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RESEARCH ARTICLE

The role of fantasy–reality distinctions in preschoolers' learning from educational video

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Abstract

The current study examined if preschoolers' understanding of fantasy and reality are related to their learning from educational videos. Forty-nine 3- to 6-year-old children watched short clips of popular educational programs in which animated characters solved problems. Following video viewing, children attempted to solve real-world problems analogous to the problems in the videos and were asked to describe similarities between the video problems and the problems they solved in the lab. Additionally, children were tested for their understanding of which aspects of the clips and characters were realistic and possible and which were fantastical and impossible in the real world. Children were most likely to transfer solutions from clips that had moderate elements of fantasy or incorporated fantastical elements at moments that were relevant to solving the problem. Additionally, children's understanding of which elements of the clips were fantastical was related to their transfer. Findings are discussed in terms of their implications for the role of the fantasy understanding in children's learning from media.

Highlights

- Over the preschool years, children come to understand what aspects of animated programs are and are not possible in the real world.
- Preschoolers learn problem-solving skills from animated shows when they have a clear boundary between fantasy and reality.
- Engaging with moderate fantastical content in animated programs can support abstract thinking.

KEYWORDS

analogical transfer, cognitive development, educational media, fantasy–reality, learning, preschool

1 | INTRODUCTION

Nearly a half century of research examining the effectiveness of educational television (distinct from television programs without curriculum goals) has found young children learn educational content and develop school readiness skills from engagement with educational programming (Calvert, Strong, Jacobs, & Conger, 2007; Crawley, Anderson, Wilder, Williams, & Santomero, 1999; Hawkins, 1977; Rosen, Schwebel, & Singer, 1997; Schmidt et al., 2005). However, not all children learn from all television programs, and variability in children's cognitive response states may mediate the effects of media exposure on a given child (Valkenburg & Peter, 2013). In particular, Fisch's (2000) capacity model highlights the ways programs with narrative elements too discrepant from the educational content may tax children's working memory and interfere with learning, especially as more attention is devoted to processing the narrative, rather than the educational content. Considering children's educational programs often incorporate elements of fantasy (e.g., animals that talk), while also adhering to many realistic social conventions (e.g., attending school) and physical laws (e.g., humans cannot fly), one cognitive task young children face is to discern which elements of an educational program should be transferred outside of that program into children's knowledge base about the real world. The current study examines how children's fantasy–reality distinctions relate to learning of specific educational content from educational television programs.

Although access and exposure to interactive media continue to grow, educational television programs, whether viewed on actual televisions or streamed on portable devices in full or as short clips, are still a primary form of media exposure for preschool children (Common Sense Media, 2013; Kabali et al., 2015; Rideout, Saphir, Pai, & Rudd, 2014). Given the continued prevalence of video programming in young children's lives, research questions concerning the influence of these shows on preschoolers' developing problem-solving and abstract thinking abilities are relevant for providing children with high-quality early learning experiences (Common Sense Media, 2013; Gutnick, Robb, Takeuchi, & Kotler, 2010). For the purposes of the current study, educational media are screen, digital, print, or interactive media that has specific curriculum and learning goals; and the current study uses television programming, available on broadcast television, DVDs, digital download, and portable streaming devices, as the primary stimuli (Kirkorian, Wartella, & Anderson, 2008).

The bulk of research demonstrating the positive effects of educational television programming for preschoolers has focused on literacy and social skills, although some research has examined other higher-order cognitive skills (Barr & Hayne, 1999; Bryant & Anderson, 1983; Crawley et al., 1999; Linebarger & Walker, 2005; Rice, Huston, Truglio, & Wright, 1990; Salomon, 1983; Schlesinger, Flynn, & Richert, 2016; Whitehurst & Lonigan, 1998; Wright et al., 2001). For example, researchers found regular *Sesame Street* viewers had greater cognitive reasoning skills than their sporadic viewing counterparts (Bogatz & Ball, 1971; Comstock & Paik, 1991); and 2- to 5-year-old children who regularly watched a program that featured pseudo interactions (e.g., characters asking viewers to answer a question, pausing, and responding to the answer) had higher flexible thinking and problem-solving skills than non-viewers (Crawley et al., 1999). Overall, research has suggested some cognitive benefits to children's viewing of high-quality educational programming, and a growing body of research is considering how children process the fantastical content often embedded in educational media (e.g., Mares & Sivakumar, 2014).

2 | PROCESSING FANTASY CONTENT

Predictions about how the fantasy content of a program may relate to children's learning from that program are derived from Fisch's (2000) capacity model. The capacity model focuses on the limitations of working memory and cognitive processing as children attempt to comprehend three elements of a program: the narrative storyline, the educational content, and the distance between the two (Vossen, Piotrowski, & Valkenburg, 2014). According to this model, if the narrative and educational content of a program are too divergent, working memory will be taxed, which may interfere with learning. In contrast, learning the educational content can be promoted when the narratives and

content are well-synced (Fisch, 2000). The current study focused on whether fantasy elements in a program complement or interfere with the educational goals of that program.

The impact of fantasy on learning from television is especially relevant for early childhood as evidence suggests that the fantasy–reality distinction is actively constructed during the preschool years (Sharon & Woolley, 2004). Findings also suggest that the fantasy–reality distinctions required for processing on-screen content may be more complex than children's fantasy-reality distinctions of content in books and fairy tales. Regarding characters in educational programs, before age 5 about half of children will claim all on screen characters are pretending, even when doing realistic activities (Rosen et al., 1997). However, children as young as 4 can identify fantastical characters as distinct from real people (Skolnick & Bloom, 2006; Morison & Gardner, 1978). Additionally, although 4- to 5-year-olds may be unsure about the reality status of specific entities, children are more likely to attribute human-like properties (e.g., needs to sleep, gets older every year) to entities they believe to be real than entities they think are fantastical (Sharon & Woolley, 2004).

In regard to the events in a program narrative, 5-year-old children understand fictional programs may contain content that both can and cannot happen in the real world (Wright, Huston, Reitz, & Piemyat, 1994). Three-year-olds can differentiate between pretend and real actions (Flavell, Flavell, & Green, 1987), and 4-year-olds can discriminate impossible from possible events and claim impossible events cannot happen in the real world (e.g., Shtulman, 2009; Shtulman & Carey, 2007). By the age of 4, children will indicate a magical outcome (e.g., travelling back in time) is possible in a fairy tale but not in the real world (Subbotsky, 1994). This body of work suggests children maintain some degree of incredulity about fantastical contexts, and research on children's learning from fantasy storybooks provides reasons to consider how children's perceptions of fantasy in television may impact their learning from television programs.

Work on preschoolers' learning from storybooks has suggested that although young children may be more likely to learn new words when presented in a fantastical stories incorporating impossible events (e.g., dragons hatching eggs) than more realistic stories (Weisberg et al., 2015), children are less likely to generalize causal information from a fantastical story than a realistic story to the real world (Walker, Gopnik, & Ganea, 2015). In one study, 3- to 5-year-old children were read either a fantastical story containing violations of reality or a realistic story that did not include explicit violations of reality, in both versions a character engaged in a novel causal event (Walker et al., 2014). Children who read about the novel event in the realistic story were more likely to generalize the novel event to the real world than children who heard about the event in the context of a fantastical story (Walker et al., 2014).

Similar research has found that children may be more likely to analogically transfer from books they see as realistic rather than fantastical (Richert, Shawber, Hoffman, & Taylor, 2009; Richert & Smith, 2011). In these studies, 3- to 6-year-old children who heard stories about realistic characters or real people were more likely to solve problems using solutions modeled by those realistic characters than children who heard stories in which fantastical characters modeled the same problem-solving solutions (Richert et al., 2009; Richert & Smith, 2011). Richert and Smith (2011) identified this phenomenon as quarantining; when children recognize \salient differences between fantastical and realistic contexts, they may believe information presented in fantastical contexts is irrelevant to realistic contexts, and therefore, they do not apply information presented in fantastical contexts to the real world.

A set of recent studies have provided evidence that this type of quarantining may be evident in children's learning from video. Mares and Sivakumar (2014) found that developments of word comprehension in 3- to 5-year-olds were related to an increased perception that the words presented on screen were real, and not "just pretend." More specifically, 4- to 5-year-old children who perceived new foreign words as real were more likely to learn the meaning of those words. Similarly, Bonus and Mares (2015) examined if 3- to 5-year-old children remembered a cultural fact (what happens at a fiesta) that was presented in a *Sesame Street* clip related to beliefs about fantasy. Older children were more likely to transfer (to planning a new fiesta) if they remembered the initial content as real rather than fantastical (Bonus & Mares, 2015).

These findings suggest that, within the domains of cultural or word learning, when children perceive educational content as real, they are more likely learn and transfer that content by the age of 5 than the content they believe is pretend. However, much educational content is embedded in contexts that vary in the extent to which they are fantastical; and these fantasy elements can interfere with learning. Mares, Sivakumar, and Stephenson (2015) found that a barrier to effects of viewing diversity in programs on children's racial/ethnic attitudes was children's lack of

comprehension of the connection between animated depictions of ethnicity, in programs such as *Dora the Explorer*, and people in the real world. In other words, children did not demonstrate more positive racial/ethnic attitudes because they did not believe the fantastical, animated characters as relatable to their own lives.

One proposed explanation for quarantining is that children who have a clearly-defined distinction between fantasy and reality may be more likely than children with a fuzzier boundary to transfer from fantasy (Richert & Smith, 2011). Richert and Smith (2011) speculated children who are more sensitive to the boundaries between realistic and fantastical contexts are more likely to quarantine information from fantastical contexts to reality, because of their increased awareness of the differences between the contexts. The current study measures (a) children's awareness of the boundaries between fantasy and reality, or children's beliefs that realistic events and character traits and fantastical events and interactions with characters could happen in the real world, and (b) if children's perceptions of realism and fantasy relate to learning from contexts that contain a mix of fantastical and realistic elements.

3 | LEARNING AND TRANSFER

The current study examines young children's learning of program content through direct memory questions, analogical transfer of show content to new contexts, and recognizing analogical similarities between contexts. Analogical transfer is the ability to apply relevant information or concepts from one context to a relationally similar context (Holyoak, Junn, & Billman, 1984). Research has demonstrated children's abilities to transfer on-screen content into their understanding of the world, such as physical laws, associative properties, or problem-solving skills (Brown & Kane, 1988; Meringoff, 1980; Schlesinger et al., 2016). There are certain contextual factors that are related to high rates of transfer, such as short and simple narratives (Goswami, 2001; Holyoak et al., 1984; Singer-Freeman, 2005; Tunteler & Resing, 2002), and familiarity of or relationships with characters in the initial context (Lauricella, Gola, & Calvert, 2011). Because analogical transfer involves (a) recall or memory of the initial problem, (b) recognition of the relations between the initial and new contexts, and (c) transfer of the information from the initial to the new contexts, there are individual child factors related to successful analogical transfer of information from media contexts to the world outside of the digital screen, including memory of the initial situations and recognizing analogical similarities between contexts (Brown, Kane, & Echols, 1986; Goswami, 2001; Holyoak et al., 1984; Kim & Choi, 2003; Schlesinger et al., 2016).

In regards to transferring a problem solution after seeing an on-screen character solving an analogous problem, children's productions of an analogical solution may not reflect the deepest level of learning. The physical enactment of the problem solution could reflect either "over imitation," in which preschoolers will imitate even unnecessary actions in a sequence (Kenward, 2012), or mimicry, in which children will copy an action sequence without knowing why (Tomasello, Kruger, & Ratner, 1993). In other words, some children may demonstrate transfer of solutions by imitating action sequences demonstrated on screen without understanding the functions of the sequences. Thus, in the current study, we explicitly tested whether children recognized the relational similarities between the initial and novel contexts, or children's abstract thinking about the relations between the familiar and novel problems.

Although much analogical transfer research has used storybooks or pictures as stimuli (e.g., Goswami, 2001; Holyoak et al., 1984; Singer-Freeman, 2005; Tunteler & Resing, 2002), there is evidence that preschoolers also transfer from screen media contexts to the real world. Flynn and Whiten (2008) found an increase between the ages of 3 and 5 in children's ability to imitate a complex action sequence after viewing the action on a television, and Crawley et al. (1999) found that 77% of 4-year-olds and 82% of 5-year-olds who viewed a full episode of *Blues Clues* multiple times demonstrated transfer of learning. Schlesinger et al. (2016) found that 55% of 4- to 6-year-old children transferred a problem solution from an on-screen character after a single viewing of a one-minute clip, and this transfer was related to children's beliefs that the character was a trustworthy source of information. Building on this prior research, the current study measured children's transfer of problem-solving solutions from popular television characters solving physical problems to analogically similar, but novel, real world problems. Because children's transfer from television programs that are animated and incorporate a combination of fantastical and realistic elements to real world problems are likely

impacted by children's fantasy–reality distinctions (Richert & Smith, 2011; Valkenburg & Peter, 2013), it is hypothesized that children with firmer boundaries between fantasy and reality are more likely to engage in analogical transfer from a video clip and to acknowledge the analogical connection between the elements in the clips and the real world.

4 | STUDY

In summary, evidence suggests that preschoolers recognize differences between fantasy and reality, and children's learning from fantastical contexts is constrained as children are developing their abilities to distinguish between fantasy and reality. Based on the capacity model (Fisch, 2000), the beneficial or interference effects of fantasy could depend on either (a) the overall level of fantasy in a program or (b) how relevant the fantastical element is to the educational content. In the current study, we hypothesize that the extent of fantasy content in a television clip as well as relevance to the problem solving in the clip will be related to children's transfer. We test this hypothesis by having children watch three clips: fantasy-low (clip is animated, but everything else is realistic), fantasy-irrelevant (clip is animated, and incorporates other fantastical elements, but the fantasy elements are not directly related to solving the problem), and fantasy-relevant (clip is animated, and incorporates fantastical elements, some fantastical elements are directly related to solving the problem, although the actual solution is realistic and possible).

Additionally, we hypothesize children's learning and transfer will be related to their fantasy–reality boundaries. In the current study, measures of children's belief about realistic elements of characters were derived from Sharon and Woolley's (2004) study in which children attributed human-like attributes to some fantastical entities. Measures of children's belief about the fantastical nature of characters were derived from Bond and Calvert (2014) and Schlesinger et al.'s (2016) measures of social realism, which indicate if children believe they can interact with characters outside of the television in the real world. Measures of event possibility/impossibility were video-specific, but were based on Shtulman's (2009) study of children's judgments of impossible and improbable events.

Using these measures to create realism understanding and fantasy understanding scores, we specifically hypothesize that children who are more likely to believe realistic elements are possible and fantastical elements are impossible will be more likely to demonstrate analogical transfer of video content to the real world. Supporting this hypothesis, research examining differences in children's learning from informants who learn other people's thoughts through extraordinary communication (e.g., mind reading) or ordinary communication (e.g., verbally asking) indicated fantasy–reality distinctions were related to learning (Kim & Harris, 2014). Children who had greater differentiation between extraordinary and ordinary abilities were also more likely to learn from the extraordinary informant (Kim & Harris, 2014).

5 | PARTICIPANTS

Participants in this study were 49 children (51% female) who ranged in age from 3 years and 9 months to 6 years and 11 months (M = 5.296, SD = 0.864). Participants were divided into 1 of 2 age groups: 4- to 5.5-year-olds (n = 27, range = 3.76 to 5.39; 51.9% female) and 5.5- to 7-year-olds (n = 22, range = 5.48 to 6.94; 50% female). The sample was ethnically-diverse: 28.6% Hispanic-American, 18.4% Anglo-American, 6.1% African-American, 2.0% Asian-American, and 44.9% Multi-ethnic. Of those identifying multiple ethnicities, 20.4% identifies as both Hispanic-American and Anglo-American, 14.3% identified as both African-American and Anglo-American, and remaining participants identified as African-American/Asian-American (n = 2), Hispanic-American/African-American (n = 1), African-American/Hispanic-American/Native American (n = 1), and Hispanic-American/African-American/Asian-American (n = 2). Participants were recruited from a community sample in Southern California, and the primary language of all participants was English. Parents were compensated $20 for bringing their child to an on-campus research lab, and children received a small toy after participation.

6 | MATERIALS

6.1 | Video stimuli

Three 2-minute video clips were viewed by participants, each featured a different character. Videos were edited versions of professionally-produced educational television programs that were available for purchase and viewing on national television. Each clip explained how to solve a different physical problem, each of which falls in the range of science, technology, engineering, and mathematics (STEM) education and abstract thinking skills promoted in early childhood education standards (California Department of Education, 2013). All videos were animated and included formal features (e.g., quick cuts between scenes).

6.1.1 | Fantasy-low [Ramp clip]

The Ramp clip featured an animated boy (who likes to learn about science and problem solving) trying to get his giant stuffed animal on his bed; his solution was to push his stuffed animal up a ramp onto his bed (ramp solution). Aside from atypical hair and skin colors, there were no explicit violations of realistic physical laws, and there were no anthropomorphized animals.

6.1.2 | Fantasy-irrelevant [Pulling clip]

The Pulling clip featured an animated boy (who speaks Spanish and likes to help rescue animals) trying to rescue birds that fell into the ocean; his solution was to use a life preserver to pull the bird onto his boat (pulling solution). There were no explicit violations of realistic physical laws; however, anthropomorphized animals (puffins) were speaking, singing, and dancing. As such, the fantastical elements of the clip occurred in moments of the clip that were irrelevant to the problem solution itself.

6.1.3 | Fantasy-relevant [Tape clip]

[1]The Tape clip featured an animated girl (who speaks Spanish and likes to help other people and animals) trying to cross a windy river with a sailboat with holes in the sail; her solution was to use tape to patch the holes, and the wind pushed the sailboat to the other side of the river (tape solution). There were no explicit violations of realistic physical laws; however, anthropomorphized animals were speaking, piloting a boat, and used opposable thumbs. Additionally, an anthropomorphized animal (a purple squirrel) actually enacted the solution, while the animated girl offered tape as the solution and counted along with the anthropomorphized animal. As such, the fantastical elements of the clip occurred in moments of the clip that were relevant to the problem solution itself, although the solution conformed with real-world physical laws.

6.2 | Transfer tasks

Children were asked to solve four novel problems, each one analogically similar to and directly following the respective clips.

6.2.1 | Ramp task

In the ramp task, participants were presented with a large stability ball, and asked to find an easy way to get the ball on top of a table in the testing room. They were presented with a plastic four-foot long storage bin lid, a large cardboard box slightly shorter than the table, an empty envelope box lid, an 11 × 17-inch piece of white paper, a triangular piece of chalk analogous to a piece of cake, and a child-sized oven mitt meant for a play kitchen. The analogical solution was to lay the plastic lid again the table like a ramp, and roll the ball up the ramp (ramp solution).

[1]This was a 2-min clip of a full-length episode used in Calvert et al., 2007.

6.2.2 | Pulling task

In the pulling task, participants sat on a couch and were shown a doll-sized bicycle on a floor, and were asked to find a way to get the bicycle on the couch without leaving the couch. They were presented with a miniature life preserver created from a 3-inch plastic flying disc with the center cut out attached to a 24-inch string, a 4-inch paper flag that can be unraveled to 36 inches of thin paper or stretched upwards to be an approximately 18-inch long hollow pipe, a 60-inch string with a magnet glued to the end, a children's style golf club, and the doll that came with the bicycle attached to a 24-inch long string. The analogical solution was to toss the miniature life preserver onto the bicycle handles and pull the bicycle onto the couch (pulling solution).

6.2.3 | Tape task

In the tape task, participants were shown an active fan blowing on a parachute with five holes, attached to a doll on a miniature skateboard and told some item in the scenario was broken, and asked to find a way to fix what was broken to move the doll across the floor using only the wind from the fan. They were presented with a roll of painter's tape, five small binder clips, five outlet covers (roughly the same size as the holes), five cardboard circles (roughly twice the size as the holes), an 8 × 11-inch piece of construction paper (roughly the size of the parachute), and a miniature flying disc. The analogical solution was to tape the holes in the parachute, and then, the fan moved the doll across the rug on the skateboard (tape solution).

6.3 | Measures

6.3.1 | Prior exposure

Because the clips were chosen from currently available children's programs, parents reported their children's exposure to the shows from which the clips were drawn in two ways. On a paper survey, parents indicated how often their child watched each of the shows (0 = *never* to 6 = *a couple of times a day*); these responses were averaged for a general prior exposure variable (3 items; Crohnbach's α = .752). Additionally, parents indicated whether or not their child had seen the specific episode of the shows used in this study (*yes*, *no*, *unsure*).

6.3.2 | Understanding video clip realism and fantasy

Children's judgments of whether events and character features in the video clips were possible in the real world were measured through 22 questions, drawn from prior research assessing children's beliefs about possible and impossible events (see Shtulman, 2009) and character reality status (Bond & Calvert, 2014; Schlesinger et al., 2016; Sharon & Woolley, 2004). Children indicated whether each event was possible in the real world or whether each trait was true of the character, and responses were coded as −1 (*no*) to 0 (*don't know*) to +1 (*yes*). The full list of questions is available in Appendix A. Eleven questions were about features of the clips (two event questions) and the characters (nine character questions, three for each character) that were realistic and therefore could be possible in the real world. Responses were averaged for a realism understanding variable (11 items, Crohnbach's α = .684). The other 11 questions were about features of the clips (two event questions) and the characters (nine character questions, three for each character) that were fantastical and therefore impossible in the real world. Responses were reverse coded and then averaged for a fantasy understanding variable (11 items, Crohnbach's α = .944).

6.3.3 | Solution possibility

For each type of solution presented in each clip, children were asked how certain they were that a person could perform that solution in the real world. Children were first asked if the solution could be done in the real world, and then indicated if they were really sure or a little sure for scores ranging from −2 (*not possible*, *really sure*) to +2 (*possible*, *really sure*) for the ramp, pulling, and tape solutions.

6.3.4 | Solution memory

For each clip, children were asked to describe how the character solved her or his respective problem; children were given a score of 1 if they correctly recalled how the character solved their problem (e.g., for the ramp video, children had to indicate the character used a ramp or a synonym as a solution to earn a point). As is common in research into analogical transfer, children who did not correctly remember the solution were reminded of the solution before being presented with the transfer tasks (Brown & Kane, 1988; Schlesinger et al., 2016).

6.3.5 | Analogical transfer

Transfer tasks are described above. Children were given a score of 1 if they solved the transfer task using the analogical solution. For example, to earn a point for the ramp transfer task, children had to (a) create a ramp using any item provided by the researcher, and (b) push the ball up the ramp. After each transfer task, children were provided the opportunity to make three analogical connections between different items and processes in the videos and their respective transfer tasks for each of the three videos video (Appendix B). In three direct questions, children were asked to indicate what items in the lab test problem corresponded with which items in the problem in the clips. For example, for the ramp task, children were asked, "What in this room is like the giant stuffed animal,… ramp,… and bed… from the video?" Children received one point for correctly identifying the item in the lab that was related to each element in the clip. The solution and connections scores were tallied for each clip for fantasy-low transfer, fantasy-irrelevant transfer, and fantasy-relevant transfer scores ranging from 0 to 4.

6.4 | Procedure

The study took place in a laboratory testing room arranged like a living room with a couch, comfortable chair, television, and two child-sized tables with matched chairs. Following parental and child assent processes, parents completed a demographic and media exposure survey as part of a larger study. Children participated in an interview about what kinds of activities they enjoy as a warm-up exercise; then, children were asked the solution and event possibility questions, watched the animated video clips, answered the memory questions, and engaged in the transfer tasks.

Children watched all clips in one of four counterbalanced orders. Although children were allowed to comment to the experimenter during the video clips, experimenters refrained from responding or encouraging irrelevant conversation. Children were not discouraged from interacting with the video clips (e.g., making bird calls when instructed by a character), but the experimenter did not join or model the behavior like a caregiver may. Immediately following each video clip, participants' video event memory was tested (solution memory). For children who answered incorrectly or forgot video events, they were reminded of the video events as a form of scaffolding to increase their likelihood of transfer (Richert & Smith, 2011; Schlesinger et al., 2016). For example, if children did not describe the use of a ramp to solve the ramp problem they were told: "he used a ramp to push his stuffed animal up on his bed."

Following the solution memory questions, participants were asked to solve the analogical transfer problems for each video. Children who applied the same solution to the analogical transfer problems as the characters used in the videos correctly solved the analogical transfer problems (analogical transfer). A pilot study with 21 children (52.4% female; age M = 5.41, SD = 0.79) determined that children in this age group did not provide the correct transfer solutions spontaneously to these problems without exposure to the video clips, which is consistent with previous analogical transfer research acknowledging children are unlikely to spontaneously produce expected solutions without exposure to the initial problems (Richert & Smith, 2011; Schlesinger et al., 2016). Following each analogical transfer task, children were asked to explicitly note analogical similarities of three specific analogical elements of the task (analogical connections) with their respective video counterparts. After viewing all three videos and completing the memory, analogical transfer, and analogical connection tasks, children answered the character trait questions.

7 | RESULTS

Preliminary analyses examined sex differences, prior exposure, and children's judgments of solution possibility. Following these analyses, we examined if children's solution memory and transfer varied by the fantasy level of the clips and then examined if transfer was related to children's reality and fantasy understanding.

8 | PRELIMINARY ANALYSES: SEX DIFFERENCES, PRIOR EXPOSURE, AND SOLUTION POSSIBILITY

All variables were examined for sex differences. There were no sex differences in the outcome variables; therefore, sex was not considered further in analyses. The averaged prior exposure score indicated that children had seen the shows from which the clips were drawn on average once or twice a month (M = 1.528, SD = 1.067). In terms of the specific episodes from which the clips were drawn, parents reported that 10.2% (42.9% no, 42.9% unsure) of the children had seen the fantasy-low (ramp) clip before, 30.6% (16.3% no, 46.9% unsure) had seen the fantasy-irrelevant (pull) clip before, and 6.1% (59.2% no, 28.6% unsure) had seen the fantasy-relevant (tape) clip before.

Children were relatively certain the ramp (M = 0.449, SD = 0.679), pulling (M = 0.592, SD = 0.610), and tape (M = 0.551, SD = 0.614) solutions were possible in the real world. Paired-sample t-tests indicate no significant differences in possibility judgments of the three solutions prior to clip viewing, indicating children had roughly equivalent views that the solutions that would be presented in the videos were possible in the real world. The primary analyses are reported below, however, of note is that solution possibility judgments were not significantly correlated with related transfer scores: fantasy-low (ramp), r = .108, p > .25; fantasy-irrelevant (pull), r = −.011, p > .25; fantasy-relevant (tape), r = −.024, p > .25. Thus, solution possibility was not included in further analyses.

9 | FANTASY–REALITY UNDERSTANDING, MEMORY, AND TRANSFER

In terms of solution memory, 46.9% of children correctly remembered the fantasy-low (ramp) solution, 49.0% of children correctly remembered the fantasy-irrelevant (pull) solution, and 73.5% of children correctly remembered the fantasy-relevant (tape) solution. McNemar's test analyses indicated children were significantly more likely to remember the fantasy-relevant solution than the fantasy-low, p = .001, or fantasy-irrelevant, p = .004, solutions, which were not significantly different from each other. Independent sample t-tests indicated children who remembered the relevant solution from the clip did not have higher transfer scores than children who did not remember the solution: fantasy-low (ramp), $t(47)$ = 1.022, p > .25, Cohen's d = .291; fantasy-irrelevant (pull), $t(47)$ = .675, p > .25, Cohen's d = .193; fantasy-relevant (tape), $t(47)$ = .302, p > .25, Cohen's d = .102. This is not unexpected and is consistent with prior research on transfer from books and video (Richert & Smith, 2011; Schlesinger et al., 2016; Bonus & Mares, 2015; Mares & Sivakumar, 2014), given that children were reminded of the solution to the problem that the character used before they were tested for transfer.

Additionally, solution memory was not significantly related to children's fantasy understanding (fantasy-low [ramp], $t(47)$ = .290 p > .25, Cohen's d = .083; fantasy-irrelevant [pull], $t[47]$ = .686, p > .25, Cohen's d = .196; fantasy-relevant [tape], $t[47]$ = 1.321, p = .193, Cohen's d = .467) or realism understanding (fantasy-low [ramp], $t(47)$ = 1.418, p = .163, Cohen's d = .403; fantasy-irrelevant [pull], $t[47]$ = 1.499, p = .141, Cohen's d = .428; fantasy-relevant [tape], $t[47]$ = .489, p > .25, Cohen's d = .175). Thus, unrelated to transfer or fantasy-reality understanding, solution memory was not included in the predictive analyses reported below.

The means and standard deviations of all variables are presented in Table 1. Paired sample t-tests confirmed that children were significantly less likely to correctly claim that fantastical video clip features were impossible in the real world than to claim that realistic video clip features were possible in the real world, $t(48)$ = 4.930, p < .001, Cohen's d = 1.901. Additionally, independent sample t-tests indicated 4- to 5.5-year-olds (M = −0.057, SD = 0.747) had

TABLE 1 Correlations (and descriptive statistics) with fantasy–reality understanding and analogical transfer

	PE	RU	FU	F-L-T	F-I-T	F-R-T
Prior exposure	–					
Realism understanding	−.126	–				
Fantasy understanding	−.293*	.039	–			
Fantasy-low transfer	−.127	.173	.348*	–		
Fantasy-irrelevant transfer	−.058	.223	.138	.612**	–	
Fantasy relevant transfer	−.170	.159	.356*	.484**	.417**	–
Mean	1.528	.746	.199	1.918	1.184	2.146
SD	1.067	.298	.719	1.367	1.014	1.367

Note. PE = prior exposure; RU = realism understanding; FU = fantasy understanding; F-L-T = fantasy-low transfer; F-I-T = fantasy-irrelevant transfer; F-R-T = fantasy-relevant transfer.

[a]$p < .10$,

*$p < .05$,

**$p < .01$,

***$p < .001$

significantly higher fantasy understanding scores than 5.5- to 7-year-olds (M = 0.492, SD = 0.564), $t(47) = 2.848$, $p = .007$, Cohen's d = 0.829; older children were more likely to correctly recognize that impossible events could not happen in the real world. In contrast, there was no age difference in children's realism understanding; 4- to 5.4-year-olds (M = 0.724, SD = 0.293) were as likely as 5.5- to 7-year-olds (M = 0.744, SD = 0.333) to claim the realistic aspects of the clips and characters were real.

Pearson's bivariate correlations are also reported in Table 1. Although prior exposure was not correlated with children's realism understanding (Table 1), prior exposure was significantly negatively correlated with fantasy understanding, $r = -.293$, $p = .043$, such that children with greater prior exposure were more likely to incorrectly claim that fantastical events on the clips were possible in the real world. This finding will be considered in the discussion; however, as prior exposure was uncorrelated with the learning variables, it was not included in further analyses.

In regard to the relation between transfer and fantasy–reality distinctions, transfer was unrelated to children's realism understanding for any of the clips. In contrast, transfer was significantly positively correlated with fantasy understanding for transfer from the fantasy-low, r = 348, $p = .014$, and fantasy-relevant, $r = .356$, $p = .013$, clips.

Figure 1 presents mean transfer scores for each clip by age group. To examine the role of clip fantasy, age, and fantasy-reality understanding in children's transfer, we ran a 3 × 2 repeated measures analysis of covariance on children's transfer scores, with clip fantasy (fantasy-low vs. fantasy-irrelevant vs. fantasy-relevant) as the within-subject variable, age group (4–5.5 vs. 5.5–7) as the between-subjects variable, and reality understanding and fantasy understanding as the covariates. Repeated Planned Contrasts tested if the Fantasy-Low and Fantasy-Irrelevant clips differed from the Fantasy-Relevant clip.

There was a main effect of age group, $F(1, 44) = 5.403$, $p = .025$, $\eta_p^2 = .109$, such that 5.5- to 7-year-olds (M = 2.087, SD = 0.203) had higher transfer scores than 4- to 5.4-year-olds (M = 1.438, SE = 0.178). There were no significant interactions between age group and other variables.

There was a trend toward a main effect of clip fantasy, $F(2,88) = 2.733$, $p = .071$, $\eta_p^2 = .058$. The repeated planned contrasts indicated a significant univariate effect for the difference between then fantasy-irrelevant and fantasy-relevant clips, $F(1,44) = 5.155$, $p = .028$, $\eta_p^2 = .105$, but not between the fantasy-low and fantasy-relevant clips, $F(1,44) = .433$, $p > .25$, $\eta_p^2 = .010$. As Figure 1 indicates, transfer was lowest for the fantasy-irrelevant clip, and children were equally likely to transfer from the fantasy-low and fantasy-relevant clips.

There were no main effects of realism understanding or fantasy understanding; however, there was a significant interaction between clip fantasy level and fantasy understanding, $F(2,88) = 3.130$, $p = .049$, $\eta_p^2 = .066$. Again, the

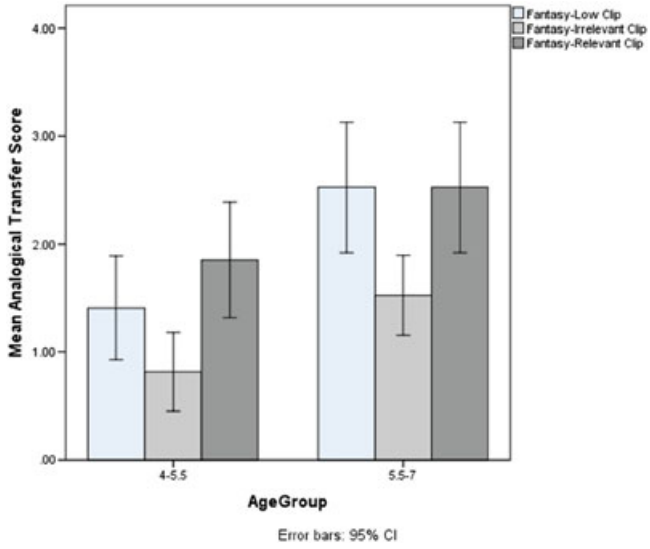

FIGURE 1 Mean transfer score by clip type and age group

repeated planned contrasts indicated a significant univariate effect of this interaction for the difference between the fantasy-irrelevant and fantasy-relevant clips, $F(1,44) = 5.722$, $p = .021$, $\eta_p^2 = .115$, but not between the fantasy-low and fantasy-relevant clips, $F(1,44) = .319$, $p > .25$, $\eta_p^2 = .007$. This interaction is evident in the differential correlations between fantasy understanding and transfer for each clip (Table 1). In particular, fantasy understanding was significantly correlated with transfer from the fantasy-low and fantasy-relevant clips, but not from the fantasy-irrelevant clip. More specifically, children with a better understanding that the fantastical elements of a clip cannot happen in the real world were more likely to transfer from clips that were low in fantasy or introduced fantastical elements in a way that facilitated problem solving, suggesting fantasy understanding facilitates learning from the fantasy-low and fantasy-relevant clips, but not from thefantasy-irrelevant clips.

10 | DISCUSSION

The current study examined if preschoolers' developing abilities to recognize the aspects of educational videos that are fantastical and realistic relate to analogical transfer of a problem solution presented in a video clip to a real-world problem-solving context. The study also examined how fantasy-reality understanding relates differentially to how fantasy is incorporated into educational programs. Consistent with past research, the preschoolers in the current study had a fairly clear understanding of what is and is not possible in the real world (Shtulman, 2009) and did not overwhelming claim that what they saw on the television programs was possible in the real world (Flavell, Flavell, Green, & Korfmacher, 1990; Wright et al., 1994).

There were some age differences in this understanding, however. In particular, 4- to 7-year-olds knew that the realistic aspects of the clips could happen in the real world. In contrast, 4- to 5.5-year-olds were less clear in their understanding that fantastical aspects of the clips could not happen in the real world. Additionally, older children had higher transfer scores than younger children. A variety of factors related to age likely contribute to children's increased transfer from and abstract processing of television (e.g., inhibitory control, memory, and socialization to learn from educational programs); however, in the current study, children's transfer was related to clip fantasy and their own fantasy understanding, even after accounting for the effects of age. Thus, the discussion focuses on age-related developments in fantasy understanding and the processing of fantasy content.

Prior research has suggested that children's belief about the reality status of information presented in a video predicts subsequent transfer of that information into a new context (Bonus & Mares, 2015; Mares & Sivakumar, 2014). In the current study, children generally believed the solution was possible in the real world, but their beliefs about solution possibility were unrelated to memory or transfer of the problem solutions demonstrated in the clips. Thus, one conclusion may be that beliefs about the realistic possibility of program content only influence children's learning of language (Mares & Sivakumar, 2014) or cultural facts (Bonus & Mares, 2015), but not problem solving. However, the current study differed from prior studies in two key ways. First, we tested children's beliefs that the problem solution was possible in the real world before children were shown the clip stimuli; we did not test if children's beliefs about the solution possibility changed after watching the clips. Second, the actual solution in each video was realistic and possible, even when fantasy elements were involved in the solution (i.e., an anthropomorphic squirrel solved the problem but used a possible, realistic solution).

The importance of children's initial encoding of information as realistic/relevant is further illuminated by fact that children were least likely to transfer from the clip in which fantasy was incorporated in a way that was irrelevant to solving the problem and that transfer from the fantasy-irrelevant clip also was unrelated to fantasy understanding. There are three, likely interacting, processes that may explain this pattern. First, and related to the discussion above, this decrease would be predicted by findings suggesting preschoolers need assistance in understanding the relevance of televised content in order to transfer their learning into real-world situations (Mares et al., 2015). It is possible that children's belief about solution possibility may have decreased for the solution in the fantasy-irrelevant clip after viewing that clip. Thus, future research could test children's views of solution possibility after those solutions have been presented in contexts that vary by fantasy level. Second, this decrease in transfer would be predicted by child capacity (Fisch, 2000) and researchers who argue that cognitive overload can result from shows that are very discrepant from children's real life experiences (Lillard & Peterson, 2011). Thus, future studies could examine changes in inhibitory control or working memory following the viewing of this kind of fantasy-irrelevant clip.

Third, this decrease in transfer would be predicted by the quarantining hypothesis that children may quarantine problem solutions learned in a fantastical context until they have a strongly established fantasy–reality distinction (Richert & Smith, 2011). The lack of relation between fantasy understanding and transfer from the fantasy-irrelevant clip in the current study could suggest children's fantasy understanding was not sufficient to facilitate transfer from this particular clip. As will be discussed below, fantasy understanding did facilitate transfer from some video clips; but these findings in particular point to the need for researchers to examine how varying degrees and domains of children's fantasy–reality distinctions may relate differentially to learning and transfer.

In contrast to the limited transfer from the fantasy-irrelevant clip, transfer was higher and equivalent for the fantasy-low and fantasy-relevant clips. Transfer also was related to fantasy understanding for both clips. Better performance on these clips is consistent with the capacity model (Fisch, 2000; Vossen et al., 2014), such that fantasy elements can increase attention to and learning of educational content when that content is moderately discrepant from children's real world experiences (as in the fantasy-low clip) or is relevant to the presentation of the educational content (as in the fantasy-relevant clip).

Additionally, this pattern of relations suggests that children's processing of the reality status of video content promoted children's learning of the intended lesson in the clips. According to the moderate-discrepancy hypothesis, cognitive overload can result from shows that are very discrepant from children's real life experiences (Lillard & Peterson, 2011), but shows that are moderately-discrepant from reality can promote cognitive engagement. According to this hypothesis, and similar to Vygotsky's (1978) zone of proximal development, children's active cognitive participation while viewing moderately-discrepant fantastical video clips (like the ones used in the current study) could promote abstract and divergent thinking about the televised content. Recent research on the positive relation between fantasy–reality distinctions and learning from pretense supports this interpretation (Hopkins, 2015).

Thus, one implication of these findings is that children's processing of the reality and fantasy status of program content may have prompted abstract thinking beyond the effects of age and experience. These findings also are in line with past research suggesting that children can perform better on cognitive tasks when those tasks are framed within

a fantasy context (for review, see Harris, 2000). In regard to transfer of learning, children's engagement in fantastical contexts often has the added benefit of supporting abstract thinking (e.g., Dias & Harris, 1990). This is consistent with Vygotsky's (1978) characterization of the imagination as a form of abstract thought that scaffolds children to independently develop their perceptions of the real world. Not only are young children provided with many fantasy contexts as part of their education, but there are known benefits to presenting educational content in a fantasy context (Sutherland & Friedman, 2012; Weisberg et al., 2015). Therefore, it is important that future research continue to examine the factors (such as fantasy–reality distinctions) that support children's learning from fantasy, particularly in those instances in which uncertainty about the fantasy–reality distinction may lead to quarantining (Richert & Smith, 2011).

An additional finding was that children were most likely to remember the solution from the fantasy-relevant clip, but memory was unrelated to transfer. In the current study, children were reminded of the solution before completing the transfer task, so this lack of relation between memory and transfer was not unexpected. However, these findings add to a growing body of research noting inconsistent findings on the relation of reality understanding to memory and the relation of memory to transfer (Bonus & Mares, 2015; Mares & Sivakumar, 2014). Future studies should continue to examine how fantasy content and fantasy–reality understanding relate to both memory and transfer, as well as how these aspects of learning relate to each other.

Another, unpredicted, finding was that children's fantasy understanding was negatively related to their prior exposure to the programs from which the clips were pulled. In other words, children who had seen the shows more frequently were more likely to believe the fantastical elements of the clips were possible in the real world. Mares and Sivakumar (2014) also found that prior exposure positively predicted children's beliefs that fantastical characters were real. Thus, researchers should continue to examine what factors help children understand which aspects of a show or program (or even interactive games) are not expected to be transferred to their knowledge base about the real world and which aspects are.

10.1 | Limitations

We note several limitations to this study that should be considered in interpreting the findings. We particularly point to issues related to our video stimuli and sample size, as well as the potential of generalization to learning of engineering concepts. The methodology involved using available episodes from a variety of different television programs to be ecologically consistent with the types of television programs children are already watching. Although the video clips from the shows tested levels of fantasy, the clips also had unique features, such as variability in character genders and ethnicities and different types of social or pseudo-interactions with the audience. Studies suggesting that children's perceptions of character expertise influence transfer from those characters (Schlesinger et al., 2016) and that children's interactions with characters promotes identification with and far transfer from those characters (Calvert et al., 2007) indicate future research should continue to examine how children process, interact, and transfer from educational video.

Additionally, this study had relatively small sample size, which raises concerns about generalizability. Power analyses indicated this sample size was sufficient to detect moderate effect sizes, and the sample itself was diverse and in an age range appropriate for the episode clips and tasks. However, the smaller sample limited the ability to test for individual or group-level factors that may have been related to children's fantasy beliefs or analogical reasoning. Thus, research should continue to examine children's differential susceptibility to effects of these kinds of media (Valkenburg & Peter, 2013).

A third limitation is related to the transfer tasks used to assess children's learning of problem-solving techniques. The analogical transfer tasks were based on content that were intended by the program creators to teach engineering-related problem-solving skills. Although STEM concepts are integrated into early childhood curriculum, core standards are vague about the topics and approaches to teaching young children STEM concepts (California Department of Education, 2013). Thus, the types of problem-solving solutions displayed in the clips in the current study may vary

from those taught in actual classrooms or in children's day-to-day experiences. Therefore, future research may consider the extent to which the STEM concepts presented in educational media are supplemental to or divergent from the STEM curriculum in preschool classrooms (California Department of Education, 2013).

10.2 | Conclusion

As a whole, the findings suggest a better understanding that the fantastical elements of programs cannot happen in the real world facilitates transfer from programs that contain moderate amounts of fantasy (e.g., animated children who do mostly realistic things) or that utilize fantastical elements in ways that are synched with the intended educational content. In contrast, fantasy understanding may not facilitate transfer from programs in which the fantasy content is irrelevant to the information (a problem solution in this case) that needs to be transferred. As such, these findings support the capacity model, which suggests processing irrelevant fantasy content may tax children's working memory and provide no benefits to abstract thinking outside of the context of the program itself. In contrast, processing fantasy content in programming that is moderate (but low) in fantasy content or incorporates fantasy in ways that are relevant to the educational goals of the program may promote abstract processing of content and thereby facilitate transfer of learning outside of the program itself.

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APPENDIX A

Items for understanding video clip realism and fantasy scores.

A.1 Realism understanding

Possible events

Can teachers talk to children?

Can people learn about leaves?

Character reality status

Does the character eat food?

Does the character sleep?

Does the character get older every year?

A.2 Fantasy understanding (11 items, *alpha* = .944)

Impossible events

Can animals talk like people?

Can animals sail a boat?

Character fantasy status

Can you see each character at the store?

Can the character go to your school?

Can each character play tag with you?

APPENDIX B

Items for Analogical Transfer Score

	Video	Transfer
Ramp	Problem: Character used a ramp to push his stuff animal onto his bed. Item 1: Stuffed animal Item 2: Ramp, inclined plane, wood board Item 3: Bed	Analogical Solution: Child uses a ramp to push a ball on a table. Connection 1: Ball Connection 2: Ramp: Plastic lid Connection 3: Table
Pull	Problem: Character used life preserver to pull puffins on a boat. Item 1: Puffins Item 2: Life preserver Item 3: Boat	Analogical Solution: Child uses mini life preserver toy to pull toy bicycle on a couch. Connection 1: Doll bicycle Connection 2: Miniature life preserver Connection 3: Couch
Tape	Problem: Character put tape over holes in sail so wind can blow a boat. Item 1: Sail Item 2: Sticky tape Item 3: Wind (natural)	Analogical solution: Child puts tape over holes in a parachute, so a fan can blow a skateboard. Connection 1: Parachute Connection 2: Sticky tape Connection 3: Wind (fan)