddie heads home for dinner. Mom made spaghetti and meatballs—Eddie's favorite!
10	After the park, Eddie heads home for dinner. Mom made spaghetti and meatballs—Eddie's favorite!				After dinner it's time for bed. Eddie flies up the stairs to his bedroom.
11					What a busy day!

Note. Bold text indicates the impossible events used in the deep fantasy condition (Study 1) and in the reordered condition (Study 2b). Italicized text indicates the novel problem and solution. This information was presented the same way in all stories. The story character was gender-matched to the participant (Eddie for boys and Janie for girls).

Appendix B

Memory questions

Reality judgment questions

Where does Eddie/Janie live? Is that a real place you could visit, or is it just in the story?
 Could a person really walk through the wall?
 Could a person really fly down the stairs?

Memory questions

What color shirt was Eddie/Janie wearing?
 Who does Eddie/Janie live with?

Appendix B (continued)

Reality judgment questions

- Does Eddie/Janie have any brothers or sisters?
 What is Eddie's/Janie's dog's name?
 What color is Eddie's/Janie's dog?
 What did Eddie/Janie have to drink with his/her breakfast?
 What are Eddie's/Janie's friends' names?
 What toys did Eddie/Janie and his/her friends play with?
 What was the name of the dog next door?
 What did Eddie/Janie and his/her dog do when they went to the park?
 What did Eddie's/Janie's mom make him/her for dinner?

References

- Bonus, J. A., & Mares, M.-L. (2019). Learned and remembered but rejected: Preschoolers' reality judgments and transfer from *Sesame Street*. *Communication Research*, 46(3), 375–400.
- Brabham, E., Boyd, P., & Edgington, W. D. (2000). Sorting it out: Elementary students' responses to fact and fiction in informational storybooks as read-alouds for science and social studies. *Reading Research and Instruction*, 39(4), 265–289.
- Brown, A. L., Kane, M. J., & Echols, C. H. (1986). Young children's mental models determine analogical transfer across problems with a common goal structure. *Cognitive Development*, 1(2), 103–121.
- Corriveau, K. H., Kim, A. L., Schwalen, C. E., & Harris, P. L. (2009). Abraham Lincoln and Harry Potter: Children's differentiation between historical and fantasy characters. *Cognition*, 113(2), 213–225.
- Daehler, M. W., & Chen, Z. (1993). Protagonist, theme, and goal object: Effects of surface features on analogical transfer. *Cognitive Development*, 8(2), 211–229.
- Dias, M. G., & Harris, P. L. (1988). The effect of make-believe play on deductive reasoning. *British Journal of Developmental Psychology*, 6(3), 207–221.
- Dias, M. G., & Harris, P. L. (1990). The influence of the imagination on reasoning by young children. *British Journal of Developmental Psychology*, 8(4), 305–318.
- Fisch, S. M. (2000). A capacity model of children's comprehension of educational content on television. *Media Psychology*, 2(1), 63–91.
- Ganea, P. A., Canfield, C. F., Simons-Ghafari, K., & Chou, T. (2014). Do cavies talk? The effect of anthropomorphic picture books on children's knowledge about animals. *Frontiers in Psychology*, 5. <https://doi.org/10.3389/fpsyg.2014.00283>.
- Gerrig, R. J., & Prentice, D. A. (1991). The representation of fictional information. *Psychological Science*, 2(5), 336–340.
- Holyoak, K. J., Junn, E. N., & Billman, D. O. (1984). Development of analogical problem-solving skill. *Child Development*, 55(6), 2042. <https://doi.org/10.2307/1129778>.
- Hopkins, E. J., & Weisberg, D. S. (2017). The youngest readers' dilemma: A review of children's learning from fictional sources. *Developmental Review*, 43, 48–70.
- Johnson, C. N., & Harris, P. L. (1994). Magic: Special but not excluded. *British Journal of Developmental Psychology*, 12(1), 35–51.
- Kotaman, H., & Balci, A. (2017). Impact of storybook type on kindergarteners' storybook comprehension. *Early Child Development and Care*, 187(11), 1771–1781.
- Legare, C. H., Gelman, S. A., & Wellman, H. M. (2010). Inconsistency with prior knowledge triggers children's causal explanatory reasoning. *Child Development*, 81(3), 929–944.
- Lehr, S. (1988). The child's developing sense of theme as a response to literature. *Reading Research Quarterly*, 23(3), 337. <https://doi.org/10.2307/748046>.
- Li, H., Boguszewski, K., & Lillard, A. S. (2015, March). The effect of anthropomorphic media on children's knowledge of trains. Poster presented at the biennial meeting of the Society for Research in Child Development, Philadelphia.
- Li, H., Eisen, S., & Lillard, A. S. (2019). Anthropomorphic media exposure and preschoolers' anthropomorphic thinking in China. *Journal of Children and Media*, 13(2), 149–162.
- Lillard, A. S., Drell, M. B., Richey, E. M., Boguszewski, K., & Smith, E. D. (2015). Further examination of the immediate impact of television on children's executive function. *Developmental Psychology*, 51(6), 792–805.
- Lillard, A. S., & Sobel, D. (1999). Lion kings or puppies: The influence of fantasy on children's understanding of pretense. *Developmental Science*, 2(1), 75–80.
- Mares, M.-L., & Sivakumar, G. (2014). "Vámonos means go, but that's made up for the show": Reality confusions and learning from educational TV. *Developmental Psychology*, 50(11), 2498–2511.
- Mayer, D. A. (1995). How can we best use children's literature in teaching science concepts?. *Science and Children*, 32, 16–19.
- Pinkham, A. M., Kaefer, T., & Neuman, S. B. (2014). Taxonomies support preschoolers' knowledge acquisition from storybooks. *Child Development Research*, 2014, 1–10.
- Potts, G. R., John, M. F. S., & Kirson, D. (1989). Incorporating new information into existing world knowledge. *Cognitive Psychology*, 21(3), 303–333.
- Richert, R. A., & Schlesinger, M. A. (2017). The role of fantasy–reality distinctions in preschoolers' learning from educational video. *Infant and Child Development*, 26(4), e2009. <https://doi.org/10.1002/icd.v26.410.1002/icd.2009>.

- Richert, R. A., Shawber, A. B., Hoffman, R. E., & Taylor, M. (2009). Learning from fantasy and real characters in preschool and kindergarten. *Journal of Cognition and Development, 10*(1-2), 41–66.
- Richert, R. A., & Smith, E. I. (2011). Preschoolers' quarantining of fantasy stories. *Child Development, 82*(4), 1106–1119.
- Rosengren, K. S., & Hickling, A. K. (1994). Seeing is believing: Children's explanations of commonplace, magical, and extraordinary transformations. *Child Development, 65*, 1605–1626.
- Shtulman, A., & Carey, S. (2007). Improbable or impossible? How children reason about the possibility of extraordinary events. *Child Development, 78*(3), 1015–1032.
- Sobel, D. M., & Lillard, A. S. (2001). The impact of fantasy and action on young children's understanding of pretence. *British Journal of Developmental Psychology, 19*, 85–98.
- Stahl, A. E., & Feigenson, L. (2015). Observing the unexpected enhances infants' learning and exploration. *Science, 348*(6230), 91–94.
- Stahl, A. E., & Feigenson, L. (2017). Expectancy violations promote learning in young children. *Cognition, 163*, 1–14.
- Strouse, G. A., Nyhout, A., & Ganea, P. A. (2018). The role of book features in young children's transfer of information from picture books to real-world contexts. *Frontiers in Psychology, 9*. <https://doi.org/10.3389/fpsyg.2018.00050>.
- Walker, C. M., Gopnik, A., & Ganea, P. A. (2015). Learning to learn from stories: Children's developing sensitivity to the causal structure of fictional worlds. *Child Development, 86*(1), 310–318.
- Weisberg, D. S., & Goodstein, J. (2009). What belongs in a fictional world?. *Journal of Cognition and Culture, 9*(1-2), 69–78.
- Weisberg, D. S., Hirsh-Pasek, K., Golinkoff, R. M., & McCandliss, B. D. (2014). Mise en place: Setting the stage for thought and action. *Trends in Cognitive Sciences, 18*(6), 276–278.
- Weisberg, D. S., & Hopkins, E. J. (2020). Preschoolers' extension and export of information from realistic and fantastical stories. *Infant and Child Development, 29*(4). <https://doi.org/10.1002/icd.v29.410.1002/icd.2182>.
- Weisberg, D. S., Ilgaz, H., Hirsh-Pasek, K., Golinkoff, R. M., Nicolopoulou, A., Dickinson, D. K., & Nicolopoulou, A. (2015). Shovels and swords: How realistic and fantastical themes affect children's word learning. *Cognitive Development, 35*, 1–14.
- Weisberg, D. S., & Sobel, D. M. (2012). Young children discriminate improbable from impossible events in fiction. *Cognitive Development, 27*(1), 90–98.
- Woolley, J. D., & Cox, V. (2007). Development of beliefs about storybook reality. *Developmental Science, 10*(5), 681–693.
- Woolley, J. D., & Van Reet, J. (2006). Effects of context on judgments concerning the reality status of novel entities. *Child Development, 77*(6), 1778–1793.